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RESEARCH ARTICLE

Economic growth, social, and welfare development during COVID-19 pandemic: do country-specific characters matter in the MENA region?

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Abstract

The coronavirus disease 2019 (COVID-19) pandemic has generated major shocks that have crippled the economic development of many countries and regions. The COVID-19 pandemic has hampered not only economic development but also global countries from achieving their sustainable development goals through various channels. Given their first experience, many countries have no guidelines for measuring the true impact of the pandemic on their economic and social development, either at the global, regional, or country level. Amid the current slow research development in this area, this study investigates the medium- and long-run impact of the COVID-19 pandemic on the United Nation's achievement of sustainable development goals. The sample in the study comprises the Middle East and North African countries, including Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, and Yemen. The social development goals are approximated by economic growth and human development index, which play as the dependent variables representing two models, respectively. From another aspect, independent variables are derived from three primary sectors: government, households, and healthcare providers. In estimating the model, the study implements the panel regression estimation method using multiple variance estimators. The study findings will help policymakers formulate deliberate policy plans to stabilize economic and social fluctuations in the region and to improve the performance of basic macroeconomic parameters.

Keywords Environ-economic · COVID-19 pandemic · MENA · Panel data

JEL Classification Codes: O1 · I3 · I15 · I18

Introduction

The coronavirus disease 2019 (COVID-19) pandemic, which started in 2019, is a new global disease phenomenon with substantial impacts worldwide. The pandemic has forced humanity to adapt to a new way of life, the so-called new normal, where distance is a key component of every daily activity. The changing daily life has also marked deep scars on the economic health of countries globally through supply and demand, which led to economic contractions and inevitably forced countries to raise their debt. Scholars agree that the COVID-19 pandemic has increased the susceptibility of vulnerable countries because of the sundry shocks distressing the world economies (OECD 2020; Agbe 2020; IFC 2020). Consequently, the pandemic has moved countries further from achieving their sustainable development goals (SDGs) of the United Nations (Fenner and Cernev 2021; Samout and Marnissi

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2020). Furthermore, the precise impact of the pandemic on economic and social development is unknown owing to the absence of formal procedures in mitigating COVID-19-related global diseases, which makes every country mitigate the pandemic differently.

The substantial adverse impact of the pandemic also occurred in the Middle East and North Africa (MENA) region. Figure 1 illustrates the dynamics of economic growth (i.e., gross domestic product (GDP) growth) and human development index (HDI) in the MENA region before and during the pandemic.

Figure 1 shows that the COVID-19 pandemic has significantly impacted MENA's economic and social development. Regarding economic growth, panel (a) shows that at the start of the pandemic, GDP growth declined from 2.05% in 2018 to 1.12% in 2019. Furthermore, the decline fell even further to − 3.57% in 2020, which was the lowest GDP growth of MENA's economy within the last decade. Similarly, in the case of HDI, which we use in this case to represent social development, the pandemic also corresponds to the fall of HDI significantly from 0.765 in 2019 to 0.756 in 2020, as shown in panel (b).

The disruption in economic activities has made the MENA region, including United Arab Emirates (UAE), reconsolidate its strategies toward achieving the SDGs (Farayibi and Asongu 2020). Some of these could include the following: (i) leverage on new sets of macroeconomic and developmental policies that would reposition MENA to cope with the new economic realities (Coibion et al. 2020a); (ii) institute managed containment measures that are in tandem with the economic realities in the region; (iii) engage collaboratively with international partners as economic losses can easily spread from one state to another (MENA is no exception) via various channels. Although the COVID-19 pandemic corresponds to falling economic growth and HDI, an empirical study is necessary to validate this hypothesis. This gap in the literature, particularly for the MENA region, motivates this study to investigate.

This study investigates the impact of the COVID-19 pandemic on the SDGs of the United Nations in the MENA region. The MENA region in our study includes Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, UAE, and Yemen. With regard to SDGs, most of the SDGs, such as no poverty, zero hunger, equality, and sustainable cities, can be achieved by increasing social welfare. In this study, we use economic growth and HDI to approximate SGDs. Precisely, economic growth is used to approximate SDG 8 (i.e., promote inclusive and sustainable economic growth, employment, and decent work for all). From another aspect, HDI is constructed based on health, education, and living standards. Hence, HDI is used to approximate SDG 1 (i.e., ends poverty in all its forms everywhere), SDG 3 (ensures healthy lives and promotes well-being for all ages), and SDG 4 (i.e., ensures inclusive and quality education for all and promotes lifelong learning).

This research is important for two reasons. First, preliminary highlights show that MENA (i) faced an estimated loss of US $42 billion of GDP, (ii) saw an increase in the unemployment rate by 1.2% caused by the pandemic, and (iii) lost over 1.7 million jobs in 2020 (ESCWA 2020). Thus, given the interconnectedness and interdependence of countries owing to globalization, economic losses might spread to the MENA region through various channels. Examples include the disruption of prices and global trade (Brunnermeier et al. 2020), decrease in remittance flows, contraction of tourism, and the atrophy of domestic capital, accompanied by the fall in oil prices (Agbe 2020). Second, the weaknesses of macroeconomic variables driven by the pandemic require a proper understanding of the consequences of the COVID-19 pandemic in the selected geography.

The research question in this study is to examine the macroeconomic and social impact of the COVID-19 pandemic across MENA nations. In answering the research question, some objectives are as follows. First, this study aims to

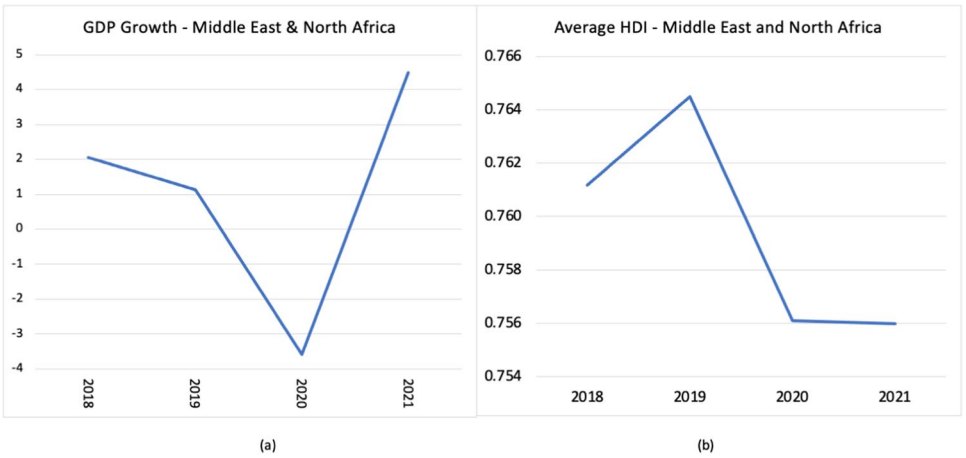

Fig. 1 **a** GDP growth 2018–2021 (World Bank 2022) and **b** HDI 2018–2021 (UNDP 2022)

provide an overall economic outlook and regional development during the global pandemic in MENA countries, including the UAE. Second, this study aims to elaborate on the role of country-specific characteristics by examining the effects of the COVID-19 pandemic on economic growth. Based on the estimated empirical findings, we finally aim to provide policy implications to mitigate the economic challenges which the MENA region and the UAE face in the post-COVID-19 pandemic period.

In answering the research question, we develop two models. The first model aims to investigate the impact of the COVID-19 pandemic on economic growth, whereas the second model aims to examine the impact of the COVID-19 pandemic on HDI. The dependent variable in the first model is GDP growth, derived from the World Bank, whereas the dependent variable in the second model is HDI, derived from the United Nations Development Programme (UNDP). The independent variables in both models are identical, which are classified into three groups, namely, government, households, and healthcare providers. The government-related variables include stringency index, number of COVID-19 cases, and number of deaths. The household-related variables include life expectations and population growth. Finally, the variables from healthcare providers include handwashing facilities and hospital beds.

In estimating the model, we apply the panel vector autoregressive method (PVAR) as the primary method of analysis. We also incorporate the role of country-specific characteristics that would determine the trajectory of the developmental policies. In accommodating country-specific characteristics, we build multiple PVAR model alternatives based on various variance estimators, such as pooled ordinary least squares (OLS), robust estimators, clustered country, clustered time, bootstrap, and jackknife estimation. Furthermore, under each model alternative, two scenarios are applied, namely, with and without lagged controls. More specifically, the first scenario is the case where the independent variables are in the contemporaneous time horizon. Then, the second scenario is the case where the independent variables are in one lag period horizon. Thus, we simulate four models in total.

The PVAR is adopted mainly because of the following. From the methodological perspective, a regional reform agenda is imperative to manage structural imbalances and create a new inclusive growth model. However, most of the analyses reviewed focus on point estimation using the pooled fixed effect method (e.g., OECD 2020; Gourinchas 2020; ESCWA 2020; Agbe 2020). This approach cannot capture the dynamic effect of the COVID-19 pandemic over time. Thus, we apply the PVAR to address this issue. Based on the impulse response function, the effects of the COVID-19 pandemic in the MENA over the considered time horizon can be identified.

The novelty of this study is considered as follows. First, to the best of our knowledge, this study is the first to investigate the impact of COVID-19 on SDG objectives focusing on economic growth and HDI, particularly in the MENA region. Second, our study is also novel as we propose thorough multiple variables covering the government policy, households, and health care providers, which have not been explored in previous literature. Third, in terms of the estimation method, our study also differs from the past literature in the form of presenting multiple scenarios of regressions using different assumptions of variance estimators and lag effects. Given its novelty, this study is expected to deliver findings that can be useful either for policymakers in practice or for the development of the current literature.

Some contributions of this study are as follows. First, this study contributes to filling the literature gap, which is the missing studies focusing on the impact of the COVID-19 pandemic on SDGs, particularly economic growth and HDI, in MENA countries. Second, this study contributes to policymaking analysis. That is, this study is about the implications of the pandemic on several economic variables and the potential effects of subsequent waves of the pandemic arising new trends worldwide. Moreover, the study aims to understand relevant macroeconomic policies to hedge the pandemic, particularly in vulnerable states such as MENA nations. Third, this study would help the selected middle-income countries in MENA to better handle the consequences of the pandemic and reposition their economies toward achieving sustainable development.

