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Economic issue and technological resilience of pre- and post-COVID-19

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Abstract

Purpose – The purpose of this paper is to investigate the impact of COVID-19 pandemic on the changing relationship between technology and economic activity in MENA countries.
Design/methodology/approach – The generalized method of moments (GMM) was applied to explore the presence of dynamic causality between technology, inflation, unemployment, foreign direct investment, trade opening, gross fixed capital formation and economic growth for 14 MENA countries before and after COVID-19.
Findings – Empirical evidence shows that the economic predictor variables change signs and impact negatively the economic growth as a result of the adverse consequences of the MENA health crisis. More interestingly, there is a unique, positive, meaningful relationship between ICT and economic growth.
Originality/value – The results show that economic resilience in MENA is significantly affected by digital infrastructure during the epidemic crisis. The authors conclude that macroeconomic adjustment and innovation improve the predictive performance of the health news model. Countries could take strong measures to support new strategies to strengthen their innovation competitiveness.

Keywords ICT, Economic growth, Covid-19, GMM, MENA countries
Paper type Research paper

1. Introduction

The Tunisian revolution of 2011 has inspired other countries in the Middle East and North Africa (MENA) namely Egypt, Libya, Jordan, Syria, Morocco and Bahrain. Political uncertainties have affected economic activity, financial markets and innovation in these countries (Ben Romdhane Loukil, Loukil, & Kammoun, 2021; Samitas, Kampouris, & Umar, 2022; Kammoun, Ben Romdhane, & Fakhfakh, 2020a; Kammoun Loukil, & Ben Romdhane, 2020b). In January, 2020, the World Health Organization (WHO) announced an international public health emergency prior to the formal declaration of COVID-19 as a pandemic. Travelers from Italy, China and other affected countries are at risk of introducing Covid-19 into the MENA region. According to the World Health Organization (2020), this global pandemic of coronavirus disease (COVID-19) is ranked among the most serious health crises in human history (Almarayeh & Almarayeh, 2021). After a short period of time, some countries have already been affected. Most serious, from the date of completion of this study,

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Reuteurs (2021) showed the spread of the epidemic that the United Arab Emirates has recorded 740,362 contamination cases and 2,139 deaths; Iraq has had 2,062,863 cases of contamination and 23,344 deaths; Bahrain had 277,040 cases of contamination and 1,393 deaths; Egypt had 336,582 cases of contamination and 19,011 deaths; and Saudi Arabia had 548,930 cases of contamination and 8,804 deaths. As an attempt to limit the rapid spread of COVID-19, governments in pandemic MENA countries have put in place several preventative measures such as social distancing, canceling events and closing schools. As a result, many economic activities have been influenced, such as business, trade, transport, services and production. At the beginning of this pandemic, the MENA economy suffered a major shock and significantly reduced the main macroeconomic variables, namely gross domestic product (GDP), which contracted by 5.4%. This fall is explained first by the price of oil which is recorded a significant decrease in the price of crude oil from USD 68.90 at the beginning of January 2020 to USD 50 on February 28, 2020. Second, by the increase in food prices that has increased by more than 20% since February 14, 2020. According to the United Nations (2020), the Arab region experienced a 45% drop in its foreign direct investment (FDI) flows in 2020. Several empirical studies have been developed to assess the impact of corona virus disease on financial systems (Alfaro, Chari, Greenland, & Schott, 2020; He, Liu, Wang, & Yu, 2020; Zhang, Hu, & Ji, 2020; Ali, Alam, & Rizvi, 2020; Ashraf, 2020; Ftiti, Ben Ameur, & Louhichi, 2021; among others). Other studies analyzed the economic impact at the beginning of COVID-19 (Abdelkafi, Loukil, & Ben Romdhane, 2022; Baldwin & Tomiura, 2020; Gans, 2020; Susskind & Vines, 2020; among others).

