Effects of ICT Investment and Usage on Economic Growth in MENA Countries: Does Governance Matter?

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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DECLARATION

I declare that this thesis contains no material which has been accepted for the award to the candidate of any other degree or diploma, and to the best of my knowledge contains no material previously published or written by another person except where due reference is made in the text.

Mohammed Nayel Abu Alfoul

25th March 2022

Abu Alfoul

PUBLICATIONS

Based on the research carried in this thesis, the following paper has been presented:

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DEDICATION

TO MY FATHER AND PROUD MOTHER, WHO FROM AN EARLY AGE GAVE ME THE CONFIDENCE TO DO ANYTHING I SET MY MIND

AND

TO MY WIFE AND MY SON, WITHOUT WHOM THIS DISSERTATION WOULD NOT HAVE BEEN COMPLETED EARLY.

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بسم الله الرحمن الرحيم

(In the name of Allah, the Entirely Merciful, Especially Merciful)

"Allah will raise those who have believed among you and those who were given knowledge, by degrees. And Allah is Aware of what you do" (Qur'an, 58:11).

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LIST OF ABBREVIATIONS

ARDL	Autoregressive Distributed-Lagged Model
ADF	Augmented Dickey-Fuller
CC	Control of corruption
DPD	Dynamic panel data
ECT	Error Correction Term
GCC	Gulf Cooperation Council
GE	Government effectiveness
GFC	Global financial crisis
GMM	Generalized Method of Moments
GOV	Quality of governance
ICT	Information and communication technology
IMF	International monetary fund
ISIS	Islamic State of Iraq and the Levant
ITU	International Telecommunications Union
LLC	Levin, Lin and Chu
LNG	liquefied natural gas
MENA	Middle East and North Africa
OLS	Ordinary least squares
OPEC	Organization of the Petroleum Exporting Countries

PV	Political stability and absence of violence
R&D	Research and Development
RL	Rule of law
RQ	Regulatory quality
UNWTO	World Tourism Organization
VA	Voice and accountability
WDI	World development indicators
WGI	Worldwide Governance Indicators

ABSTRACT

Information and Communications Technology (ICT) is considered an important component in improving the efficiency of various economic activities. However, this is often interrelated with a country's quality of governance, particularly in developing countries, such as the Middle East and North Africa (MENA). The MENA countries have relatively well-developed ICT coverage, but they suffer from poor quality of governance. Therefore, this region provides a setting to examine new research questions, such as 'Do ICT investment and usage affect economic growth in MENA countries?' and 'Does the impact of ICT investment and usage on economic growth depend on governance quality?'.

The main objective of this study is to investigate the long- and short-run impact of ICT investment and usage on economic growth on the one hand, and the moderating role of the quality of governance on the association between these variables on the other hand. The theoretical foundations of this study can be found in endogenous growth theory as proposed by Barro (1996b) and Romer (1990).

This study contributes to the ICT literature by emphasising the countries' quality of governance in the association between technology and economic growth. More importantly, this study is the first to use all the Worldwide Governance Indicators (WGI) developed by the World Bank as moderator variables in the association between ICT investment, usage, and economic growth. This study applies the panel ARDL method and uses data for 16 MENA countries between 1995 and 2018. The results suggest that ICT usage alone does play a significant role in contributing to better economic growth, whereas ICT investment has an insignificant impact on economic growth in MENA region. Interestingly, improvements in quality of governance increase the effectiveness of ICT investment and usage in the economic growth of the MENA countries.

The results are of importance for policymakers interested in improving the effectiveness of ICT's contribution to economic growth, by exposing the potential impacts of the MENA region's governance indicators on ICT investment and usage. It is important to mention that the MENA countries' policymakers face the challenge of slow economic growth, and they need to formulate policies aimed at increasing ICT investment and usage. Thus, they also need to develop policies that enhance governance quality, as without effective governance, no significant improvements in economic growth can be expected from ICT investment and usage

in the MENA region. The MENA countries' policymakers should guide ICT investment and usage to achieve greater labour productivity to increase and accelerate economic growth.

Keywords: ICT investment; ICT usage; Quality of governance; Economic growth; MENA

CHAPTER 1: INTRODUCTION

1.1. BACKGROUND

Information and communication technology (ICT) plays a pivotal role in boosting economic growth. In particular, the widespread use of ICT in the last few decades has enabled many countries and their governments to transform information into something that can drive an economy. In 2019, the total global investment in ICT products and services was over US$421 billion, and over 51 percent of the world's population used the internet (International Telecommunication Union 2020). Since the mid-1980s, economic growth and the capacity of governments to effectively formulate and implement sound policies have been based on the collection, processing, and transmission of data (Toader et al. 2018). This study examines the effectiveness of technology (measured by ICT investment and usage) on economic growth when subject to a particular level of governance.

First, this study defines ICT and determine its components. According to Walter (1985), ICT collects, preserves, retrieves, processes, estimates, and transmits information through computer, digital, and/or electronics-related means. In other words, ICT involves the collection, preparation, saving, and publication of data, including text, audio, video, and pictures, which are accessed and extracted utilising computers and telecommunication technology (Niebel 2018). ICT is an umbrella term for any of the following modes or applications: the internet, mobile/cellular phones, computers, network hardware/software, satellite communications, and electronic/digital television on cable or aerial networks (International Telecommunication Union 2017).