The rest of the paper is organized as follows. "Review of theoretical and empirical literature" section presents the review of the theoretical and empirical literature, and "Theoretical framework" section highlights the methodology adopted for the study. "Data and specification of model" and "Empirical results and discussion" sections show the discussion of results and requisite policy recommendations. Finally, "Conclusion, recommendations, limitations, and areas for future research" section concludes the study.

Review of theoretical and empirical literature

Review of theoretical literature

A theoretical underpinning ensuing from extant studies provides the anchor to transverse the review of the macroeconomic analysis of the pandemic to predicate the discussion. Hinged on theoretical foundations, the study established the trajectory of the effects of infectious diseases on the performance of macroeconomic variables. This study, therefore, provides the framework for assessing the transmission

mechanism between global infectious disease and socioeconomic activities.

From a neoclassical perspective, a pandemic induces an output shock that arises from the desire to make rational decisions necessary to smooth the path of consumption. From the supply side, a pandemic induces a temporary supply shock in the short run because of the disruptions of the distribution process of goods and services in the economy. This disruption further aggravates the uncertainty surrounding established global supply chains and the subsequent consequences on labor demand and transportation costs. From the demand side, a corresponding fall in aggregate demand ensues owing to policy responses designed to contain the spread of the virus, such as restrictions in movement and social distancing, which limit the extent of economic activities.

The time dimension of the supply and demand shocks is moderated by the conceptual characterization of the shocks. For instance, an endogenous supply and demand shock yields policy responses from the domestic economy, moderated by the degree of flexibility and efficiency of the macroeconomic policy transmission framework. However, an exogenous demand and supply shock defies domestic policy prescriptions because of the primordial drivers of such shock, which are not domiciled within the domestic economy.

Furthermore, theoretical analysis showcasing the macroeconomic implications of the COVID-19 pandemic has been documented. Although not exhaustive, such analysis corroborated the theoretical linkage between infectious diseases and the subsequent performance of macroeconomic variables. Some of the macroeconomic consequences of the pandemic include the following: (i) inducing a negative shock to the growth rate of productivity, (ii) generating a large negative shock to the utility of consumption, and (iii) aggravating the macroeconomic effects by altering optimal rational responses of economic agents (Fornaro and Wolf 2020; Faria-e-Castro 2020; Eichenbaum et al. 2020; Yeyati and Filippini 2021; Ekwebelem et al. 2021).

Productivity growth is linked to the growth in the stock of factor inputs, such as labor and capital. An incursion of a global pandemic induces a corresponding disruption in the aggregate factor inputs. As opined by Fornaro and Wolf (2020), this case may induce labor hoarding by firms who rather hold on to their workers at a loss or let them go at the given wage, destroying the match and losing future profits. This case becomes plausible because of the endogenous technological changes and stagnation traps caused by the temporary supply shocks that originate from the shutdown. However, the elasticity of the production function moderates the extent of output loss and the adjustment mechanism.

Furthermore, an infectious disease such as the pandemic elicits sporadic government responses to contain the spread of the disease. Such responses often involve instituting sundry restrictions such as social distancing, outright restriction of movement, and shutdown of interactions, which negatively affect economic activities. The restrictions crowd out potential production and consumption activities and moderate the level of utility maximization of goods and services during the period. These scenarios cause a negative shock to the utility of consumption and disrupt the RBC hypothesis, which postulated a lifetime path for consumption smoothening (Faria-e-Castro 2020; Ekwebelem et al. 2021).

The pandemic also affected the potential responses from economic agents caused by several restrictive policies instituted to prevent the spread of the virus, which may not allow optimal rational choices. This case offsets the response trajectory of the economic agents in a bid to edge against probable losses during such periods. This event, therefore, has macroeconomic consequences, but the magnitude may depend on the speed at which the disease spreads and the corresponding potency of the implementation framework of the government containment policies (Eichenbaum et al. 2020; Yeyati and Filippini 2021).

In another parlance, the pandemic induced contractions in the employment level because of the incomplete market framework resulting from several containment policy measures. Given the intertemporal elasticity of substitution, the shutdown exercise in the affected sectors reduced the marginal utility of unaffected goods, thereby leading to a significant decrease in the demand for such goods. The crowd-out in demand and potential production losses unwittingly resulted in downsizing and labor loss (Guerrieri et al. 2020). Such employment cut signaled an autonomous response from the firms to protect shareholders' interests and returns on investment.

Essentially, the pandemic portends serious implications for the conduct of fiscal and monetary policies, given that the general policy environment becomes murky because of the increased uncertainty in the level of the policy transmission mechanism (Tieman et al. 2021). From the monetary policy perspective, the pandemic created a difference in marginal propensities to consume because of the possibility of an incomplete market model, allowing for heterogeneous agents and uninsurable income risk and liquidity constraints (Guerrieri et al. 2020). From the fiscal policy viewpoint, government expenditure increased exponentially above the pre-pandemic levels causing some fiscal imbalance, particularly for countries with precarious fiscal structures. This case had lasting effects on the subsequent conduct of macroeconomic policies because of the pandemic hangover and sporadic fiscal fragilities across the globe (Adebayo et al. 2022).

Review of empirical literature

Empirically, the COVID-19 pandemic has exacerbated the susceptibility of vulnerable countries (OECD 2020; Agbe 2020; International Finance Corporation 2020). In particular, the economic disturbances caused by the pandemic have made the MENA states reprioritize their approaches toward achieving the SDGs (Farayibi and Asongu 2020). For instance, the MENA had leverage on new sets of macroeconomic and developmental policies that would help MENA to cope with the new economic realities (Coibion et al. 2020a). Meanwhile, the economic consequences of the pandemic were significant, where country-specific characteristics would determine the trajectory of developmental policies in middle-income nations, such as Egypt, Jordan, Morocco, Mauritania, and Tunisia. The pandemic-driven shocks relate to negative effects on employment, poverty rates, and production activities. The spread of COVID-19, thus, has severe economic costs, accompanied by major events in terms of negative demand, disruption in supply chains, and the collapse of oil prices (OECD 2020; Usman and Akadiri 2022).

The stringent policies proposed by the MENA governments, *inter alia*, lockdown rules, social distancing, or other restrictions on business, involve a series of economic harms. Moreover, the region is facing a trade-off between these restrictive measures and socioeconomic losses. Gourinchas (2020) noted that the trade-off between measures to contain the spread of COVID-19 and economic goals is even more obscure, as the crisis could have been deeper without these containment measures. The such analysis emphasizes globalization patterns and economic losses, which can easily spread from one state to another (and MENA is no exception) through various channels, such as the disruption of prices and global trade, decrease in remittance flows, contraction of tourism, and the atrophy of domestic capital, all accompanied by the fall of oil prices (Agbe 2020).

Apparently, the pandemic induced a global economic recession that cuts across major countries, including the MENA region, whose economy responded to global economic shocks and a fall in global oil prices. The fiscal deficit in the region decreased because of the support for households and government bailouts to companies funded through the issuance of debt instruments. Output disruption and fiscal fragility generally induced by the pandemic in the MENA countries and beyond placed by the government increased the government debt burden, particularly in developing countries (Yeyati and Filippini 2021).

Sundry fiscal imbalance induced changes in a country's response to collective actions toward the United Nations' SDGs. Many countries, such as the MENA region, could not meet up with their sundry commitments to the achievement of global goals. Thus, many redeployed their funds and support to cushion the effects of the major shocks from the pandemic. This case showed the differentials in governance structure and the ability to respond to emergencies because the pandemic revealed the precariousness of most developing countries. The economic imbalance between developed and developing countries became pronounced because of the skewed trajectory of COVID-19 (Marzouk et al. 2022).

In Egypt, COVID-19 disrupted the achievement of the SDGs. In a system dynamic model of Marzouk et al. (2022), the ramification associated with health and economic consequences slowed down the achievement of the SDGs. As such, limited resources, setting priorities right, and the ability to make a comparison between the cost and benefit of every action moderated the achievement of various poverty reduction and alleviation initiatives (Batisha 2022). Hence, most economies were affected, where MENA countries such as Tunisia seized the opportunity to accelerate the adoption of technological solutions and renewable energy market potentials (Santos-Carillos et al. 2020; Eissa 2020; Samout and Marnissi 2020).

The financial market was negatively affected in the MENA region during the pandemic as a country, for instance, Morocco had a major decline in their share index on the announcement of the COVID-19 case. Egypt and Morocco are part of the countries with the highest number of confirmed cases of COVID-19 in Africa (Ekwebelem et al. 2021). This case was an offshoot of the COVID-19-induced negative effect on the GDP of many countries resulting from the crowd-out in economic activities. Most MENA countries had a negative GDP growth rate during the COVID-19 pandemic. For instance, Egypt had a 3.5% decline in GDP growth depicting a contraction in the country's economy (Fuente-Mella et al. 2021; Cross et al. 2020).

The disruptions in global trade during the pandemic in turn affected the economies of MENA countries. There was a disruption in the supply chain, whereas imports and exports were greatly destabilized because of the lockdown and restriction policies. The country's net exports fell as demand was rationalized or reprioritized. MENA countries focused on healthcare delivery and citizens' survival, thereby having some adjustments in the composition of the imported goods. Import substitution and how to make locally made products were also prioritized to survive through the pandemic. Most producing countries that lacked raw materials adopted the rationing model. This case led to an approximately 13% decrease in the production of automobile manufacturers because of less access to parts, whereas pharmaceutical companies had a shortage in materials supply (Fernandez et al. 2020; Xu et al. 2020).

In other MENA countries, the supply of food products was affected by the pandemic as farming and transportation activities (the major anchor in the delivery of these food products) plummeted. Farmers could not access their

farmlands for planting processes because of the pandemic. A fall in labor supply to farms owing to the lockdown caused pre- and post-harvest challenges to farmers and increased the level of wastage recorded by farmers. In addition, the limitations of transportation of farm products because of the quarantine, lockdown, and restriction affected the consumption of agricultural products in the MENA region. The reduction in farming activities because of the pandemic had a negative effect on output and employment (Guerrieri et al. 2020).

Extant studies revealed that demand distortions were mostly product-specific in MENA countries. Pharmaceutical products, such as chloroquine, used by countries for the treatment of COVID-19 were in high demand. Demand for other goods, such as surgical masks, gloves, nose masks, hand sanitizers, and thermometers, increased sporadically. However, demand for luxury goods fell significantly because of the shift in priority of consumers from leisure to survival and the trajectory of buying behavior from consumables to essential goods and services. Particularly, aggregate demands in the aviation industry fell drastically because travel restrictions caused a fall in air travel. Leisure and tourism in MENA countries and, indeed, across the globe were greatly affected, crowding out the potential income from the sector (Xu et al. 2020).

