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Impact of Information and Communication Technologies (ICT) on Economic Growth During the Corona-Virus Pandemic

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Haifa Mefteh[*], Youssra Ben Romdhane[**]

Abstract

This article is an attempt to assess in real time the colossal impact of the coronavirus pandemic (COVID-19) on the health, economic and social sectors in MATE countries. This study reviews the literature on the negative impacts of epidemic uncertainty on economic activity.In fact, we used Pedroni's co-integration analysis to determine the determinants of economic growth over the 2001-2020 period.Moreover, empirical results show that the decline of economic growth in these countries was triggered by a combination of a number of deaths, rising unemployment rates and a decline of gross fixed capital formation and education spending.All these costs are due to the containment measures which imply a reduction in economic activity. More than that, we find that Information and Communication Technologyplays a driving role in economic growth with a two-way link between the Internet User and GDP. This document helps promote future research and technology development to provide better solutions to fight the COVID-19 pandemic and future pandemics and thereby save the economic activity.

Keywords: COVID-19; ICT; GDP; Macroeconomic Aggregates; Government Response.

JEL: F41, O11, I10, I12,

1. Introduction

The social situation in the Maghreb has been difficult for years due to the Tunisian and Egyptian revolution of 2011, the Moroccan Rif revolt throughout 2017 and the Algerian social movements in 2019,which affected the economic environment, (Ben Romdhane et al., 2019a; Ben Romdhane et al., 2020b; Ben Romdhane et al., 2019c; Ben Romdhane and Ben Amor, 2019; Ben RomdhaneLoukil et al., 2021; Kammoun et al., 2020a; Kammoun et al., 2020b; Loukil et al., 2019). Recently, these 4 countries have been devastated by the global covid-19 pandemic, which is among the most serious health crises in human history. In fact, the WHO(2020) showed that this health crisis has generated more than 211 million confirmed infected cases and 4.55 million deaths worldwide.This pandemic has significantly damaged the global economic based on

[*] Faculty of economics and management of Sfax, University of Sfax, Tunisia
[**] Faculty of economics and management of Sfax, University of Sfax, Tunisia

supply and demand shocks, particularly the emerging markets.With great concern, the world is preparing to deal with the economic and social impact of the COVID-19 pandemic by assessing the avenues and opportunities to reduce its impact. In this context, the International Monetary Fund (IMF) has lowered its growth projections for the global economy as the COVID-19 spreads rapidly. More specifically, the IMF noted that the GDP of Tunisia, Algeria, Morocco and Egypt recorded a decreaseby 4.4%; 6.5%; 4.7% and 3.6% respectivelyin 2011 as presented in figure 1, where we noticea significant decrease at the outbreak of the Arab Spring Revolution in 2011 and recently during the spread of the Corona virus. With the health crisis, the shutdown of the 2011 economy and the drastic fall in oil prices, this instability has further increased. As a result, inequality, poverty and unemployment in the medium and long term, especially in rural areas, have undermanned thesocial pact during this crisis, OECD (2020a).In response to this serious epidemic, governments around the world have rushed with emergency measures, such as blockages, travel restrictions, cancelling public events and social distinction. In this context, Hoof (2020) noted that one-third of the world's population has been locked out to slow the spread of this pandemic. This was confirmed at the United Nations Conference on Trade and Development report (2020). In fact, these measures could reduce the negative impact of COVID-19 and avoid an economic and financial recession. However, trade volumes, such as automotive in Morocco, Tunisia and textiles in Egypt, fell sharply and were hit hard by the weakening of the global logistics industry in Africa and the MENA region (United Nations, 2020). COVID-19 related travel and transportation restrictions have a direct impact on trade in services, including tourism and foreign direct investment (FDI) due to social distancing measures and the investor's mistrust of the region's economies, OECD (2020b). As a result, the gross fixed capital formation (GFCF) declined as investment in machinery, in equipment and in building and structure, including housing (World Bank, 2020; UNCTAD, 2020).

In addition, the virus has had a huge impact on the online education system, which is becoming critical as it help governments slow the spread of the coronavirus (Chavez and Kounang, 2020; Loh and Fishbane, 2020; Young, 2020). During this period, the use of technology to address the pandemic presents several challenges.The specificity of the COVID-19 pandemic requires an excessive increase in technology and strong data coordination (Bardhan et al., 2020; O'Leary, 2020) to facilitate global collaboration in the fight against this virus. In fact, several empirical studies have been developed to assess the impact of the coronavirus disease on the financial and economic systems. Moreover, some studies have focused on the effect of COVID-19 on thefinancial markets (Alfaro et al., 2020; He et al., 2020; Zhang et al., 2020; Ali et al., 2020; Ashraf, 2020; Ftiti et al., 2021; among others). Other studies have studied the economic impact in the COVID-10 era (Susskind and Vines, 2020; Baldwin and Di, 2020; Gans, 2020; among others). However, a few studies have analyzed the impact of covid-19 on digital infrastructure (Al-Thaqeb et al., (2020); Mnif andJarboui, 2021a; Mnif andJarboui, 2021b;Bhargava's, 2020). This literature, to the best of our knowledge,has neglected to expose the relationship between the intensity of this virus, the macroeconomic aggregates and technology. Therefore, our study aims to complement this literature.