In addition, a limited number have analyzed the impact of COVID-19 on digital infrastructure (Ben Romdhane & Mefteh, 2022; Al-Thaqeb, Algharabali, & Alabdulghafour, 2020; Mnif & Jarboui, 2021; Bhargava & Shewade, 2020). This literature, to our knowledge, has neglected to expose the relationship between the intensity of this virus, macroeconomic aggregates and technology collectively.

This study aims to assess the resilience of the determinants of economic growth during the epidemic crisis through some macroeconomic and technological aggregates. The choice of the MENA area justifies its diversification and resilience to economic and political transformations. More importantly, it enjoys a privileged geographical location with access to large markets, a young and increasingly educated population and comparative advantages in several sectors such as industry, renewable energy and tourism.

The empirical study is based on the production function approach where GDP depends on the unemployment rate, the inflation (INF) rate, gross fixed capital formation (GFCF), FDI, trade opening, the rate of Internet use is an information and communication technology (ICT) proxy and the number of deaths occurring through a COVID-19 proxy for 14 MENA countries over two periods from 2001 to 2018 and 2019 to 2021, assessing the issue of the first and second waves of disease.

The rest of the article is organized as follows. Section 2 provides an overview of the literature on the impact of political and epidemic uncertainty on macroeconomic aggregates and technology in the MENA area. Section 3 describes the sample and the methodology. Section 4 presents the main results and discussion. Section 5 gives conclusion and policy implications.

2. Literature review

The relationship between uncertainty and economic activity has been documented in the literature. In the Asian context, Sharma and Kautish (2020) analyzed the effect of financial sector development on GDP growth over the period 1990–2016. The empirical results show that in the long term the stock market and the banking sector are essential determinants of economic growth. They concluded that to achieve sustainable growth, policy makers need to

take the holistic approach that can be ensured by improving the quality and reach of financial services in these Asian countries. In the same order of ideas, Sharma, Kautish, and Kumar (2018) studied the determinants of economic growth in India during the period 1971–2016. Using the Autoregressive Distributed Lag (ARDL) model, they found that in the long run, foreign aid, government final consumption expenditure and FDI have a positive and significant impact on economic growth, whereas economic growth was negatively influenced by the exchange rate and the development of human capital. In the same way, Sharma, Kautish, and Kumar (2019) clarified the impact of external and internal determinants of INF in India during the years 1978–2015. Through the ARDL model, the results of the study revealed that oil consumption has a direct impact on domestic prices. Similarly, due to the increase in employment, INF tends to increase in the long term. Furthermore, the relationship between deficit financing and the domestic price is found to be negative and significant, while the impact of FDI on the domestic price is found to be inconclusive in the long run. Sharma and Kautish (2021) analyzed the implications of foreign aid on GDP per capita in the seven middle-income countries of South and Southeast Asia from 1990 to 2016. Using the model of least squares, they found that the aid-policy interaction has a significant and positive impact on economic growth in the region. Economic literature shows great interest in the relationship between international trade, FDI and technology on capital accumulation, productivity and GDP. Alshamsi, Bin Hussin, and Azam (2015) examined this relationship between the rate of INF and GDP per capita on inward FDI inflows into the United Arab Emirates (UAE). On the basis of annual data for the period 1980–2013, the ARDL estimate showed that INF has no significant effect on FDI inflows while the proxy of GDP per capita used for market size has a significantly positive impact on FDI inflows. Innovation in developed (technologically advanced) and developing (technologically less advanced) countries has once again become an unavoidable topic of debate in the theories of international trade and endogenous growth. Romer's model and the Schumpeterian approach to growth (Aghion & Howitt, 1992) stress that openness to international trade and FDI, if it is beneficial, is because it increases incentives to innovation, by increasing the size of the market and consequently the rent of monopoly and economic growth. Despite all these non-adverse factors the MENA area is considered as a Greenfield opportunity for the expansion of FinTech. In this context, Saidi and Mefteh (2020) examined the relationship between FDI, ICT and transport for 63 countries with different income levels over the period 2000–2016. Empirical results for GMM estimators have shown that transport infrastructure and ICT are two positive determinants for economic growth and FDI attractiveness. In the same vein, Ben Romdhane Loukil *et al.*, (2021b) analyzed digital infrastructure and institutional indicators for ten 10 MENA countries between 2011–2014 and 2017. The empirical results show strong evidence of the crucial role of freedom of investment and digital infrastructure.