The pandemic's effect on social capital reshaped and redefined work dynamics in the MENA region. Conventional and traditional work modes were liberalized and leveraged with technology. New semantics, such as virtual class, virtual teamwork, and virtual meetings, dominated the workspace as the restriction forced new order in social cohesion with less face-to-face interaction. Despite the negative unemployment implications, the new normal redefined work modes giving employees the opportunity to work from home. This case had the substantial potential to reduce the family–work conflict, such as increased childcare and generally improve work–life balance (Kniffin et al. 2022). However, as most home settings were not work-friendly, this case caused a great strain on their effectiveness and productivity (Carnevale and Hata 2020).

Overall, there was a shift in global attention from the achievement of the SDGs to tackling the pandemic. The slowdown of economic activities in MENA countries increased the level of inequalities and created conspicuous imbalances among sectors. As the goals are intertwined and overtly connected, progress with one of the goals will lead to the other goals and vice versa (Fenner and Cernev 2021). Thus, there was a trade-off between keeping up with the commitment to achieving SDGs and preferring solutions to the emergency health cum economic problems ravaging across the globe. This event places a probability of attaining the SDGs as stated by the United Nations by the year 2030 because of the pandemic-driven compromises.

Recent studies

The impact of the COVID-19 pandemic on economic growth and HDI is a newly growing research topic, particularly for MENA countries. This topic is new because no formal procedure is available to mitigate this new pandemic. Hence, how the pandemic affects a country's economy or through which channel the pandemic impacts the country's economy, and human development is not fully understood. This section specifically examines recent studies related to the achievement of SDGs and how they relate to our study. However, most recent studies focused on climate change.

The closest recent studies to ours are the studies of Adebayo et al. (2022), Abdussalam et al. (2022), and Akadiri et al. (2022), who investigated the impact of renewable and non-renewable energy consumption on carbon emission amid the COVID-19 pandemic. These studies were conducted in the UK during the pandemic of 2020–2021. The studies demonstrated that renewable energy consumption decreases carbon emissions, whereas the rise of fossil energy consumption increases carbon emissions, even amid the COVID-19 pandemic. Furthermore, a positive variation of COVID-19 cases reduces carbon consumption, which means reducing economic growth. Hence, the finding also confirms that the pandemic indirectly reduces economic growth through reduced carbon consumption, which hampers the country from reaching SDG 8 (decent work and economic growth). The studies implemented some non-linear estimation techniques, such as non-linear ARDL and Markov switching regression. However, although the studies involved COVID-19, the literature gap remains in terms of the absence of HDI.

Other recent studies also indirectly showed the relationship between energy consumption and economic growth amid uncertainty, although uncertainty is not COVID-19 pandemic related. For example, globalization can also be considered an economic uncertainty, considering that through globalization, a country may experience external shocks originating from other countries. Suki et al. (2020) examined the impact of globalization on environmental quality under the environmental Kuznet curve hypothesis. Their study is conducted in the case of Malaysia during the period 1970–2018. In the study, globalization includes social, economic, and political factors. Using the quantile autoregressive distributed lag (QARDL), their study demonstrated that globalization affects environmental quality negatively in the long run. In other words, this finding indicates that globalization uncertainty reduces economic growth, which decelerates the country to achieve SDG 8 more quickly. However, their study still lacks HDI.

The uncertainty of globalization is also introduced by Miao et al. (2022). Specifically, Miao et al. (2022) examined the impact of financial globalization and renewable

energy consumption on ecological footprint, which indirectly relates to economic growth. The higher ecological footprints indicate higher energy consumption and indirectly show higher economic growth. Their study was conducted in newly industrialized countries over the period of 1990–2018. Using the method of moments quantile regression as the primary estimation method, their study demonstrated that financial globalization affects economic growth positively. In other words, financial globalization can help the country reach SDG 8 more quickly. Furthermore, economic growth and natural resource rents tend to increase carbon emissions. However, no information regarding the role of HDI is provided in this study.

Khan et al. (2019) introduced uncertainty in terms of economic and social factors. Specifically, Khan et al. (2019) investigated the impact of logistic, economic, and social factors on environmental sustainability in some emerging Asian countries. Their study demonstrated that logistics increases per capita income but increases carbon emissions in the countries group, which indicates rising economic growth. Their study implemented a fully modified OLS model and dynamic OLS. Furthermore, their study demonstrated that some social factors such as political instability, natural disaster, and terrorism could impact environmental quality negatively and hence prevent achieving SDG 8 even further. However, although Khan et al. (2019) provided economic and social factors, they did not incorporate simulation regarding the presence of economic uncertainty in the model. Moreover, their study has a literature gap in terms of the absence of HDI.

For example, Sharif et al. (2019) investigated the impact of renewable and non-renewable energy consumption on carbon emissions across 74 nations. Their study was conducted within the period from 1990 to 2015. Their study demonstrated that non-renewable energy consumption has a detrimental impact on environmental quality, whereas renewable energy is able to reduce environmental degradation. Furthermore, their study demonstrated that financial development has a positive impact on environmental quality (Kirikkaleli et al. 2021), increases economic growth, and is helpful in achieving SDG 8 more quickly. Their study was conducted using the CIPS unit root test, Westerlund bootstrap cointegration, Pedroni cointegration, FMOLS, and heterogeneous panel causality test. The finding of Sharif et al. (2019) is also similar to that of Sharif et al. (2020a), demonstrating that economic growth significantly and positively affects carbon emissions across different quantiles. Moreover, their study showed that the environmental Kuznets curve (EKC) hypothesis is confirmed in the country. Furthermore, globalization and transportation impose a negative impact on environmental quality in the country, although they may boost economic growth. However, Sharif et al. (2019, 2020a) did not incorporate HDI in their study.

Innovation is also a type of uncertainty as its coming is not predictable, and its presence can affect the global economy significantly. Adebayo et al. (2023a) examined the impact of technological innovation, renewable energy consumption, and natural resources rents on carbon emissions in the case of Brazil, Russia, India, and China between 1990 and 2019. Based on the CS-ARDL as the primary method of estimation, their study demonstrated that innovation, renewable energy, and natural resource rents reduce environmental degradation by preventing pollutants production either in the short and long run. This result implies that economic growth may remain constant amid the increased consumption of renewable energy because of the role of innovation (Kirikkaleli et al. 2021). Even in the long run, renewable energy consumption may likely enhance economic growth, followed by pollutant reduction. Thus, renewable energy consumption is helpful in helping the country to achieve SDG 8. However, Adebayo et al. (2023b) also did not incorporate HDI in the study.

Sharif et al. (2020b) investigated the impact of renewable and non-renewable energy consumption on carbon emission in the case of Turkey. The study was a long-run investigation within the period of 1965–2017. Their study also demonstrated that renewable energy consumption decreases carbon emissions by pressuring ecological footprint in the long run. However, the falling ecological footprint may also affect reduced fossil energy consumption, which affects economic growth negatively in the short run and hampers the country to achieve higher growth. However, in the long run, more sustainable growth is achievable owing to the rising innovation and environmental technology, which accelerates the country to achieve SDG 8. The study also demonstrated that a causal relationship occurs between renewable energy consumption and economic growth. Finally, the EKC hypothesis is also confirmed in the country. However, Sharif et al. (2019, 2020b) lacked HDI in terms of their relationship with environmental quality.

Wang et al. (2023) investigated the impact of nuclear, hydro, and biomass energy on environmental degradation in China within the period of 1970–2020. The study also incorporated economic growth as one of the additional control variables. Using the quantile regression, their study demonstrated that nuclear, hydro, and biomass energy contribute to environmental degradation in the country by raising ecological footprints. This finding, thus, hampers the global economy from reaching SDG 8 in the long run, as economic growth may be boosted in the beginning but may not sustain because of environmental degradation. The study of Wang et al. (2023) is also missing HDI.

Similarly, Adebayo et al. (2023b) also investigated the impact of economic growth on environmental quality amid the role of hydroelectricity energy consumption and natural gas energy consumption. The study examined the relationship in the case of the USA over the period 1965–2020.

Using the wavelet local multiple local methodologies, their study demonstrated that economic growth negatively affects environmental quality in the country, either in the short or long run. Furthermore, the study demonstrated that hydroelectricity energy consumption and natural energy consumption contribute to the rising carbon emissions in the country. Hence, hydroelectric energy consumption may boost economic growth in the short run but may jeopardize the sustainability of economic growth in the long run. However, Ullah et al. (2023) also missed presenting the role of HDI.

Wan et al. (2022) investigated the impact of natural resource abundance, green financing, and government environmental policy on environmental quality. The sample in this study is China during the period of 2000–2019. The study demonstrates that natural green investment, natural resource management, and environmental tax policy increase environmental quality, which means reducing environmental degradation in China in the short- and long-term. This finding implies that natural green investment, natural resource management, and environmental tax policy may help the country to achieve long-run sustainable economic growth in the future, which suits the SDG 8 objective. Finally, another example is from Xiao and Sahar (2022), who examined the impact of green financing and green technology on carbon emissions. The study incorporated G10 countries as a sample within the period of 2000–2018. Using the QARDL, their study demonstrated that green financing and green technologies reduce carbon emissions. In other words, green financing and green technologies encourage carbon neutrality in the region, which means promising to help the country to achieve SDG 8 more quickly and deliver sustained economic growth.

Research gap and summary

Across all the literature compared above, evidently, studies focusing on the impact of the COVID-19 pandemic on SDGs are limited, specifically economic growth and HDI. The research gaps between past literature and the present study can be categorized into some points. First, no past literature incorporated economic growth and HDI simultaneously. Second, a literature gap exists in the case of the relationship between COVID-19 and HDI, which is less explored by the current literature. Third, from the perspective of the sample used in the study, similar studies for Middle East countries are also lacking, such that further studies are required to enrich the current literature regarding the impact of COVID-19 on SDG objectives in the Middle East region.

Therefore, this study differs from other studies in terms of several aspects. First, to the best of our knowledge, this study is the first to investigate the impact of COVID-19 on SDG objectives focusing on economic growth and HDI, particularly in the MENA region. Second, our study is also novel as we propose thorough multiple variables covering the government policy, households, and health care providers, which have not been explored in the previous literature. Third, in terms of the estimation method, our study presents multiple scenarios of regressions using different assumptions of variance estimators and lag effects. Given its novelty, this study is expected to deliver findings that can be useful either for policymakers in practice or for the development of the current literature.