This is especially vital after seeing how the uncertainty of COVID-19 affected local and global economies by assessing the causal meanings between these three concepts by graphically analyzing the impact of government responses to this pandemic in the era of Covid-19. Furthermore, the objective of this study is to assess the impact of the governments' response measures on the macroeconomic aggregates and technology, in particular during this pandemic. Therefore, the choice of the four North African countries (Morocco, Algeria, Tunisia and Egypt) justifies the fact that these 4 countries are part of the middle-income countries, which are not standardized and have limited monetary creation capacities due to the fragility of their economies. More importantly, these countries experienced common social movements during 2011. More particularly, we examine the response of the macroeconomic aggregates and specifically the ICT to the different types of government actions, including the containment Health Index, the Economic Support Index, the total number of school and work closures, among others. Moreover, the objective of this study is to use the production function approach where the GDPdepends on the unemployment rate, fixed capital formation, numbers of deaths of Covid-19 and the ICT in the 4 countries (Tunisia, Egypt, Morocco, Algeria) over a period spanning 2001-2020, to assess the issue of the first and second wave of the pandemic. Although the performance implications of the determinants of economic growth are divergent and vary according to several factors, our empirical results show thatthe ICTs are seen as an engine of economic growth, which has been devastated by the coronavirus. More interestingly, we are trying to empirically prove that government measures, such as the containment and closure of schools and workplaces, have contributed to the deterioration of the economy in these North African countries. This result could be explained in part by the fact that the North African countries complain about the low incomes of the political revolutions, a lack of employment and the rising poverty rates and are therefore facing a free fall in productivity and a dramatic fall in GDP. In this context, there are several channels through which this epidemic will affect the economic activity in these countries. The rest of this article is organized as follows. The first part of **section 2** provides an overview of the literature on assumptions related to the causal relationship between the macroeconomic and ICT aggregates and economic growth. **Section 3** details our sample and methodology. **Section 4** presents the main results. **Section 5** concludes the paper with some remarks on the results and some policy implications.

2. Literature Review

Humanity has experienced various pandemics over the past century, leading economists to study their effects on thefinancial and economic systems. During the recent COVID-19 health crisis, extensive literature has been developed to assessits impact on theeconomic activity (Chinazzi et al.,2020; Atkeson, 2020). Against this backdrop, Fernandes et al., (2020) analyzed the effect of COVID-19 on the economic activity on a sample of 30 countries and found that, on average, each additional month of the crisis costs 2.5-3% of theglobal GDP. According to these authors, the economic costs during this pandemic have been unevenly distributed, particularly in the employment sector, where they confirmed that younger and less educated workers are unfortunately more likely to lose

their jobs. Similarly, Ozili (2020) studied the impact of Covid-19 on the Nigerian economy and it showed that the economic slowdown in Nigeria was triggered by a combination of lower oil prices and the fallout from the COVID-19 outbreak, which not only led to a lower demand for petroleum products, but also prevented economic activities from taking place when distancing policies were applied. In addition, this author confirmed that the state intervention did not prevent the economic crisis. In the same context, Altig et al., (2020) examined the economic impact of this virus and notedthe massive job losses and the incision of economic contraction in relation to the shock. These results were confirmed by Ohia et al., (2020); Correia et al., (2020) and Eichenbaum et al., (2020).Similarly, Aycock and Chen (2020) examined the relationship between the level of spread of the COVID-19 and economic development in the United States. Empirical results showed that there is a relatively consistent relationship between GDP and COVID-19 cases. More specifically, they found that income inequality and access to health care is greater in the United States than in the European countries. In the same region, Joyce and Prabowo (2020) confirmed the negative impact of the COVID-19 on the U.S. budgets as a result of the measures taken against this pandemic. In fact, they said that as a result of the budget deficit, the United States is increasing taxes and cutting spending, knowing that this legislation has increased the deficit by $2.5 trillion between 2020 and 2021. On the other hand, through a comparative study between the closed economy (in the Covid-19) and the normally functioning economy, Mulligan (2020) stated that the closure places the market production of 25-28% below the normal in the short term. In addition, he concluded that the closure costs $7 trillion a year and that employment has already fallen by $28 million in early April 2020. Similarly, Atalan (2020) evaluated the effect of confinement days on the spread of the coronavirus in 49 countries and found that its spread can be significantly reduced by this preventive restriction. He said that this government lock-in is effective on health and the environment. In fact, these results were confirmed by the study of Aycock and Chen (2020). Similarly, Vitenu-Sackey and Barfi (2021) evaluated the impact of the pandemic on poverty reduction and global GDP through a panel of 170 countries. The empirical results showed that there is a negative relationship between the rigour of many people, the contraction of the disease, poverty reduction and economic growth. On the other hand, deaths have so far positively affected both poverty reduction and economic growth. In the context of education, the World Bank (2020) noted that the closure of schools in Morocco and Tunisia disproportionately has affected the most vulnerable students, in particular those without the digital equipment or Internet connection necessary for distance learning. In addition to the COVID-19 news the macroeconomic aggregates respond to the government actions, such as the blockages and the cancellation of public events and social distancing, and the economic support. Therefore,the research is intended to complement previous studies by analyzing the effectiveness of government actions on the macroeconomic aggregates, such as unemployment, ICT, gross fixed capital formation, and higher education spending during the COVID-19period for the North African countries.In the context of education, the World Bank (2020) noted that the closure of schools in Morocco and Tunisia disproportionately affects the most