Several empirical studies have been developed to assess the impact of corona virus disease on financial and economic systems in the era of the pandemic. In this context, Ben Romdhane and Mefteh (2022) analyzed the impact of the corona virus pandemic (COVID-19) on the health, economic and social sector in the country Morocco, Algeria, Tunisia, Egypt (MATE). Using the GMM method, they clarified the determinants of economic growth over the period spanning 2001–2020. The empirical results show that the decline in economic growth in these countries was triggered by a combination of high death rates, rising unemployment interest rates and a decline in gross fixed capital expenditures on training and education. More than that, we find that ICT plays a driving role in economic growth with a two-way link between the Internet user and GDP. Abdelkafi *et al.* (2022) analyzed the impact of COVID-19 pandemic on INF and exchange rate volatility. They used the dynamic panel data model to study the effect of COVID-19 spread and the governments' measures implemented in order to support economies. They are based on monthly data from January to September 2020 for five Asian countries (Malaysia, India, Indonesia, Japan and China) and five Latin countries (Argentina,

Brazil, Mexico, Colombia and Ecuador). The results show that high infections negatively affects exchange rate and INF; the governments' responses increase INF and lead to a fall in the exchange rate. Indeed, the implementation of health protocols that brought the countries into a new economic and financial crisis as economic agents could not freely engage in economic activities. Therefore, policy makers in both regions should invest in health infrastructure to improve the capacity of the national health system to withstand the epidemic of communicable diseases.

Altig *et al.* (2020) analyzed the degree of uncertainty about the pandemic in the United States. They concluded with the ushering of huge jumps of uncertainty in response to the pandemic and its economic benefits. They concluded that the increase in the number of deaths is a major factor in the deterioration of GDP and output. In the European context, Büchel, Legge, Pochon, and Wegmüller (2020) analyzed the effect of COVID-19 on international merchandise trade in Switzerland. They confirmed 11% drop in trade during the period between January and July. They approved that the severity of the containment measures negatively affects Swiss trade flows. To avoid contracting the virus, households reduce their consumption and labor supply (Eichenbaumand *et al.*, 2020), while businesses reduce their investments in response to declining demand, increasing uncertainty and labor shortages. Even Yang *et al.* (2020) found that information systems and information technologies play an important role in the health sector. This idea is confirmed by Chen, Del Genio, Carlson, and Bosilovich (2008); Thompson, Whitaker, Kohli, and Jones (2019). In this card, Mingis (2020) found a positive relationship between poverty and education during this pandemic, especially in affected countries. He concluded that the shift to online education in the Arab world is intensifying inequalities. These results are confirmed with studies by Furman, Geithner, Hubbard and Kearney (2020), Keogh-Brown, Jensen, Edmunds, and Smith (2020), Zhang *et al.* (2020) and Ali *et al.* (2020). This study is intended to complement previous studies by analyzing the effectiveness of government actions on macroeconomic aggregates, namely unemployment rate, INF, ICT, GFCF, trade openness (TO) and the number of deaths due to Coronavirus as a proxy for the pandemic for the MENA region.

3. Materials and methods

The following section interprets the two data extraction models for the current empirical survey. In addition, this section is classified into two sub-categories, the first being (1) data and descriptive analysis and the second being (2) the empirical model and strategy for each model. Descriptive analysis and data clarify data problems, data sources, variable reductions and their descriptive analysis. The model and estimation strategy outline the econometric model and evaluation strategy used for the current empirical survey.