Theoretical framework

The COVID-19 pandemic is a new experience for countries globally. Hence, economists, academics, and policymakers have no solid understanding regarding the transmission of this new disease on the economic stability of a country. Similarly, no well-known theoretical foundation lies in explaining how the pandemic affects the economy. However, although a new disease, the COVID-19 pandemic's impact on the economy and its transmission mechanism should be approximated by some general theories. This section focuses on the theoretical framework of the study. Specifically, we provide some theoretical justification behind the selection of the variables employed in the model.

The theory of economic growth is the primary key behind our theoretical framework. Solow growth theory (Solow 1956) is considered a pioneer in economic growth theory. The theory explains that economic output (Y) is the product of total factor productivity (TFP), capital (K), and labor (L). That is:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}, \tag{1}$$

where α is capital share. Furthermore, Mankiw et al. (1990) further developed the Solow growth theory by incorporating the element of innovation or human development into the growth equation. The theory is, thus, modified as follows:

$$Y_t = K_t^{\alpha} H_t^{\beta} \left(A_t L_t\right)^{1-\alpha-\beta}, \tag{2}$$

where H denotes human capital or innovation, and β denotes the share of human capital. This equation implies that human capital is an essential intrinsic part of economic growth. This definition is also similar to UNDP's definition stating that HDI measures social and economic development based on health, knowledge, and standard of living. Hence, economic growth theory is a central theory behind our theoretical framework for both our dependent variables (i.e., economic growth and HDI).

Our theoretical framework involves some agents, namely, households, government, and healthcare providers. Figure 2 describes the logical chart from our theoretical framework.

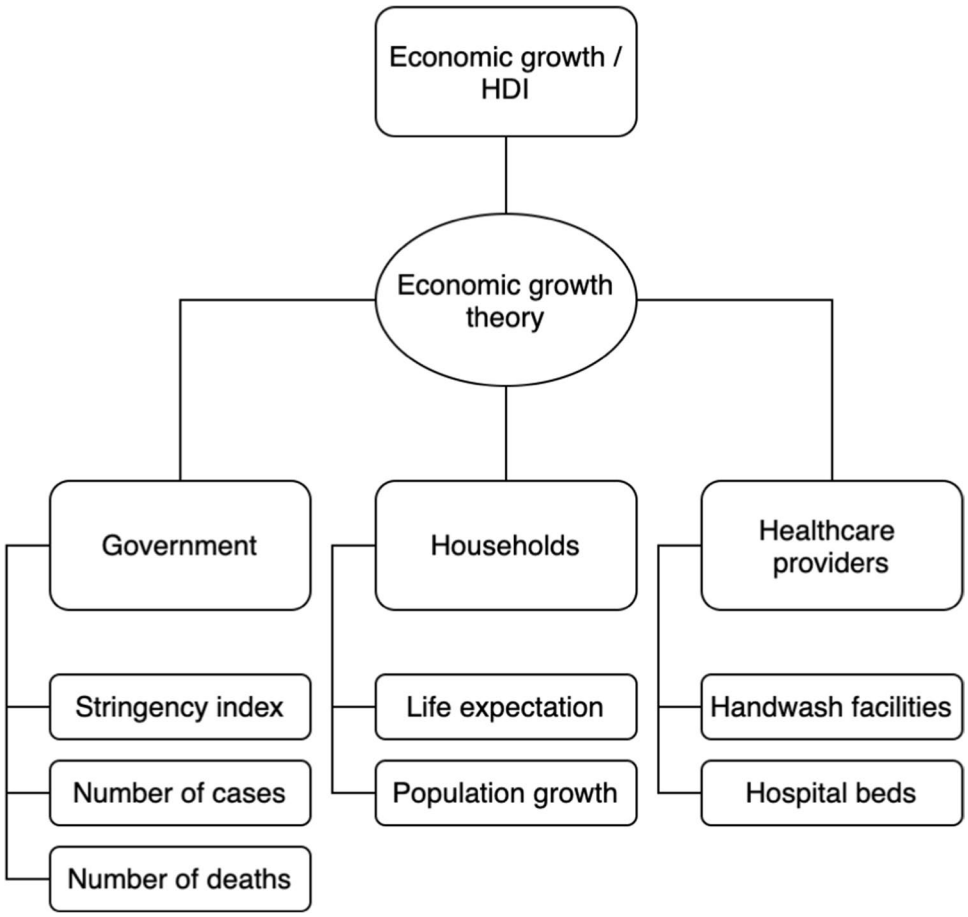

Fig. 2 Theoretical framework

Three variables are presented to represent government contribution to the overall economic growth, namely, the stringency index, the number of cases, and the number of deaths. The last two variables are categorized into the government side as the local government is the only authority having the right to recap and announce the number of cases and the number of deaths from the disease. The stringency index is a variable involved in this study that is strongly related to the falling labor productivity, particularly owing to the lockdown policy. A lockdown is a government policy to isolate a particular region from outsiders during a pandemic. This regulation inevitably restricts people's movement, including some productive activities such as working, studying, or trading. Although some replacement programs, such as work from home or study from home, were encouraged, these programs were not sufficient to replace the falling rate. In addition to the lockdown, people who were infected by the disease were also obliged to isolate themselves at home or at a hospital and take rest, which disables them from gaining optimal productivity.

One of the possible transmission channels from the COVID-19 pandemic to the economy is falling labor productivity. The impact of falling productivity on the economy is significant. Recall that even the simplest economic growth model from Solow defines Y as the interaction between TFP, K, and L (with respect to capital share and labor share). Hence, the falling productivity and labor is caused by the impact of the COVID-19 pandemic on the economy from L, which should reduce output, everything else equal. Although the rise of TFP theoretically can offset the falling labor, unfortunately, people and organizations require time to adapt to a new normal, and hence, the adverse impact of falling labor productivity on the economy should be greater. The number of cases and deaths also contribute to the falling labor productivity. The higher number of COVID-19 cases forces people to isolate and miss work. This situation also reduces economic activities, income, and hence, economic growth in general.

Another transmission channel from the pandemic on the economy is the confidence factor. Two variables in this study relating to this channel are the number of cases and deaths. In addition to causing a drop in labor productivity, the soaring number of COVID-19 cases and deaths also influences investors' perception of the country's investment security. Investors tend to suspend their plans to invest until the country's destination situation becomes under control. The number of cases and deaths not only signals a gloomy future economy but also affects the capital flow and hence stock market and currency

market performance. General currency exchange theories apply here. Some countries experience significant currency depreciation during the pandemic as capital tends to outflow from the country and reduces the demand for local currency. Similarly, falling productivity and the negative sentiment from continual information of the number of cases and deaths also erode stock market capitalization.

Two variables incorporated in our model come from the healthcare system. That is, handwashing facilities and hospital beds per 1000 people are chosen to represent the contribution of healthcare providers to the overall economic performance. The first variable, handwashing facilities, is incorporated into the model to signal mitigation efforts in curbing the negative impact of the pandemic on the economy. Handwashing had never become so important until COVID-19 appeared. It is probably the second key element of protection against the virus after the lockdown. The greater the number of handwashing facilities, the better the sanitation, and hence, the greater the degree of health. The greater the degree of health, the more able the people to engage in economic activities and the faster the economic growth. The general microeconomic theory applies here. When people are healthy enough, they can allocate more time to work over leisure, increase productivity, and hence have a greater output.

Hospital bed (read: hospital) availability is also considered crucial for the economy. Productivity remains the ultimate channel through which hospital beds affect the economy. The impact of hospitals on the economy is twofold. First, more hospital beds provided indicate more cases confirmed, which reduces labor productivity and weakens economic growth. Second, nevertheless, more beds provided also indicate a possibility of more quick recovery, thereby helping the future economy to recover quickly.

Finally, from the perspective of households, two variables are considered to enter the model, namely, life expectancy and population growth. Life expectancy also affects the economy through productivity theory. Rational expectation theory suggests that future expectations will influence our decision today. When people have a long life expectancy, he or she would also expect to generate more income in the future. This future income ideally affects economic decisions today, creating a stream of expenditure in the future, and guarantees more upcoming economic growth. The COVID-19 pandemic undoubtedly deteriorates households' life expectancy. Consequently, with a shorter life expectancy, people tend to be more precautionary toward their assets and prefer saving over spending. Therefore, economic growth is expected to deteriorate. From another aspect, population growth is also expected to fall during the pandemic, which makes labor supply becomes less and decelerates economic growth.

Data and specification of model

Data

Economic variables include GDP, employment, poverty, inflation, and exchange rates, whereas sustainable development variables are based on the HDI, which includes GDP per capita, life expectancy at birth, and education level (measured by adult literacy and enrolment rates in education) (Nourry 2008). The COVID-19 pandemic is measured as the total number of confirmed cases and individuals tested. Data will be sourced from the World Development Indicator, whereas the COVID-19 data shall be extracted from the John Hopkins University database, which provides daily updates on COVID-19 cases globally.

Model specifications

This study seeks to answer the following questions: what is the medium- and long-run impact of the COVID-19 pandemic on economic growth in the MENA region? Do these consequences have implications for the achievement of SDGs?

The requisite empirical models to estimate the effect of the COVID-19 pandemic on economic growth and development variables are specified as follows:

$$\text{Economic Dependent}_{i,t} = \alpha + \gamma_1 \text{Pandemic}_{i,t} + \gamma_2 \sum \text{Control}_{i,t} + \mu_{i,t} \quad \text{where}: t = 1,2,3,\ldots,T; i = 1,2,3,\ldots,N, \tag{3}$$

where $\text{Economic Dependent}_{i,t}$ denotes a vector of selected economic variables for country i at time t. $\text{Pandemic}_{i,t}$ indicates an array of COVID-19 variables for country i at time t. $\text{Control}_{i,t}$ controls for an array of country-specific characteristics for country i at time t. $\mu_{i,t}$ is the error term for country i at time t.

$$\text{Development Dependent}_{i,t} = \alpha + \gamma_1 \text{Pandemic}_{i,t} + \gamma_2 \sum \text{Control}_{i,t} + \mu_{i,t} \quad \text{where}: t = 1,2,3,\ldots,T; i = 1,2,3,\ldots,N. \tag{4}$$

After examining the effects of the COVID-19 pandemic on economic growth using Eq. (3), we then elaborate on the pandemic's impacts on country- and region-level development by proposing regression Eq. (4). $\text{Development Dependent}_{i,t}$ contains a vector of sustainable development indices. $\text{Pandemic}_{i,t}$ indicates an array of COVID-19 variables for country i at time t. $\text{Control}_{i,t}$ conrols for an array of country-specific characteristics for country i at time t. $\mu_{i,t}$ is the error term for country i at time t.