vulnerable students, in particular those without the digital equipment or Internet connection necessary for distance learning. These results were confirmed by the studies by Bashir et al., (2021); O'Leary, (2020). For this part, Even Myers (2020) found that information systems and information technology (IS/IT) play an important role in the health sector. This idea was confirmed by Chen et al., (2008) and Thompson et al., (2019). In this context, Mingis (2020) found a positive relationship between poverty and education during this pandemic, especially in the affected countries. He concluded that the shift to online education in the Arab world is intensifying inequalities. These results are confirmed by the studiesof Atalan (2020); Ozili ,(2020); Cotula, (2020); Maliszewska et al.,(2020); Furman (2020), Keogh-Brown et al. (2020); Zhang et al., (2020); Ali et al., (2020); Baker et al., (2020); Barro et al., (2020). Recently, Antwi et al. (2020) have noted that the economic recovery is evolving based on COVID-19 information and government control.In addition to the COVID-19 news, the macroeconomic aggregates respond to the government actions, such as the blockages, cancellation of public events and social distancing, and economic support.This study is therefore intended to complement previous studies by analyzing the effectiveness of government actions on the macroeconomic aggregates, such as unemployment, ICT, gross fixed capital formation, and higher education spending during the COVID-19period for the North African countries.

3. Methodology

To test the nature of the relationship between the variables while avoiding any spurious correlation, the empirical investigation in this study consists of three steps: We start by testing for the stationarity of the variables. Then, prompted by the existence of unit roots in the time series, we test for the long term co-integrating link between the variables in the next step of estimation using the co-integration technique developed by Pedroni (2004). Thus, we use Pedroni's co-integration tests in order to examine the long-term relationship between the studied variables. Granted the long run relationship, we explore the causal relationship between the variables by testing for Granger causality in the final step.The main objective of this study is to analyze the impact of Covid -19, Innovation Technology and the macroeconomic aggregates on Economic growth (GDP) for North African countries (Morocco, Algeria, Tunisia and Egypt).Then, the economic and technological data were collected from two sources, namely: the World Bank and Oxford during a period extending from January 1, 2020 to December 2020.For some data, the comparison was made between the current year and the previous one, while for the other data, the comparison was made on a monthly basis.However, the descriptive analysis made it possible to graphically analyze the effect of government responses on macroeconomic aggregates and ICTs.Many studies, like those of Saidi and Chebli, (2018), Rehman et al., (2019), among others, included the ICT variables in their empirical models to examine their impacts on economic growth. Moreover, Taiwo (2019), Collin and Weil (2019) and others studied the relationship between human capital and economic growth.Recently, Ozili (2020) among others has includedthe Covid-19 variables in this empirical model to examine their impacts on economic growth. The empirical results showed that there is a negative relationship between the infected causes and economic growth which was

confirmed by Susskind and Vignes (2020); Baldwin et al., (2020) and Gans (2020).

The general specification of the model to be estimated can be written as follows:

$$lnY_{i,t} = \alpha_0 + \alpha_1 ln\, UI_{i,t} + \alpha_2 lnCov_{i,t} + \alpha_3 lnX_{i,t} + \alpha_4 lnM_{i,t} + \alpha_5 lnCF_{i,t} + \alpha_6 lnDEP_{i,t} + \alpha_7 lnUMP_{i,t} + \mu_{i,t} + \varepsilon_{i,t} \quad (1)$$

where *i*= 1..... *N* represents the country (there are 4 countries in the present case), *t* = 1… *T* represents the study period (going from 2000 to 2020), α_1, α_2, α_3, α_4, α_5, α_6 and$\alpha_7$represent the long-term elasticity estimates of economic growth with respect to exports of ICT goods, imports of ICT goods, the internet users, Covid-19,the gross fixed capital formation, spending on higher education and unemployment rate, respectively.μ is country-specific effects; and ε is the classical error term.

4. Empirical findings

4.1. Data and descriptive statistics

The descriptive statistics for all variables used in the empirical investigation are presented in **Table 1.** These statistics show that all variables are normally distributed from their mean values relative to each other. Moreover, thenegative skewness coefficients indicate that the distribution is skewed to the left, with more observations on the right. In fact, all the variables have low skewed values Skewness. On the other hand, the statistic of Jarque-Bera shows that all the variables used in the analysis have a normal distribution. Then, a detailed definition of the variables is presented in **Table 2**.

Table 1: Description and measurement of the variables

Variable	Description	Measurement
Y	Gross domesticproduct (GDP)	As measured by the GDP per capita (constant 2010 US$)
Cov	Covid-19	number of deaths of covid-19
Exp	exports of ICT goods	% of total exported goods
Imp	imports of ICTgoods	% of total imported goods
Int	Internet users	As measured by the internet users (per 100 people)
CF	gross fixed capital formation	%annual growth rate
Dep	expenses on higher education (% of public spending on education)	the public spending rate
Ump	Unemployment rate	The active population rate

Table 2: Data and descriptive statistics of the variables

	DEP	FBCF	COV	IU	M	PIB	UMP	X
Mean	25.87909	1.979156	0.054287	33.85916	5.223694	2.469657	14.27333	4.216493
Median	25.01235	1.234679	0.048902	36.80000	5.267899	3.043450	14.55000	4.166928
Maximum	29.23451	12.80570	1.000000	67.66000	6.625126	6.709521	18.33000	7.376833
Minimum	22.05146	-12.71537	0.000000	4.297966	3.801100	-8.600310	1.000000	1.250975
Std. Dev.	2.245876	5.101075	0.220072	21.27012	0.765766	3.252791	2.693338	1.957296
Skewness	0.011588	-0.580292	-1.90820	0.033910	-0.135960	-1.933800	-2.883308	-0.151939