3.1 Data and descriptive statistics

We use annual data from 2001 to 2018 and 2019 to 2021 to clarify the determinants of economic growth before and after the COVID-19 pandemic. We extract as much data as we can from the World Bank data. We apply GDP as a dependent variable, which is an approximation of economic growth. The variable number of individuals using the Internet % of the population is used as a proxy for ICT. In addition, the number of deaths is a proxy for COVID-19 is collected from the Johns Hopkins University Coronavirus Resource Center (JHU-CRC) website. We collect data on net inflows of FDI (% of GDP), TO (% of imports and exports of GDP), INF rate (consumer price index), unemployment rate (labor force rate) and GFCF (%annual growth rate). All data collected are presented in Table 1.

The data for the panel of 14 countries from the MENA region (Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Iran, Jordan, Lebanon, Turkey, Egypt, Algeria, Libya,

Morocco and Tunisia) are used for empirical purposes. The choice of the MENA region is justified by the fact that this region includes countries that have experienced political changes during the same period, such as Tunisia, Libya, Egypt and Yemen. This political instability exacerbates the difficulties faced by the authorities in managing the COVID-19 pandemic. In Lebanon, the collapse of the economy is having a catastrophic impact on public services and people's livelihoods. In Yemen and Syria, ongoing armed conflict combined with the pandemic has further exacerbated the crisis.

Thus the selection of countries and variables was based essentially on the following:

(1) The MENA countries attempt to industrialize and develop their economic activities; however, the propagation of corona virus affects the development. As a result, several economic activities have been influenced such as trade, transport, production and economic growth.

(2) At the commencement of this pandemic, the MENA economy endured a major shock and significantly reduced the main macroeconomic variables namely GDP, which was contracted by 5.4%. This fall is explained especially by the price of oil which recorded a significant decrease in the price of crude oil from USD 68.9 in January 2020 to USD 50 on February 28, 2020.

(3) Additionally, amid the 1990s, MENA region countries adopted novel strategies to boost their support to the worldwide economy. Furthermore, approximately 95% of the MENA region nations are at the moment part of the WTO and have built up a number of rules-based trading frameworks in order to decrease tax barriers.

Table 2 shows descriptive statistics of the data before and after COVID-19 crisis including minimum, maximum, mean and standard deviation.

3.2 Correlation matrix

The correlation matrix below shows the correlation coefficients between the dependent and independent variables. Only half of the correlation matrix will be displayed because a correlation matrix is symmetrical. Notice that the correlation coefficients along the diagonal of the table 3 are all equal to 1 because each variable is perfectly correlated with itself. These cells are not useful for interpretation. Table 3 shows that economic growth is positively correlated with the stock of foreign investment, GFCF and TO but, negatively correlated with unemployment rate and COVID-19 variable.

3.3 Model specification

The underlying objective of our empirical study is to analyze the economic determinants of economic growth for a sample of 14 MENA countries before and after COVID-19 and how the

Table 1. Description and measurement of variables

Variable	Definition and measurement
GDP growth	Gross domestic products (annual %)
FDI	Foreign direct investment net inflows (% of GDP)
INT	Number of individual using internet % of population
INF	Consumer price index
TO	Sum of exports and imports of goods and services (% of GDP)
UMP	The inactive population rate
GFCF	Gross fixed capital formation (%annual growth rate)
COV	Number of death due to COVID-19

Source(s): Authors

Before Covid-19					After COVID-19			
Variable	Mean	Std.Dev	Min	Max	Mean	Std.Dev	Min	Max
lnGDP	0.2425	9.6175	−24.8741	90.8475	0.4652	9.6952	−61.5285	121.7745
lnINT	3240.1244	9852.4526	0.08145	56320.8475	4285.9568	1645.9685	0.0995	6985.4965
lnUMP	6.5254	4.4521	0.6542	23.4254	9.6523	5.9582	0.8785	28.3986
lnINF	90.0214	45.8541	25.5142	510.3625	109.9856	58.0985	30.6525	756.652
lnGFCF	4.5263	11.8475	−50.8547	120.7451	5.9563	17.6526	−81.8564	162.096
lnTO	75.6325	42.9852	28.7415	301.7852	99.9856	57.2352	31.6359	325.8565
ln FDI	6.1230	32.5236	−9.4826	326.7562	9.65235	43.9658	−12.1485	450.1528
LnCov					0.0563	0.3265	0	1