Equations (3) and (4) are estimated using two different approaches. First, the selected variables are specified using the homogenous panel analysis to capture regional features, following Baltagi et al. (2002) and Salisu and Vo (2020).

The homogenous panels' approach is motivated by its property of a short T dimension. In addition, the homogeneous panel model is parsimonious (particularly with short *T*, which is the case here) compared with heterogeneous estimators. Given the short time span since the emergence of the COVID-19 pandemic, the problem of insufficient observations for a country-by-country analysis is most likely to occur (Baltagi 2008). Second, we include country-specific characteristics in both equations by using a robust regression model. The reason is that this method offers more reliable results compared with the traditional OLS methodology that is only liable for the violation of the best linear unbiased estimator properties.

Our economic variables in Eq. (3) comprise GDP, employment, poverty, inflation, and exchange rates, whereas our sustainable development variables are based on the HDI and include GDP per capita, life expectancy at birth, and education levels, which are measured by adult literacy and enrolment rates in education (Nourry 2008). The COVID-19 pandemic is measured as the total number of confirmed cases and the total number of individuals tested. We collect data on economic variables and development from the World Development Indicators of World Bank database, whereas we employ data on the measures of COVID-19 from the John Hopkins University database that provides daily updates on COVID-19 cases globally.

Empirical results and discussion

This section explains the estimation results for the model given in the previous section. Furthermore, based on the result, some insights and discussions are provided. Recall that this study aims to investigate the impact of the COVID-19 pandemic on the MENA regional economic development, which is proxied by multiple economic and development indicators. The countries include Egypt, Jordan, Morocco, Mauritania, Tunisia, and UAE. The economic indicators include GDP, employment, inflation, and exchange rates, whereas the development indicators include HDI, output per capita, life expectancy, and education level.

Summary statistics

Table 1 presents a statistical summary of the variables utilized in the model. Across the sample, the mean per capita GDP in the sample is 9.930, with the minimum at 7.299 and the maximum at 11.669. Furthermore, in terms of cases, the summary shows that there are 9.698 cases across the sample on average. The summary statistics also demonstrate that, on average, there are 6057 deaths across the sample. The average life expectancy of a person in the sample is 75 years. The life expectancy of the sample ranges from 66 to 76.6 years old. Finally, amid the pandemic, the HDI of the sample is 0.756 on average, ranging from 0.47 to 0.919.

In terms of a stringency index, the summary shows that, on average, the index of the sample countries is 64.55 out of 100. The stringency index is measured based on the share of people that are vaccinated compared with eligible vaccinated citizens. Hence, 64.55 can be interpreted as the proportion of people across the sample countries that have been vaccinated. Furthermore, in terms of handwashing facilities, the sample countries have the average quality of handwashing facilities at 81.36 out of 100, which is considered good. Handwashing facility refers to the quality level of handwashing facilities provided by a country during the pandemic. Hospital refers to the number of hospital beds per thousand people. In terms of hospital, the summary shows that the number of hospital beds per thousand people in the sample countries is extremely low, which is roughly only two beds per 1000 people.

Figures 3 and 4 exhibit the dynamics of the variables utilized in this study. As shown in Fig. 3, the total cases and total deaths during the pandemic across sample countries were exponentially increasing. Both increased very steeply in the beginning, but the marginal increase diminished through time. The diminishing marginal increase most likely occurs because of the vaccination progress in the countries. Figure 4 depicts the dynamics of the rest of the variables, namely, GDP per capita, stringency

Table 1 Summary statistics

Variable	N	Mean	Min	p50	Max	SD	Skew	Kurt
Ln (GDP per capita)	6066	9.930	7.299	9.792	11.669	1.000	−0.499	3.426
Ln (cases)	6352	9.698	0.000	10.843	14.238	2.996	−1.096	3.748
Ln (deaths)	5977	6.057	0.000	6.273	10.986	2.341	−0.430	2.772
Stringency	6359	64.554	0.000	65.740	100.000	21.278	−0.779	3.349
Ln (POP)	6397	16.467	14.347	16.138	18.444	1.132	0.037	2.070
Handwash	2433	81.367	49.542	83.741	97.400	14.897	−0.989	3.015
Hospital	6397	1.874	0.700	1.600	3.700	0.751	0.815	2.920
LIFEEX	6397	75.743	66.120	76.680	82.970	3.657	−0.554	3.704
HDI	6397	0.756	0.470	0.748	0.919	0.106	−0.846	3.748

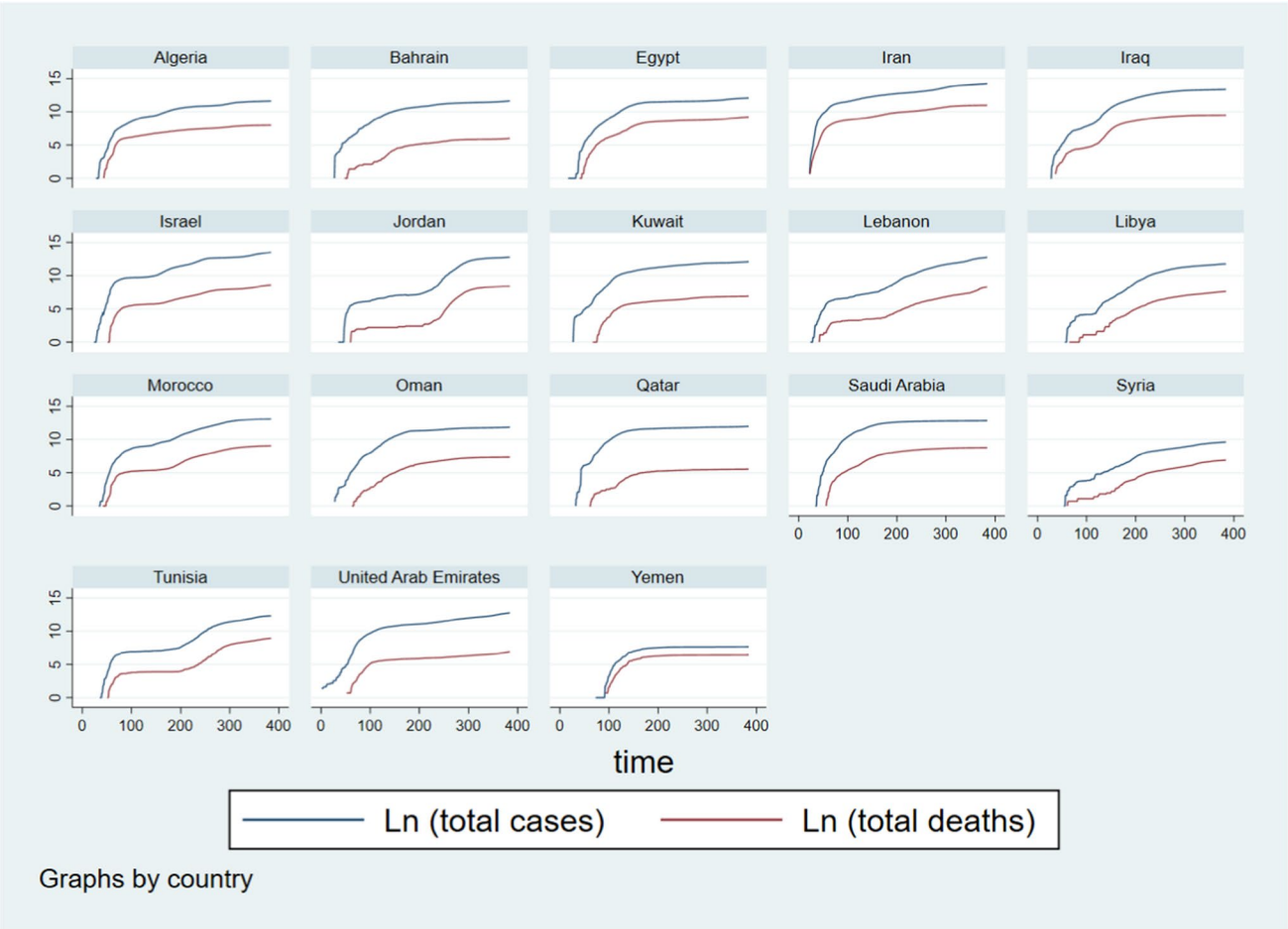

Fig. 3 Total COVID-19 cases and deaths (in log form) in the MENA countries during the pandemic

index, handwashing facilities, life expectancy, HDI, population growth, and hospital beds, across the sample countries (Fig. 4). The most visible variable among the countries is the stringency index. The similarity of the variable across countries is that the index increases very steeply in the beginning, reflecting a panic response to the pandemic, which is also a new experience for most governments. However, through time, some countries have shown an increasing trend of the stringent index, such as Iran, Tunisia, Jordan, and Lebanon. As for the rest of the countries, the stringent index tends to be decreasing in trend, which reflects a relaxation for citizens' mobility. This relaxation policy is most likely implemented considering economic growth.

Correlation matrix

Table 2 demonstrates a correlation matrix among the variables utilized in the model. A standard Pearson's correlation analysis is applied among the variables.

Based on the correlation matrix, output per capita is positively correlated with the number of cases, stringency index, handwashing facilities, hospital beds, life expectancy, and HDI. This finding implies that the increase in per capita GDP corresponds to the increase in the latter variables (the number of cases, stringency index, handwashing facilities, hospital beds, life expectancy, and HDI). From another aspect, output per capita is negatively correlated with deaths and population. The number of cases is positively correlated with all variables. However, the number of deaths is negatively correlated with the stringency index, hospital beds, and life expectancy. This finding suggests that the sample countries are, on average, experiencing more deaths when the stringency index and hospital beds are declining. Moreover, the life expectancy of people declines when more deaths are confirmed.