	DEP	FBCF	COV	IU	M	PIB	UMP	X
Kurtosis	1.629580	5.053918	3.28078	1.713357	2.314265	7.534613	15.97460	1.776601
Jarque-Bera	6.105412	8.08799	2.80731	5.395159	1.768561	1.4434	6.1807	5.164402
Observations	78	78	78	78	78	78	78	78

4.2. Unit root tests.

In order to understand whether there is a long termrelationship between all the variables,we apply co-integration tests to check whether all the variables are stationary at level or not because if they are not, they should be preceded by first difference to make these stationary.

Therefore, the Levin et al. (LCC, 2002) and Phillips-Perron (PP) tests are performed to verify the stationarity of the different series. The results, which are presented in table3, show the values of the Student statistic (t) for the variables at level and at first difference while the unit root test indicates that all series are integrated of order one (I (1)), which means that they are stationary in first difference.

Table 3: Unit root test of (Levin Lin and Chu) and Phillips-Perron (PP)

	LLC		PP	
	Level	First difference	Level	First difference
GDP	-2.60323 (0.2732)	-5.20127 (0.0000)***	1.01537 (0.0013)	-7,62855 (0.0000)***
IU	-2.36865 (0.0089)	-2.52503 (0.0058)***	0.34706 (0.6357)	-2.85021 (0.0022)***
X	2.94913 (0.8287)	-4.02978 (0.0000)***	1.59063 (0.9442)	-2.14232 (0.00161)***
M	-2.20858 (0.0136)	-6.27394 (0.0000)***	-1.42440 (0.0772)	-5.14119 (0.0000)***
COV	-2.32180 (0.0091)	-4.24073 (0.0000)***	0.30017 (0.7213)	3.21884 (0.0012)***
UMP	-3.17217 (0.0008)	-4.18416 (0.0000)***	-2.83792 (0.0023)	-4.04663 (0.0000)***
FBCF	-4,46261 (0.0718)	-2.47176 (0.067)**	-2.21936 (0.0132)	-5.29209 (0.0000)***
DEP	4.04135 (0.5165)	-4.30141 (0.0000)***	-1.18187 (0.1186)	-2.61569 (0.0045)***
Note: *** Significant at 1%, p-value in parenthesis				

Notes: P-values in parentheses, ***, ** significant at 1% and 5% levels respectively

4.3. Co-integration analysis

After obtaining the stationarity of the data, by testing whether there is a long-term equilibrium relationship between these variables, we use the co-integration test ofPedroni (2004), which includes seven co-integration tests on data from both homogeneous and heterogeneous panels. Therefore, the panel co-integration test is used to investigate the long-term equilibrium relation between the dependent variable and all the independent ones as a group in the model.

The results of Pedroni's (2004) test reported in table 4 confirm the rejection of the null hypothesis of no co-integration.Based on the p-values, we can conclude that economic growth and its determinants are co-integrated in the long-term.In fact, the results of both the within and between dimension statistics show that the alternative hypothesis of co-integration should be accepted for the panels along with the global panel.Based on these findings, we can saythat the endogenous and exogenous variables have a long-term relationship in all panels.Moreover, the study of co-integration makes it possible to test the existence of a stable long-term relationship between the variables.

Table 4: Results of pedroni's co-integration test

Alternative hypothesis: common AR coefs. (within-dimension)					
		Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic		-2.173557	0.0031	-2.635027	0.0021
Panel rho-Statistic		3.019544	0.0030	3.178586	0.0093
Panel PP-Statistic		3.512536	0.000	4.046551	0.0000
Panel ADF-Statistic		2.979400	0.0005	4.431338	0.0000
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		4.028772	0 .0000		
Group PP-Statistic		4.752817	0 .0000		
Group ADF-Statistic		4.389713	0 .0000		
Cross section specificresults					
Phillips-Peron'sresults (non-parametric)					
Cross ID	AR(1)	Variance	HAC	Band width	Obs
1	0.733	1.042343	1.217941	1.00	17
2	0.572	1.464691	1.464691	0.00	19
3	0.572	1.464691	1.464691	0.00	19
4	0.733	1.042343	1.217941	1.00	17
Augmented Dickey-Fuller results (parametric)					
Cross ID	AR(1)	Variance	Lag	Max lag	Obs
1	0.692	1.118811	1	--	15
2	0.408	1.277302	1	--	18
3	0.408	1.277302	1	--	18
4	0.692	1.118811	1	--	15

Table 5: Empirical results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEP	0.110590	0.179766	0.615188	0.0 404
CF	-0.206945	0.058313	-3.589099	0.0007
IU	0.112804	0.020642	5.464780	0.0000
Cov	-0.220741	0.061301	3.600971	0.0005
M	-0.073831	0.608198	0.121139	0.0037
UMP	-0.199869	0.114802	-1.740988	0.0860
X	-0.008307	0.261485	-0.031766	0.0559
C	3.341421	3.918111	0.852814	0.0306
R-squared	0.502038	Meandependent var		2.469657
Adjusted R-squared	0.459957	S.D. dependent var		3.252791
S.E. of regression	2.390399	Akaike info criterion		4.666256
Sumsquaredresid	405.6946	Schwarz criterion		4.877756
Log likelihood	-174.9840	Hannan-Quinn criter.		4.750923
F-statistic	11.93019	Durbin-Watson stat		1.504279
Prob(F-statistic)	0.000000			