Source(s): Authors

Table 2.
Descriptive statistics

Table 3.
Correlation matrix

Before Covid-19									After COVID-19							
	GDP	FDI	INT	To	UMP	INF	GFCF	GDP	FDI	INT	To	UMP	INF	GFCF	COV
GDP	1.000							1.000							
FDI	0.362	1.000						0.449	1.000						
INT	−0.021	−0.025	1.000					−0.030	−0.049	1.000					
TO	0.005	0.029	−0.021	1.000				0.003	0.032	−0.035	1.000				
UMP	−0.196	−0.015	−0.195	0.051	1.000			−0.246	−0.062	−0.352	0.056	1.000			
INF	−0.198	−0.042	−0.035	−0.045	0.195	1.000		−0.156	−0.045	−0.015	−0.046	0.263	1.000		
GFCF	0.0215	0.000	0.162	0.106	−0.062	−0.142	1.000	0.026	0.001	0.195	0.145	−0.045	−0.141	1.000	
COV								−0.016	−0.032	−0.056	−0.125	0.046	0.326	−0.451	1.000

Source(s): Authors

Asian region is resilient to this epidemic. Specifically, the study aims to study the impact of INF, unemployment rates (UMP), GFCF, Internet users (INT), TO and FDI net inflows on economic growth before and after the COVID-19 pandemic. The economic variables used in this study were collected from the World Bank. We make up our panel estimate of the generalized moments method (GMM) in two models.

We use the log-transformation of variables and we write equation (1) with specification, as follows:

$$lnY_{i,t} = \alpha_{0+}\alpha_1 lnY_{i,t-1} + \alpha_2 lnINT_{i,t} + \alpha_3 lnCOV_{i,t} + \alpha_4 lnFDI_{i,t} + \alpha_5 lnTO_{i,t} + \alpha_6 lnINF_{i,t} + \alpha_7 lnUMP_{i,t} + \alpha_8 lnGFCF_{i,t} + \mu_{i,t} \quad (1)$$

where, i : The country.

t : The time dimension

$\mu_{i,t}$: The error term of the model

α_0 : Constant

The second model is dedicated to expressing the effect of Coronavirus on the growth of the region's MENA region from 2019 to 2021 using the GMM-GLS (generalized least squares) estimator. The use of GMM-GLS regression is justified by the short epidemic period ($T = 3$) while our sample is 14 countries ($N = 14$). Since the number of years is less than the number of countries and our sample is reduced by input, we change the method and choose the GMM-GLS estimate (Nijman & Palm 1991).

4. Results and discussion

Table 4 shows the results of the GMM estimation. There is a positive relationship between economic growth and the macroeconomic variables. GFCF, FDI and TO positively affect economic growth before COVID-19 period. This is due to the support for private sector development over the past decades to ensure economic diversification. The positive reforms have encouraged increased investment and economic growth. The results show that an increase in GFCF of 1% leads to an increase in economic growth of 4.52%. This is confirmed by the studies of Solow (1956), who stated that GFCF is the basis of economic growth. Ugwuegbe and Urakpa (2013), d'Orji and Peter (2010) suggested that GFCF expenditures enable the economic system to improve productive capacity. They contribute to innovation, which aims to introduce new processes and products.