Based on the matrix, a more stringent policy is a positive sentiment causing handwashing facilities, hospital beds, life expectancy, and HDI to grow positively as well, as shown by a positive correlation between the stringent index and these variables. However, the statistical summary demonstrates a negative correlation between the stringency index

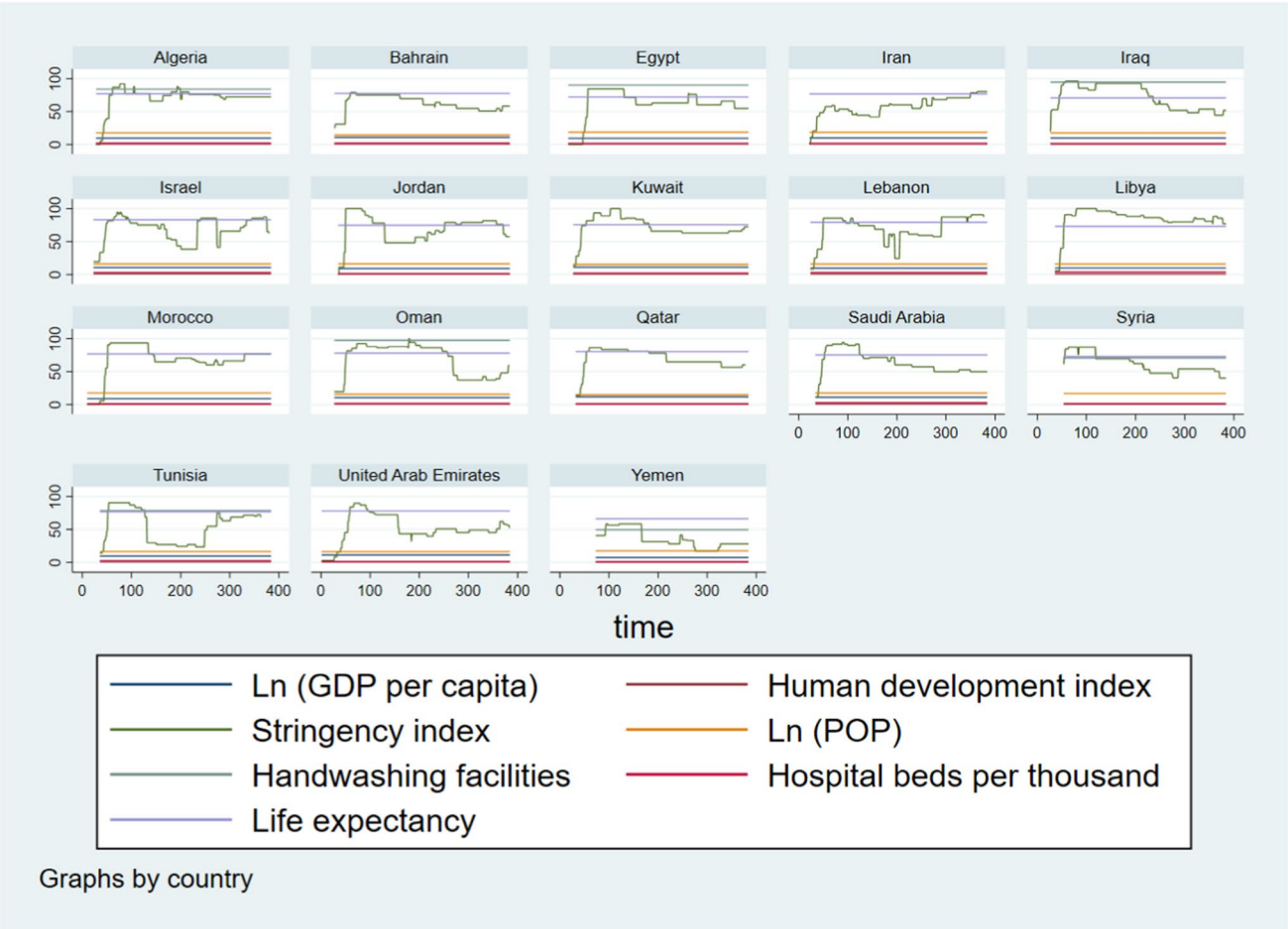

Fig. 4 GDP per capita, human development and other development indexes in the MENA

Table 2 Correlation matrix

Variable	1	2	3	4	5	6	7	8	9
1- Ln (GDP per capita)	1.0000								
2- Ln (cases)	0.2516*	1.0000							
	0.00000								
3- Ln (deaths)	−0.0715*	0.8655*	1.0000						
	0.0000	0.0000							
4- Stringency	0.1636*	0.1990*	−0.1992*	1.0000					
	0.0000	0.0000	0.0000						
5- Ln (POP)	−0.5270*	0.0727*	0.4548*	−0.1127*	1.0000				
	0.0000	0.0000	0.0000	0.0000					
6- Handwash	0.9453*	0.4339*	0.2579*	0.4288*	−0.0533*	1.0000			
	0.0000	0.0000	0.0000	0.0000	0.0085				
7- Hospital	0.2010*	0.0315*	−0.0619*	0.2553*	−0.2581*	0.4973*	1.0000		
	0.0000	0.0120	0.0000	0.0000	0.0000	0.0000			
8- LIFEEX	0.6357*	0.2177*	−0.0441*	0.1385*	−0.4491*	0.5970*	0.3091*	1.0000	
	0.0000	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000		
9- HDI	0.8873*	0.3109*	0.0511*	0.1360*	−0.4236*	0.8587*	0.3528*	0.8196*	1.0000
	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	

and population, which makes sense as larger populations are harder to manage. Similarly, handwashing facilities, hospital beds, life expectancy, and HDI are more deteriorating when the population grows positively, as reflected by the correlation sign among them. Handwashing facilities and hospital beds are positively correlated, including handwashing and HDI. Furthermore, the summary shows that life expectancy is positively correlated with HDI.

Estimation results

Two estimated models are generated. The first model utilizes GDP per capita as a dependent variable, whereas the second model utilizes HDI as a dependent variable. Under each model, two scenarios are provided, namely, (i) with lagged control variables (contemporaneous model) and (ii) without lagged control variables (lagged model). Table 3 demonstrates the first case where the dependent variable used is GDP per capita, with the additional scenarios of lagged control variables presented in Table 4. Furthermore, Table 5 shows the second case utilizing HDI as the dependent variable, and its lagged control scenario is presented in Table 6. For the sake of accuracy, we applied multiple estimation techniques. In the first scenario, we applied pooled OLS regression (with no fixed effects), a regression with the robust estimator, a regression with clustered countries, a regression with clustered time, a fixed effect with the OLS estimator, bootstrap estimation, and jackknife estimation. Furthermore, in the second scenario, we applied a similar set of estimation methods except for bootstrap and jackknife estimation.

GDP per capita

Table 3 shows the estimation result of the first scenario (contemporaneous model). In the case of the first model, the estimated coefficients resulting from all different methods are almost identical. The coefficient of determinants across all methods is also similar, which is 0.998, reflecting the ability of the independent variables to explain 99.8% of the variance of the dependent variable, which is a significant number. This case also happens in the second scenario when lagged control variables are incorporated in the first model, as shown in Table 5. All the estimation coefficients are also similar across methods, with a very high R-square reaching 99.8%, which implies that lagged variables also have explanatory power as strong as their contemporaneous variables.

Across the methods, the number of COVID-19 cases negatively affects GDP per capita, where a 1% increase in COVID-19 cases statistically and significantly reduces GDP per capita by 0.015%, everything else equal. This finding can be understood as more COVID-19 cases force people to isolate, and hence, their falling productivity hinders economic activity. Economically, COVID-19 cases reduce labor supply

Table 3 Contemporaneous model 1 — linear regressions of COVID-19 on GDP per capita

VARIABLES	-1 Pooled OLS	-2 VCE robust	-3 VCE cluster country	-4 VCE cluster time	-5 VCE ols	-6 VCE bootstrap	-7 VCE jackknife
Ln (cases)$_t$	-0.015***	-0.015***	-0.015**	-0.015***	-0.015***	-0.015***	-0.015***
	[0.003]	[0.002]	[0.005]	[0.003]	[0.003]	[0.002]	[0.002]
Ln (deaths)$_t$	0.018***	0.018***	0.018**	0.018***	0.018***	0.018***	0.018***
	[0.003]	[0.002]	[0.006]	[0.003]	[0.003]	[0.002]	[0.002]
STRINGENCY$_t$	0.000***	0.000***	0.000	0.000***	0.000***	0.000***	0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ln (POP)$_t$	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***
	[0.002]	[0.002]	[0.030]	[0.002]	[0.002]	[0.002]	[0.002]
HANDWASH$_t$	0.048***	0.048***	0.048***	0.048***	0.048***	0.048***	0.048***
	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]
HOSPITAL$_t$	-0.247***	-0.247***	-0.247***	-0.247***	-0.247***	-0.247***	-0.247***
	[0.004]	[0.003]	[0.050]	[0.002]	[0.004]	[0.003]	[0.003]
LIFEEX$_t$	0.085***	0.085***	0.085***	0.085***	0.085***	0.085***	0.085***
	[0.001]	[0.001]	[0.012]	[0.000]	[0.001]	[0.001]	[0.001]
Constant	1.835***	1.835***	1.835	1.835***	1.835***	1.835***	1.835***
	[0.058]	[0.059]	[1.144]	[0.019]	[0.058]	[0.060]	[0.060]
Observations	1961	1961	1961	1961	1961	1961	1961
R-squared	0,998	0,998	0,998	0,998	0,998	0,998	0,998

Table 4 Lagged model 1 — linear regressions of COVID-19 on GDP per capita with lagged controls

VARIABLES	-1 Pooled OLS	-2 VCE robust	-3 VCE cluster country	-4 VCE cluster time	-5 VCE ols
Ln (cases)$_{t-1}$	-0.015***	-0.015***	-0.015**	-0.015***	-0.015***
	[0.003]	[0.002]	[0.005]	[0.003]	[0.003]
Ln (deaths)$_{t-1}$	0.018***	0.018***	0.018**	0.018***	0.018***
	[0.003]	[0.002]	[0.006]	[0.003]	[0.003]
STRINGENCY$_{t-1}$	0.000***	0.000***	0.000	0.000***	0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ln (POP)$_{t-1}$	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***
	[0.002]	[0.002]	[0.030]	[0.002]	[0.002]
HANDWASH $_{t-1}$	0.048***	0.048***	0.048***	0.048***	0.048***
	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]
HOSPITAL $_{t-1}$	-0.247***	-0.247***	-0.247***	-0.247***	-0.247***
	[0.004]	[0.003]	[0.050]	[0.002]	[0.004]
LIFEEX $_{t-1}$	0.085***	0.085***	0.085***	0.085***	0.085***
	[0.001]	[0.001]	[0.012]	[0.000]	[0.001]
Constant	1.835***	1.835***	1.835	1.835***	1.835***
	[0.058]	[0.060]	[1.144]	[0.019]	[0.058]
Observations	1,957	1,957	1,957	1,957	1,957
R-squared	0,998	0,998	0,998	0,998	0,998