The results of the global panel are presented in table 5.We find that the effect of the death toll from Covid-19 is negative and significant. Indeed, the increase in VOC by 1% leads to a decrease in economic growth by 0.22%. Our results are confirmed by the studies of Barro et al., (2020), which found that the number of deaths destroys economic growth, even for Ozili (2020) who approved this relationship in the Nigerian context. In addition, the effect of gross formation in the fixed capital is negative and significant. Indeed, the augmentation of GFCF by 1% causes the decrease of the economic growth by 0.206%.Theoretically, the negative impact confirms the conclusions of Kanu, Ozurumba and Anyanwu (2014), which found a negative relationship between economic growth andcapital formations in Nigeria. However, this goes against the conclusions of Bakare (2011), Orji and Peter (2010) and Ugwuegbe and Urakpa (2013), which found a significant positive relationship between economic growth and capital formation. This relationship is well marked in Figure 4 where we note a break in GFCF during the periods of crises, including the subprime crisis in 2008 and the Arab revolutions in 2011 and 2012. In addition, we confirm the negative and significant effect of the COV variable on economic growth. These results are consistent with other studies namely of Barro et al., (2020) and Correia et al., (2020). Likewise, Abadulgu and HikaWana (2020) confirmed the negative impact on economic growth for Ethiopia and Altig et al., (2020) for the United States. As the COVID-19 pandemic spread across the four North African countries that are the object of our study in March 2020, it can be concluded that these countries experienced a double health and economic shock, which occurred at a time when the countries were

facing persistent macroeconomic imbalances and an acute crisis of public and external finances. In fact, the governments of these countries have sought to slow its progress through drastic measures, including the use of military and police forces to impose mandatory confinement (see Figure 2) as the number of deaths increased rapidly (see Figure3). Moreover, the partial demobilization of the workforce during 2020 (see Figure 5) explains the decrease of GFCF as it is linked to the deterioration of production, trade volumes, foreign direct investment and trade of services during the containment period. This was confirmed by the Ozili studies (2020). On the other hand, we found a negative relationship between unemployment and economic growth. In fact, our results were confirmed by the studies ofFernandes et al., (2020) and Vitenu-Sackey and Barfi (2021).More specially, the link between the two unemployment and economic growth variables is relatively simple, especially during the 2019-2020period, which has been described as massive denigration measures. As a result, most businesses were closed which increasedthe unemployment (see Figure 6). This was confirmed by Mulligan (2020); Atalan (2020) and Binder (2020). Similarly, the spread result of the virus had alarming consequences, such as poverty. Similarly, Binder (2020) confirmed that people expect longer periods of unemployment during the different phases of the current pandemic. As a result, the sharp decline the GFCF and the unemployment rate undermined the social pact during this crisis, especially for these low-income countries.Then, in the context of education, we found that the CED has a coefficient of 0.11 indicating that it hasa positive and significant impact on economic growth. In fact, we noted that a 1% increase in CED leads to an increase of economic growth by 0.11. These results confirm the findings of Kumar (2019), who looked at the long-term relationship between education spending and economic growth in India and found that a unitary increase of public education spending increases the GDP by about 0.83 units. In other words, an increasein education spending will result in a GDP improvement by0.83.In addition, the high correlation coefficient (0.98) confirms the strong positive relationship between education expenditure and the gross domestic product. Moreover, the numerous studies whichconfirmed a positive relationship between education spending and economic growth were conducted by Ogujiuba and Adeniyi (2005) for Nigeria, Jung and Thorbecka (2001) for Tanzania and Zambia. As a result, governments around the world have adopted social distancing procedures to stop or slow the spread of the virus, using digital technology to teach and work remotely(Brynjolfson et al., 2020; Prasad et al., 2020; Bardhan, Chen and Karahanna 2020; O'Leary 2020; Chavez and Kounang 2020; Loh and Fishbane 2020). In particular, the world was totally dependent on digital technology during the crisis. It has provided a solution for learners who have been unable to access known modes of education due to the current pandemic (Soni, 2020). Following containment, the education system in the North African countrieshas undergone some changes (online education) to slow the spread of the coronavirus (see Figure 7). In line with what was confirmed from the positivity of ICT with economic growth, we found that the UI depends on economic growth at 1% level. Therefore, a high coefficient strongly confirms the positive link between economic growth and ICT. These results are similar to those of Mefteh (2021) and Loukil et al., (2019) for a

panel of 62 countries, Kammoun et al.(2020a) for a panel of 10 MENA countries, for Fiji and Kuppusamy et al., (2009) for Malaysia. Moreover, the results show that economic growth is negatively correlated with ICT imports.

This result was confirmed by the development of imports during the crisis periods, as shown in Figure 8.This result explains well the increase of the internet use among other ICT, which is caused by the consequences of the confinement in the countries of our sample since governments of these countries have decided to suspend travelling which reduced exports, during this health crisis (see Figures 8 and 9).For illustrative purposes, according to the World Trade Organization (2020), the sectoral impacts with a 2% monthly decrease imports of intermediate inputs from China implies a monthly loss of the value added of around $38 million for Tunisia and $26 million for Morocco.