Recently, the shift in the structure of the economy away from the production of goods to the provision of services, as well as the visible acceleration in the pace of technological

GDP	Coef	Std. Err	z	$P > \|z\|$		[95% Conf. Interval]
$\ln_1$(GDP)	0.2859***	0.0526	5.2154	0.000	−0.3265	−0.1529
LnTO	0.0652*	0.0496	1.6528	0.0526	−0.0195	0.1756
LnFDI	0.0157	0.0195	0.5234	0.2545	−0.0285	0.0415
LnINT	0.0016**	0.0008	2.2637	0.0123	−0.0021	0.0004
LnUMP	−0.3015	0.2985	−1.0419	0.2254	−1.04963	0.2856
LnINF	−0.0205**	0.0135	−1.4258	0.0228	−0.0496	0.0025
LnGFCF	0.0452*	0.0325	1.7132	0.0695	−0.0042	0.1362
Constant	0.1052	8.1452	0.0125	0.7856	−15.2635	16.1689

Note(s): ***, ** and * statistical significance at 1%, 5% and 10% levels, respectively
Source(s): Authors

Table 4. Result of panel GMM estimation before Covid-19

change, has increased the importance of the more intangible forms of GFCF. Our empirical results confirm that FDI has a positive effect on economic growth. The results show that an increase in FDI of 1% leads to an increase in economic growth of 1.57%. These results are consistent with the findings of Abdouli and Hammemi (2017) for the MENA region; Feridun and Sissoko (2011) for Singapore; Alshamsi *et al.* (2015) for the United Arab Emirates. However, Ahmed (2012), Saqib, Masnoon, and Rafique (2013), Elboiashi, Noorbakhsh, Paloni, and Azemar (2009) and Souman and Oukaci (2019) have confirmed that FDI has a negative influence on output. Even for the Asian context, Sharma *et al.* (2018) found that in the long run, foreign aid, government final consumption expenditure and FDI have a positive and significant impact on economic growth. In the same direction, Sharma and Kautish (2021) confirmed that foreign aid and GDP per capita have a significant and positive impact on economic growth in the seven middle-income countries of South and Southeast Asia.

We also observe that TO positively affect economic growth. The effect is significant at the 10% level which means that when TO increases by 1%, economic growth increases by 6.52%. The strong impact of TO is largely confirmed by Abdouli and Hammemi (2017). In the same context, our results prove that INF has a negative impact on economic growth. The estimated coefficient of −0.0205 implies that economic growth decreases by 2.05% if INF increases by 1%. This result is consistent with the findings of Thanh Tung, Chi Minh, and Pham (2015) for Vietnam. In India, Sharma *et al.* (2019) found that INF instability directly influences economic growth. They found that oil consumption has a direct impact on domestic prices. Similarly, due to the increase in employment, INF tends to increase in the long term.

Furthermore, the UMP does not affect economic growth. These results are not in agreement with the finding of Misini and Badivuku-Pantina (2017) and Ellen and Wilson (2019), who found a significant and negative association between unemployment and economic growth in the case of Kosovo. In the Indian context, Sharma *et al.* (2018) found that economic growth was negatively influenced by the exchange rate and the development of human capital during the period 1971–2016.

In the second model (post-COVID), the study aims to expose the response of the determinants of economic growth to the epidemic. In order to understand what factors contribute to the economic resilience of the region in a context of shock, it is necessary to know the characteristics of a region that lead to economic resilience. With the spread of the COVID-19 pandemic in early 2020, MENA countries experienced a double health and economic shock that confronted them with macroeconomic imbalances.

In response to the pandemic, MENA governments have moved quickly to implement lockdowns, including curfews, social distancing and border closures. While these measures have been fairly effective in limiting loss of life and alleviating pressure on health systems, the consequences of lockdowns have severely affected economies in the MENA region, as elsewhere. This is due to strict government responses to quickly control the spread of the pandemic. This leads us to further study the resilience of this region to pandemic uncertainty using the GMM-GLS (least generalized squares) estimate for the period 2019–2021 to assess key economic drivers of post-COVID growth in Table 5.