Table 5 Contemporaneous model 2 — linear regressions of COVID-19 on human development index

VARIABLES	-1 Pooled OLS	-2 VCE robust	-3 VCE cluster country	-4 VCE cluster time	-5 VCE ols	-6 VCE bootstrap	-7 VCE jackknife
Ln (cases)$_t$	-0.009***	-0.009***	-0.009	-0.009***	-0.009***	-0.009***	-0.009***
	[0.001]	[0.001]	[0.010]	[0.001]	[0.001]	[0.001]	[0.001]
Ln (deaths)$_t$	0.011***	0.011***	0.011	0.011***	0.011***	0.011***	0.011***
	[0.001]	[0.001]	[0.011]	[0.001]	[0.001]	[0.001]	[0.001]
STRINGENCY$_t$	-0.000***	-0.000***	-0.000	-0.000***	-0.000***	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ln (POP)$_t$	0.002	0.002**	0.002	0.002***	0.002	0.002*	0.002**
	[0.001]	[0.001]	[0.007]	[0.001]	[0.001]	[0.001]	[0.001]
HANDWASH $_t$	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
HOSPITAL $_t$	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	[0.003]	[0.002]	[0.032]	[0.001]	[0.003]	[0.002]	[0.002]
LIFEEX$_t$	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***	0.017***
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]	[0.000]	[0.000]
Constant	-0.921***	-0.921***	-0.921**	-0.921***	-0.921***	-0.921***	-0.921***
	[0.035]	[0.019]	[0.290]	[0.010]	[0.035]	[0.020]	[0.019]
Observations	2,285	2,285	2,285	2,285	2,285	2,285	2,285
R-squared	0,944	0,944	0,944	0,944	0,944	0,944	0,944

Table 6 Lagged model 2 — linear regressions of COVID-19 on human development index with lagged controls

	-1	-2	-3	-4	-5
VARIABLES	Pooled OLS	VCE robust	VCE cluster country	VCE cluster time	VCE ols
Ln (cases)_{t-1}	-0.009***	-0.009***	-0.009	-0.009***	-0.009***
	[0.001]	[0.001]	[0.010]	[0.001]	[0.001]
Ln (deaths)_{t-1}	0.011***	0.011***	0.011	0.011***	0.011***
	[0.001]	[0.001]	[0.012]	[0.001]	[0.001]
STRINGENCY_{t-1}	-0.000***	-0.000***	-0.000	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Ln (POP)_{t-1}	0.002	0.002**	0.002	0.002**	0.002
	[0.001]	[0.001]	[0.007]	[0.001]	[0.001]
HANDWASH_{t-1}	0.004***	0.004***	0.004***	0.004***	0.004***
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]
HOSPITAL_{t-1}	0.001	0.001	0.001	0.001	0.001
	[0.003]	[0.002]	[0.032]	[0.001]	[0.003]
LIFEEX_{t-1}	0.017***	0.017***	0.017***	0.017***	0.017***
	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]
Constant	-0.920***	-0.920***	-0.920**	-0.920***	-0.920***
	[0.035]	[0.019]	[0.289]	[0.010]	[0.035]
Observations	2280	2280	2280	2280	2280
R-squared	0,944	0,944	0,944	0,944	0,944

given that firms prohibit people from working and infected people need to take a rest. This resting activity reduces the productivity of firms in general and economic growth on a greater scale. Consequently, at the same population level, GDP per capita is falling.

On the contrary, the increase of death by 1% statistically increases GDP per capita by 0.018%, everything else equal. Recall that GDP per capita is the total GDP divided by population. Hence, higher deaths correspond to a lower population and thus increase GDP per capita, holding GDP constant. In other words, this finding is economically understood as higher deaths reduce the denominator in the per capita GDP, making the per capita GDP somehow grow.

Furthermore, although positive and statistically significant, the magnitude impact of the stringency index on GDP per capita is minuscule, where a one-point increase in the stringency index corresponds to a very small growth of GDP per capita. A positive relationship exists between the stringency index and GDP per capita because the stringency index can reduce COVID-19 infection, given that its policy prevents crowds from congregating. Furthermore, with the help of technology, restricted people can work from home to maintain or even increase productivity. The rising productivity corresponds to the rising GDP per capita.

Similar to the stringency index, the regression also reports that handwashing facilities also positively affect GDP per capita. Specifically, a one-point increase in handwashing facilities corresponds to an increase in GDP per capita by 0.048%, everything else equal. This finding reflects the importance of hygiene factors in boosting economic activities during the COVID-19 pandemic. From an economic perspective, handwashing facilities can help prevent a spike in COVID-19 cases. Handwashing facilities can reduce the likelihood of infection so people can continue working, either from home or at the office with shift. Thus, fewer COVID-19 cases prevent a decline in labor, maintain or increase labor supply, increase GDP, and increase per capita GDP.

Contrarily, the hospital has a negative impact on GDP per capita. The estimation found that a one-point increase in hospital beds per 1000 people significantly reduces GDP per capita by 0.247%, everything else equal. From an economic perspective, this finding shows that information regarding the increased bed per 1000 people is more perceived by society as negative than positive. In other words, information about more hospital beds disseminates negative sentiment about future economic conditions, causing economic contraction instead of expansion. With a

negative prediction of the future economy, the market may react negatively either by selling off their shares or local currency, thereby jeopardizing the economy. The pessimism can also cause the banking sector to feel reluctant to provide loans, which can hamper production activity and further contract the economy.

Finally, the impact of life expectancy on GDP per capita is only positive by 0.085%, everything else equal, indicating that the increase of life expectancy by 1 year increases GDP per capita by 0.085%. From an economic perspective, a longer life expectancy equals optimism about future economic conditions. The reason is that, with longer life expectancy, an individual believes that he or she should live and survive in the future. This optimism will influence the individual's behavior at the current time, such as in the form of increased savings, pension plan, and insurance contribution, among others, which can benefit the economy at the present time and hence raises GDP per capita.

Furthermore, in the second scenario, the lagged independent variables are incorporated into the model. Using multiple similar methods of estimation, the study also delivers similar findings compared with the first scenario. Precisely, all the estimated coefficients generated in the lagged model are identical to those under the contemporaneous scenario, as shown in Table 4.

The estimation derives some important findings. First, the findings above are almost similar across different estimation methods, reflecting the consistent reliability of the result. The only difference in the set of estimations is under regression with a clustered country where the stringency index is not statistically significant. Second, based on regression analysis using various estimators and methods, all independent variables involved in the analysis are found to be statistically significant pandemic factors affecting GDP per capita. Third, some pandemic factors that positively affect GDP per capita include the number of deaths, stringency index, handwashing facilities, and life expectancy. From another aspect, the pandemic factors affecting GDP per capita negatively include COVID-19 cases growth, population growth, and hospital beds. Fourth, although all the independent variables used are statistically significant, hospital is the most influential pandemic factor affecting GDP per capita. An increase of hospital beds per 1000 people by one bed corresponds to a decline of GDP per capita by 0.247%, which is almost twice the adverse impact of population growth and 16 times greater than the adverse impact of COVID-19 cases growth on GDP per capita. Moreover, among the positive pandemic factors, the study demonstrates that life expectancy has the greatest impact on GDP per capita during the pandemic.

HDI

Using the same independent variables, we are then interested in understanding significant COVID-19 pandemic factors affecting HDI. The investigation is also conducted using two scenarios, namely, (i) contemporaneous scenario (where all independent variables are expressed as the current period) and (ii) lagged independent variables (when all independent variables are given in terms of lagged values). In both scenarios, multiple methods are also implemented, including pooled OLS, robust, clustered country, clustered time, bootstrap estimation, and jackknife estimation. Similarly, bootstrap estimation and jackknife estimation are no longer adopted in the second scenario. Table 5 demonstrates the estimation results of the first scenario under the contemporaneous model, whereas Table 6 demonstrates the estimation results of the second scenario using lagged independent variables.

In the case of the first model, as shown in Table 5, the estimated coefficients resulting from all different methods are almost identical. The coefficient of determinants across all methods is also similar, which is 0.944, reflecting the ability of independent variables to explain 94.4% of the variance of the dependent variable, which is a significant number. This case also happens in the second scenario when lagged control variables are incorporated in the first model, as shown in Table 6. All the estimation coefficients are also similar across methods, with a very high R-square reaching 94.4%, which implies that lagged variables also have explanatory power as strong as their contemporaneous variables.

According to Table 5, the number of COVID-19 cases is statistically significant in affecting HDI. Precisely, a 1% increase in COVID-19 cases reduces HDI by 0.009, everything else equal. Given that HDI is a composite index of health, knowledge, and standard of living, this finding is understood as more COVID-19 cases signal health deterioration and hence reduce HDI. COVID-19 cases can increase HDI through a fall in productivity. Higher COVID-19 cases reflect more infections, which hinder people from working and studying, reduce income, and eventually reduce GDP and per capita GDP. However, not all model alternatives approve of this finding. The estimation using clustered countries demonstrates that COVID-19 cases do not have a significant impact on HDI.

From another aspect, the model found that the rise in deaths is also statistically significant but has a positive impact on HDI. Precisely, a 1% increase in deaths statistically increases HDI by 0.011, everything else equal. One reason behind this finding is that the HDI occurs because of the rise in living standards, which happens to be caused by the falling population due to COVID-19-related death, given the GDP constant. However, this finding is also not shared under the clustered country model.

The stringency index is also not statistically significant in the model with a clustered country but is statistically significant in the other model alternatives with a negative impact on HDI. Nevertheless, although statistically significant, the impact of the stringency index on HDI is minuscule. The negative impact of the stringency index on HDI possibly occurs through the productivity channel. That is, when social restrictions intensify, people need to adjust to new situations, such as working or studying from home, and they might not have the necessary infrastructure to support their study or work from home. This adjustment hinders productivity, deteriorates people skills, and thus reduces HDI.