5. Conclusion

The purpose of this study was to analyze and assess the impact of ICT, number of deaths from Covid-19 and other macroeconomic aggregates on economic growth in the countries of our sample over a 20-year period (2001-2020). In fact, using panel data estimation, we empirically examined how various ICT indicators affect economic growth, which is represented in our study by the GDP per capita. Therefore, the empirical results show a one-way relationship between the DEP and economic growth which means that these results are consistent with those of (Kumar, 2019) for India; Ogijuba and Adeniji(2005) for Nigiria and Thorbeka (2001) for Tanzania and Zambia; Bashir et al., (2021); O'Leary, (2020), OECD (2020b) and the World Bank,(2020). Indeed, education spending, in particular with regard to the integration of ICTs into the education system, is increasingly becoming more important in helping governments to slow the spread of the coronavirus.In addition, the results show that the relationship between the IU and the GDP is two-way which implies that these results are consistent with those of Kuppusamy et al., (2009). Moreover, these findings recommend encouraging the use of ICTs because they are useful for countries in order to play a positive role in modernizing the economic sector and create many opportunities to improve production. In other words, the positive influence of ICTs on economic growth is pushing authorities to integrate the environmental dimension into their development strategies by improving the decoupling relationship between ICTs and economic growth. As a result, there is an urgent need to better understand the roles that information systems and technology researchers can play during this global pandemic.Second, we demonstrate that our results confirm the existence of a negative relationship between the gross capital formation and economic growth due to containment and mitigation measures taken to limit the spread of the virus and save lives (see Figure 2). In fact, this decline is explained by the persistent macroeconomic imbalances and the acute crisis of public and external finances since their social movements in 2011 in the North African countries and on the other hand by the partial demobilization of the workforce during the year 2020 (see Figure 5), the bankruptcy of companies, the deterioration of production, trade volumes, foreign direct investment and trade in services.Therefore, this drop in investment strongly influences unemployment, which has a negative relationship with economic growth (Figure 6).

Our results are therefore consistent with those of Mulligan (2020);Atalan (2020) and Binder (2020). Moreover, the main policy implications arising from our study are based on the impact of ICT on economic growth in the countries of our sample. As a consequence, it is important that policy makers allow the integration of ICTs into the education system for them to play a positive role during the economic recession, due to the coronavirus.It is also important to note that the federal government needs to focus its attention on mitigating the rapid spread of COVID-19 and not be involved in creating another pandemic, which could lead to additional political instability. However, technology is still expensive to develop and adopt. Nevertheless, the COVID-19 pandemic has turned citizens, banks, regulators and government officials to technology companies to confront this pandemic and limit its. On the other hand, the ICT has turned government officials in the sampled countries towards more advanced technology companies with a higher utilization rate than before this pandemic.This shift is likely to accelerate the move towards regulatory structures that encompass and regulate technology companies as part of the fabric of the financial system. However, this study has two limitations; the first consists in the shortage of monthly data which help accurately capture the impact of Covid-19 on the macroeconomic aggregates and the ICT. Moreover, the small number of COVID-19 sightings is another issue as it was almost impossible to perform a robust econometric modeling which means that a longer sampling period is desired as it can provide a much richer research overview. Second, the situation in some countries has changed since this study was conducted.Therefore, the duration of the study is a possible limitation that could not restrict the full dynamics of pandemic situations.Moreover, future research should carry out a more robust analysis that could be adopted by other countries with similar characteristics.

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Annexe

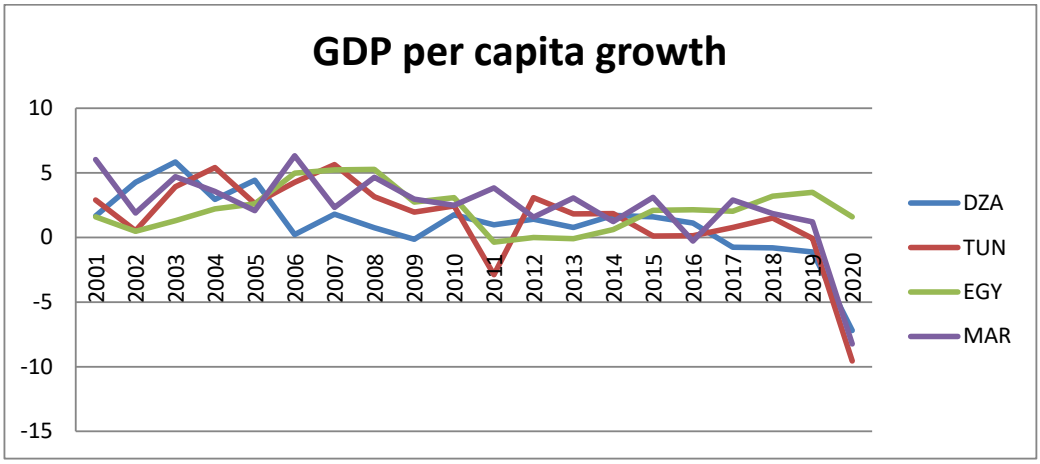
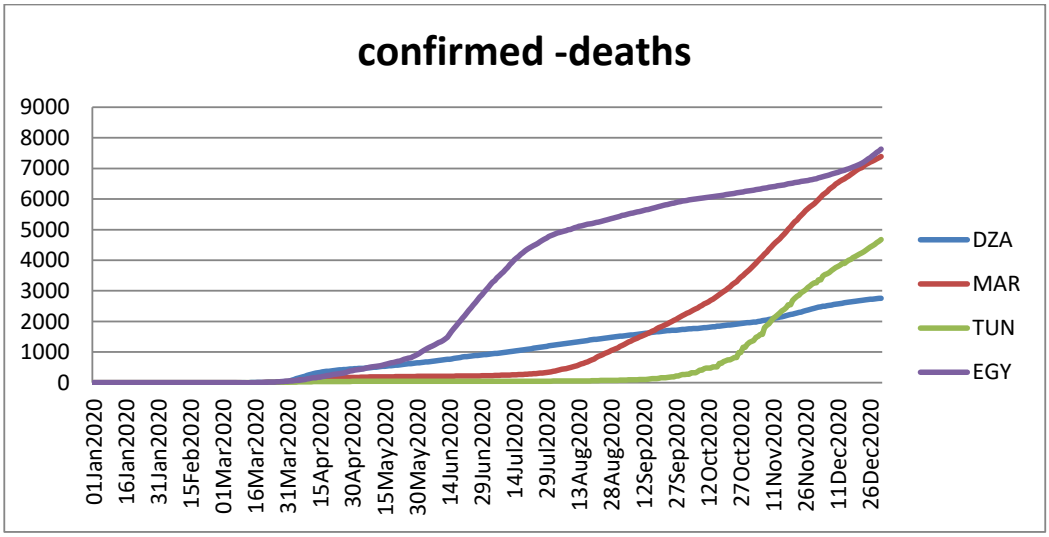