The results of our second model are summarized in Table 5. We find a negative relationship of (GFCF) with a coefficient of −1.98%. The World Bank (2020) and UNCTAD (2020) confirmed these results, production decreased even with improved equipment and investments. The confinement, the partial demobilization of the workforce is an important factor in the decline in production. Second, we confirm a negative relationship between GDP and FDI with a coefficient of −2.14%. Similarly, Ciobanu (2020) showed that all Central and Eastern European countries may face a higher level of contraction due to the decline in FDI flows. After the pandemic, the higher level of uncertainty regarding Turkey's export destinations leads to a lower economic growth rate in the country (Fang, Collins, & Yao, 2021). The United Nations (2020) noted that FDI dropped by 45% in 2020. Border closure is a major

	Coeff	*T*-Stat	Signif
α_0	0.5251***	0.0052	0.0000
GDP(−1)	−0.3582	0.0000	0.4213
LnTO	−0.0784**	−0.0452	0.0228
LnFDI	−0.0214**	−0.498	0.0301
LnINT	0.1052***	5.1527	0.0001
LnUMP	−0.2321*	−1.9562	0.0752
LnINF	−0.0285*	−0.1485	0.0632
LnGFCF	−0.0198***	−3.4875	0.0004
LnCOV	−0.2052***	3.4251	0.0003
Constant	3.341421**	0.9587	0.0452

Note(s): ***, ** and * statistical significance at 1%, 5% and 10% levels, respectively
Source(s): Authors

Table 5.
Result of panel GMM estimation after COVID-19

factor in the slowdown of economic activity in the MENA region, OECD (2020). This allows us to say that government actions such as containment and closure of schools and workplaces contribute to the resilience of the MENA economy. This result is confirmed by Mirza, Abaidi, Naqvi, Kumail, and Rizvi (2020) who evaluated the performance of equity funds in Latin American countries during the epidemic crisis. The empirical results showed that equity funds improved the effectiveness of their human capital to withstand macroeconomic shocks. This is confirmed by the studies of Ozili (2020). More importantly, we confirm a positive relationship between GDP and INT with a coefficient of 10.52%. Several empirical studies support our results regarding the positive relationship between economic growth and ICT during the epidemic such as Mingis (2020) and Maliszewska, Mattoo, and Van Der Mensbrugghe (2020). In this context, Cowie and Myers (2020) confirmed that information systems and information technology play an important role in the health sector. In addition, the World Bank (2020) noted that school closures require the digital equipment and Internet connection necessary to benefit from distance learning. These findings are confirmed with the studies of O'Leary (2020). This allows us to say that MENA countries such as Dubai, Saudi Arabia and the Emirates have benefited from the high demand for electronic products with the development of telecommuting or distance learning.

Given the diversity of health systems and their capacity to respond to the epidemic in the region, MENA governments' responses to the spread of the Coronavirus have been effective in limiting the loss of life and the spread of the pandemic in oil producing countries. In contrast, the situation is serious in Tunisia, Egypt and Lebanon, which have experienced several waves of emergence. The situation is different for the more prosperous Gulf countries, the developing economies of the Levant or North Africa, and vulnerable and conflict-affected countries such as Iran, Iraq and Libya, where the lack of hospital beds and testing capacity is a concern. Health cooperation and innovation have also improved significantly, particularly in the area of vaccine research. These results highlight significant differences between countries in their health response capacity. With respect to the COV variable, the effect on economic growth is negative and significant with a coefficient of 20.52%. These results are confirmed by Correia, Luck, and Verner (2020), Gans (2020), Susskind and Vines (2020) who find a significant and negative impact of the pandemic on GDP. In this context, Barro, Ursúa, and Weng (2020) find evidence of significant negative effects of pandemic mortality on GDP and positive effects on INF.