Furthermore, hospital is not statistically significant across all models, which is in contrast to the economic development model where hospital is the most influential pandemic factor affecting GDP per capita. Hence, under HDI models, an increase in bed provision in hospital reflects a positive sentiment as it reflects better healthcare and thus increases health as the component of HDI. Furthermore, with better healthcare and greater health quality, the standard of living can also increase, thereby increasing the overall HDI.

Handwashing facilities positively affect HDI. Specifically, a one point increase in handwashing facilities statistically and significantly increases HDI by 0.004, everything else equal. Handwashing facilities can be understood as a significant pandemic factor affecting HDI as it promotes cleanliness and a better standard of living, which is the main component of HDI. Similar to the economic rationale under GDP models, a greater number of handwashing facilities can prevent COVID-19 infections and increase health quality. Furthermore, with a greater quality of health, the HDI increases, everything else constant. Furthermore, with greater health quality, people can maintain or improve their productivity, which raises the standard of living by generating more income. Thus, with the higher standard of living, the HDI can increase.

Life expectancy also positively affects HDI. Specifically, a 1-year increase in life expectancy statistically and significantly increases HDI by 0.017, everything else equal. In terms of the positive impact of life expectancy on HDI, the rationale is similar to that under GDP models. That is, a longer life expectancy equals to optimism regarding future economic conditions. The reason is that with longer life expectancy, an individual believes that he or she should live and survive in the future. This assumption affects individuals' behavior at the current time through various economic decisions, such as in the form of increased savings, pension plans, and insurance contributions, among others. This case can benefit the economy at the present time and hence raises GDP per capita. Finally, as higher GDP per capita is equivalent to a higher standard of living, the overall level of HDI increases.

Similar results are also found when the independent variables are replaced by their lag form, as shown in Table 6. Under this second scenario, only lagged handwashing facilities and hospital are statistically significant across all model alternatives simultaneously. They both impose a positive impact on HDI with identical magnitudes as in the first scenario. Precisely, a one-point increase in handwashing facilities in the last period statistically and significantly increases HDI in this period by 0.004, everything else equal. Moreover, a 1-year increase in life expectation in the last period statistically and significantly increases HDI in this period by 0.017, everything else equal.

The estimation derives some important findings. First, the estimated results across models are not perfectly identical. The only two pandemic factors that statistically and significantly affect HDI across all model alternatives are handwashing facilities and life expectancy, making these two the most important pandemic factors affecting HDI. These two factors have a positive impact on HDI. Second, comparing the result between economic and HDI models, GDP per capita has more significant pandemic factors than HDI. This finding implies that the pandemic is more sensitive to economic growth than human development.

Conclusion, recommendations, limitations, and areas for future research

This study aims to investigate the impact of the COVID-19 pandemic on economic and human development in the MENA region. This region includes Egypt, Jordan, Morocco, Mauritania, Tunisia, and UAE. The study builds two models. The first model utilizes economic growth (GDP per capita) as a dependent variable, whereas the second model employs HDI as a dependent variable. Control variables in both models are identical, namely, the number of COVID-19 cases, the number of deaths, handwashing facilities, hospital beds per 1000 people, population growth, and life expectancy. Under each model, two scenarios are developed. The first scenario uses contemporaneous control variables, whereas the second scenario utilizes lagged control variables. For the sake of comparison, both models are estimated using multiple estimation methods, including pooled OLS, VCE robust, and VCE clustered countries, VCE clustered time, VCE OLS, VCE bootstrap, and VCE jackknife. The conclusion, policy recommendation, and limitations of this study can be explained as follows.

Conclusion

The estimation result in the first model shows that all control variables have statistically significant effects on economic development. This result holds for all estimation methods and estimators, reflecting the robustness of the result. The only difference in the set of estimations is the regression with a clustered country where the stringency index is not statistically significant. However, this is not an issue as its coefficient magnitude is minuscule.

In the first model, some pandemic factors that positively affect GDP per capita are the number of deaths, stringency index, handwashing facilities, and life expectancy. From another aspect, the pandemic factors affecting GDP per capita negatively include COVID-19 cases growth, population growth, and hospital beds. Furthermore, hospital is the most influential pandemic factor affecting GDP per capita. An increase in hospital beds per 1000 people by one bed corresponds to a decline in GDP per capita by 0.247%, which is almost twice the adverse impact of population growth and 16 times greater than the adverse impact of COVID-19 cases growth on GDP per capita. Moreover, among the positive pandemic factors, life expectancy has the greatest positive impact on GDP per capita during the pandemic.

In the second model, on the contrary, the estimation result shows that only handwashing facilities and life expectancy have statistically significant effects on HDI across all estimation methods, making these two the most important pandemic factors affecting HDI. These two factors have positive impacts on HDI. Comparing the result between the two models, GDP per capita has more significant pandemic factors than HDI. This finding implies that the pandemic is more sensitive to economic growth than human development. Finally, by estimating both models, the impacts of past and present control variables are identical.

Policy recommendations

Some policy recommendations based on the findings of this study are as follows. First, hospital is the most influential pandemic factor affecting GDP per capita. An increase in hospital beds per 1000 people by one bed corresponds to a decrease in GDP per capita by 0.247%, which is almost twice the adverse impact of population growth and 16 times greater than the adverse impact of COVID-19 cases growth on GDP per capita. From the policy perspective, this finding suggests that the authority should prioritize hospital beds availability during the pandemic, considering that this factor has the greatest multiplier effect on economic growth (i.e., GDP per capita). A negative relationship between hospital bed availability and economic growth shows that information regarding the increased bed per 1000 people is more perceived by society as negative than positive. In other words, information about more hospital beds disseminates negative sentiment, causing economic contraction instead of expansion. This behavior indicates that people may associate the increased hospital bed availability with more COVID-19 infections, deaths, and threats instead of the other way around. Hence, from the policy perspective, the relevant authority should disseminate more positive information regarding COVID-19 cases and how the government manages consistent policies during the pandemic. This consistency should be highlighted to cover various aspects, from social restrictions to patient treatment in hospital, using various media, such as electronic or social media, so that negative views can be rebounded. Thus, the government should be able to maintain market confidence to remain positive.

Second, in contrast to hospital beds availability, life expectancy has the greatest positive impact on GDP per capita during the pandemic. This positive association reflects a hope from society to be protected from the disease, which can be manifested as obedience to government-related pandemic regulations. Moreover, the positive life expectancy reflects households' and firms' optimism related to future economic conditions. This optimism should be accommodated. For example, from the financial system perspective, a positive life expectancy should be accommodated by the financial sector through the provision of various financial products that offer long-term benefits for households. Examples include pension saving plans, life insurance, and healthcare protection insurance, among others. To maintain this optimism, the government should be optimistic in combating the pandemic. The relevant authority should also disseminate positive information, be optimistic, and maintain a two-way communication with society through multiple media. Cooperation with multiple organizations, such as non-government organizations, can also help this information to reach its target more quickly.

The stringency index has opposite impacts in the two models. In the first model, the increased stringency index corresponds to higher GDP, whereas in the second model, the stringency index is associated with negative HDI. These two findings indicate that social restriction positively affects economic growth in general but reduces HDI, which is a trade-off. This finding is essential for the relevant authority to formulate policies that can balance this trade-off. One of the policies in balancing the trade-off is through harnessing communication technology. In terms of education, studying from home using video calls can be an option to prevent HDI from falling further. The national curriculum should also be adaptable to this situation by allowing students to officially take exams at home. Furthermore, in terms of corporate working, utilizing technology for working from home can be an option to balance the trade-off. However, these samples of actions need to be supported by expansive

macroeconomic policies. That is, in terms of stabilization policy, accommodative monetary and fiscal policies are recommended for the government to maintain amid the pandemic. These two accommodative policies are required particularly because, during the pandemic, households are less consuming, and firms are less producing. Hence, households and firms required economic incentives to eventually expand economic growth.

Overall, from the policy perspective, in addition to the stringency index, some policy recommendations require action. For example, the government needs to consistently encourage people to maintain hygiene, including washing their hands regularly. In this regard, expanding handwashing facilities is one policy that government should encourage. The installation of handwashing facilities should be done in every corner of public places. In addition to handwashing, other aspects related to COVID-19 prevention are also required to be ruled out, such as avoiding a crowd, reducing public events, and ensuring that public facilities operate during certain hours. Most importantly, the government should disseminate optimistic suasion to prevent the market from panicking and remain in positive sentiment.

Limitations and future recommendations

Some limitations of this study are as follows. First, the current study only estimates the impact of contemporaneous and one-period lagged independent variables on GDP growth and HDI. Future studies can improve the model by incorporating more than one-period lagged control variables to determine whether the pandemic factor requires a longer delay affecting the economy and HDI. Second, with regard to independent variables, the variables used in this study are only from healthcare aspects and do not present more significant economic- or policy-related variables, such as the stock market index, debt to GDP during the pandemic, consumer confidence, business confidence, or investor confidence, which can improve quality of the findings. These additional control variables may improve the estimation, given that our current estimation shows almost identical results across different regression methods. Third, this study treats every country in the sample identically, which should not necessarily be so, given that the economic fundamental of each country in the sample differs from one another. In addition to economic fundamentals, the intensity of the COVID-19 crisis across countries in the group sample also differs.

Future recommendations from this study can be elaborated as follows. First, the assumption of homogeneity across different countries in the sample is considered one of the limitations of this study. Thus, future studies may improve the model by incorporating categorical variables reflecting differences among the sample countries. Second, one of the improvement areas is related to independent variables employed in the model. Future studies can expand and incorporate more pandemic-related variables, such as sufficient vaccines, face masks, or even the ratio of doctors or nurses over patients. More pandemic variables are expected to deliver better estimation results. Second, the set of independent variables used in the two models (GDP per capita and HDI models) may not be identical. Some variables related to human development can be added only in the HDI model, for instance, income equality or education level, among others. Third, the improvement area is also related to the sample countries. In addition to regressing all countries simultaneously, future studies can also estimate the model for individual country samples such that the comparison between panel regression and individual country regression can be analyzed. Fourth, future studies can also incorporate mediating variables such as consumer confidence or business confidence, which potentially channel the pandemic-related variables to economic growth.

Author contribution AOF collected data and analyzed the data. IH wrote the introduction and literature review. HHT work on the methodology and wrote the conclusion and policy suggestion, SSA work on study development and proofreading.

Data availability We sourced all data from World Bank Development Database.

Declarations

Ethical approval The authors mentioned in the manuscript have agreed for authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.

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