Figure 1



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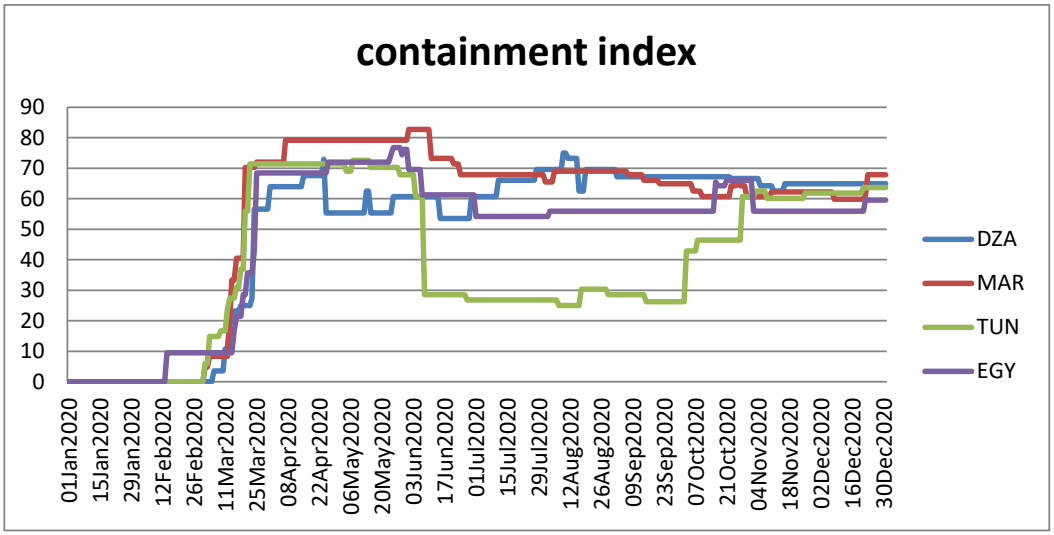