Moreover, there are negative effects of INF and UMP on GDP of −2.85% and −23.21%, respectively. These results are confirmed with the study by Ben Romdhane and Mefteh (2022) who found that the decline in economic growth in MATE countries was triggered by a

combination of many deaths from Covid-19, rising UMP, interest rate and a decline in gross fixed capital expenditure on training and education. The costs are due to containment measures which imply a reduction in economic activity. More than that, we find that ICT plays a driving role in economic growth with a two-way link between the Internet user and GDP. The confinement, the partial demobilization of the workforce is an important factor in the decrease in production and therefore an increase in prices due to the decline in supply compared to demand. These results are consistent with Ababulgu and Wana Fufa (2022), Ellen and Wilson (2019) and Suleiman and Joshua (2019) who found a negative association between unemployment and economic growth. Regarding INF, it negatively affected economic growth.

Ababulgu and Wana Fufa (2022) and Baldwin and Tomiura (2020) affirmed that COVID-19 virus has health and economic contagion effects. They confirmed that confinements lead to a sharp increase in unemployment, a decrease in tax revenues and, consequently, a depreciation of the exchange rate.

5. Conclusion and policy implication

This study discloses the drivers of economic growth in the MENA region by explaining the response of these economic factors in the COVID-19 era. Specifically, we first investigate the effect of ICT and macroeconomic variables on economic growth during the two periods 2001–2018 using the GMM method. Then, we add the COV variable that expresses the number of COVID-19 deaths during the years 2019–2021 using the GMM-GLS estimator.

Before the pandemic, we find that economic growth is positively affected by GFCF, FDI and TO and ICT. In contrast, the effect of INF on economic growth is negative and significant. These results are confirmed by several researchers such as Misini and Badivuku-Pantina (2017), Stock and Seliger (2016) and Tung and Thanh (2015). After COVID-19 propagation, the empirical results prove that all explanatory variables in our first model change sign and become negative as a result of the negative consequences of the health crisis in the MENA region. More interestingly, we find a unique and significant positive relationship between ICT and economic growth. Thus, high levels of ICT improve economic growth. This result is consistent with the findings of Maneejuk and Yamaka (2020), Kurniawati (2021). In other words, the positive association between ICT and economic growth depends on the ICT infrastructure. Moreover, the positive impact of ICT on economic growth has also been confirmed by numerous research studies in several countries. Indeed, Khan, Khan, Jiang, and Khan (2020) for the South Africa; Kurniawati (2020) for the OECD; Ghosh (2017) for MENA and Zhang and Danish (2019) for Asia. This suggests that ICT is a resilience factor, especially in times of rapid COVID-19 spread. This result is consistent with the findings of Altig *et al.* (2020), Barro *et al.* (2020), Ben Romdhane and Mefteh (2022), Correia *et al.* (2020), Gans (2020), and Ozili (2020).

When considering the relationship between ICT and COV on economic growth, the role of other explanatory variables cannot be neglected. We find that economic growth is negatively affected by GFCF, FDI and TO, the UMP and INF. This allows us to argue that government actions such as lockdowns and closures of schools and workplaces contribute to an economic crisis in. Thus, investing in digitization is a key policy consideration to limit the expansionary effects of COVID-19. More importantly, these countries could also experience a rapid recovery through technology. Indeed, MENA's geographic position is strategically advantageous and allows countries to play an important role in FDI and TO if they adopt new technologies. Furthermore, most governments in the region have taken unprecedented measures to mitigate the effects of the pandemic on the population, including rapid social transfers. In this regard, MENA governments could implement new strategies that increase ICT integration to strengthen their innovation competitiveness.

Policy makers in MENA countries therefore need to increase national investments and improve the quality of ICT. They could take bold steps to support new strategies and strengthen their innovation competitiveness, thereby producing better solutions to limit the spreading effects of any future pandemic. Indeed, policy makers have an interest in encouraging the evolution of regulatory structures that embrace and regulate technology businesses as an integral part of the economy. ICTs can help foster more technologically advanced businesses and investments that strengthen health systems. In addition, there is a need to initiate short- and long-term measures that address the needs of vulnerable groups and to strengthen regional action and funding mechanisms to build next-generation infrastructure networks.

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