Figure 3

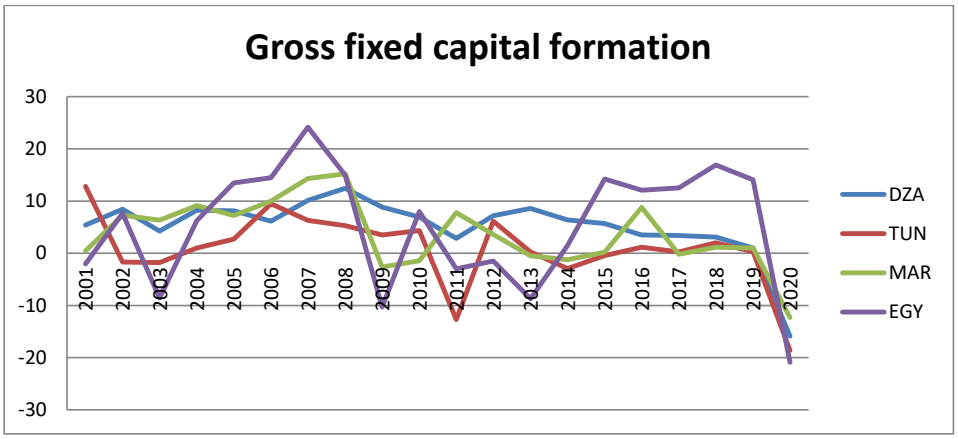

Figure 4

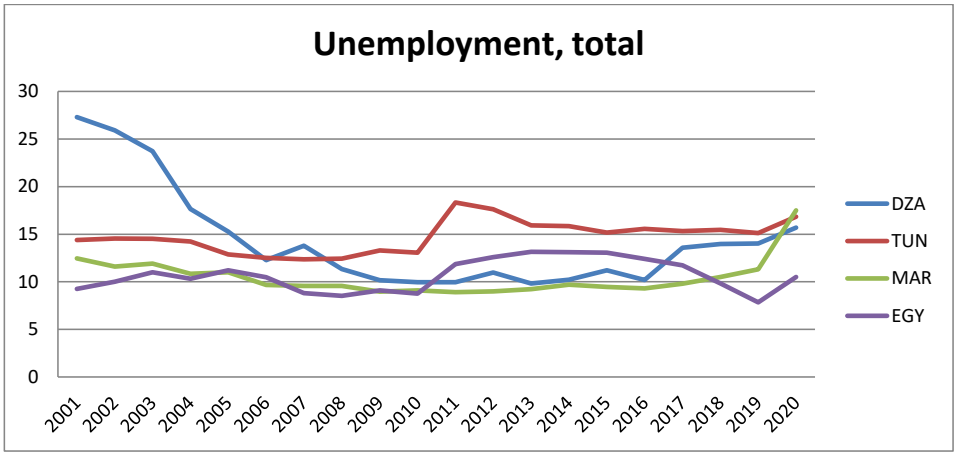

Figure 5

Figure 6

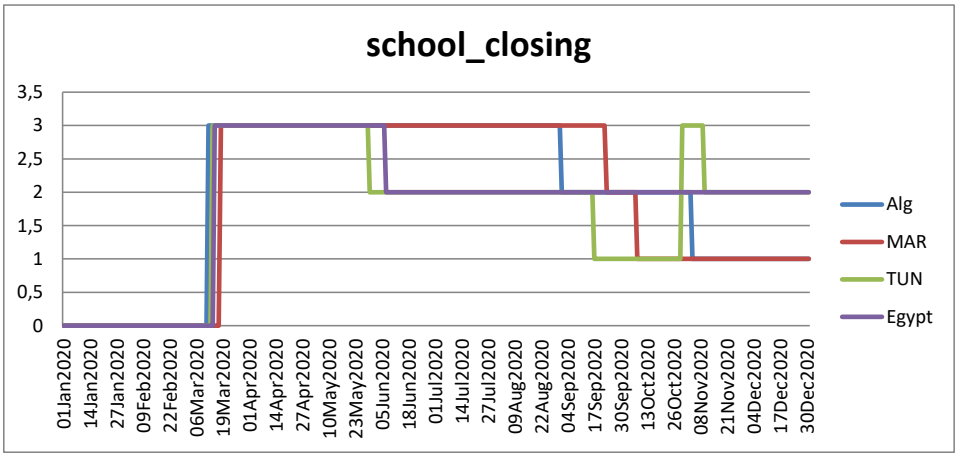

Figure 7

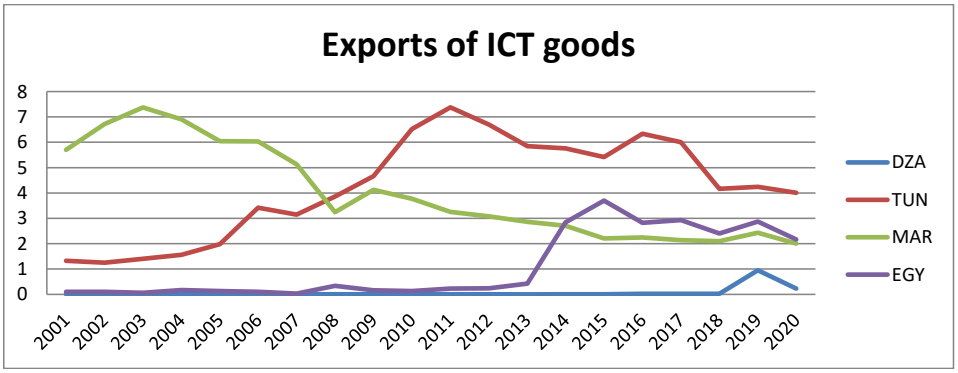

Figure 8

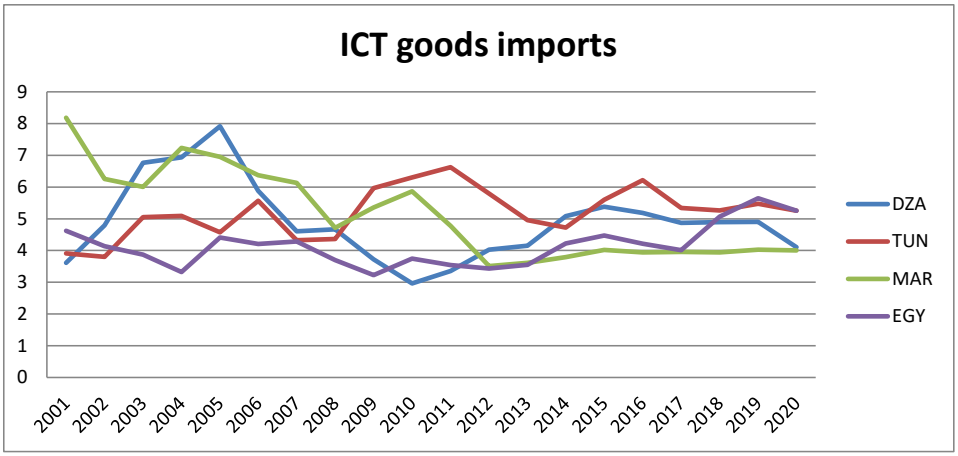

Figure 9