Previous studies have focused on the effects of ICT or the quality of governance on economic growth, but rarely have the impacts of the interaction between the two been considered. Moreover, many studies have investigated the effect of ICT on economic growth in developed countries, but there are very few studies on this subject in the context of developing countries, particularly the Middle East and North Africa (MENA) region. The World Bank (2018) has emphasised the importance of ICT in supporting economic activities, and has said that, globally, many countries have observed significant economic development from the use of ICT. This trend has led several governments in developed and developing countries to acknowledge the importance of ICT to their economies and has seen these governments invest in ICT infrastructure and adopt other forms of modern technology.

The recent empirical literature has suggested that the quality of governance promotes the growth effects of ICT investment and usage in developed countries, but research into the extent of this relationship is under-investigated. In particular, there is no research in the context of MENA countries. Thus, the limited empirical evidence means that there is a need for a more rigorous understanding of the contribution of ICT to economic growth across MENA countries, as well as an understanding of the role of the quality of governance on the association between ICT and economic growth.

Modern theories of growth (Barro 1996b; Barro and Sala-i-Martin 1997; Romer 1990) all postulate that ICT should facilitate economic growth by providing a platform for development and the adoption of innovation in industry. Internet usage accelerates the distribution of ideas and information and fosters competition to develop new products, processes, and business models, thereby facilitating economic growth. Furthermore, the role of the institutional framework can stimulate innovation, boost the ability of the national economy to grow and compete, and increase a country's macroeconomic competitiveness. This leads to the promotion of human and capital investments and bolsters the innovation capacity of businesses and individuals to achieve economic prosperity (see Acemoglu 2003; Acemoglu et al. 2005; Delgado et al. 2012; Grossman 1991; Grossman and Helpman 1991; Mauro 1995; Porta et al. 1998; among others).

The effects of ICT on the economy have been studied extensively in recent years concerning ICT's assumed critical role in accelerating economic and productivity growth. Several researchers have tested the theories mentioned above. For instance, Jin and Cho (2015) examined the effects of corruption on the contribution of ICT to economic growth, using cross-sectional and time-series data (1999–2012) for 128 countries. They found that ICT variables have a direct effect on economic growth and interaction effects between corruption and ICT on economic growth. Although the theoretical literature predicts positive results for the impact of ICT on economic growth, empirical studies have not produced conclusive results. Some studies have shown positive effects (Castaldo et al. 2018; Nasab and Aghaei 2009; Pradhan et al. 2018; Sassi and Goaied 2013; Vu 2011; among others), while other studies have shown mixed or negative impacts (Cheng et al. 2021; Ishida 2015; Lee et al. 2005; Yousefi 2011; among others). Further studies have shown a non-linear effect of ICT on economic growth (Hawash and Lang 2010; Sassi and Goaied 2013; Vu 2011).

In light of the above, this study seeks to provide insights into whether ICT investment and usage can contribute to the economic growth of MENA countries. Further, this study aims to explore the moderating role of the quality of governance in the effect of ICT investment and usage on economic growth in MENA countries. To the best of my knowledge, only a handful of studies have investigated the role of the quality of governance on the impact of ICT on economic growth (see Jin and Cho 2015; Wamboye et al. 2016). Therefore, the main contributions of this study to the literature are as follows.

First, existing studies have either examined a maximum of one or two indicators, or the average of six indicators of governance quality, and their impact on ICT and economic growth (e.g. Jin and Cho 2015; Wamboye et al. 2016). The current study contributes to the existing literature by considering all governance indicators' impact on the association between ICT investment and usage and economic growth. Hence, this study presents a comprehensive investigation into the impact of specific governance quality indicators on economic growth.

Second, many MENA economies suffer from low levels of income, high levels of poverty and unemployment, and a lack of equitable distribution of resources. Acemoglu and Robinson (2012), in their book *Why Nations Fail*, argue that the pervasive dissatisfaction that exists within MENA countries has a direct correlation with the corrupt and ineffective economic regimes in the region. Most of these economies are ruled by elites that control the resources in their countries and use them for their own benefit, rather than for social progress. Further, these regimes have handed particular elites the ability to access finance and regulatory dealings. These dealings allow the elites to dominate sensitive and important industries, which leads to MENA's uncompetitive and inactive private sectors, ultimately resulting in slow growth for MENA economies. Therefore, the effect of governance quality on ICT investment and usage may have specific impacts on economic growth in the MENA countries. To the best of my knowledge, this study is the first attempt to empirically examine the moderating role of the quality of governance and the impact of ICT investment and usage on economic growth in this region. This study uses a panel dataset covering 16 MENA countries for the period 1995–2018 to investigate this issue.

The purpose of this chapter is to present an introduction and background for this study. The remainder of this chapter proceeds as follows: Section 1.2 discusses the research problem statement; Section 1.3 outlines the research contributions and significance; Section 1.4 introduces the research objectives and main research questions; Section 1.5 offers an overview of the methodology; Section 1.6 explains the scope of the research and Section 1.7 presents the organisation of this dissertation.

1.2. PROBLEM STATEMENT

Economic growth in the MENA countries has been slow over the last few decades. This is primarily due to political instability, violence, high levels of corruption, heavy reliance on natural resources, and a slow embrace of modern technologies. Al-Rawashdeh et al. (2013) demonstrated that the MENA region lacks good governance, despite the existence of many natural resources (including crude oil and natural gas) that could lead to sustained economic growth. Tang and Abosedra (2014) found that this political instability hinders economic growth in MENA countries. Another study, by the World Bank (2018) shows that GDP growth in the MENA region remained flat during the period 2010–2018 and argued that the slowdown of economic growth in this region was due to high dependency on natural resources and weak governance.

Many studies have investigated the MENA economies, including Kaufmann et al. (2011) and Kaufmann and Fellow (2011). These studies demonstrated that investments (and international aid) in infrastructure and providing public goods would not succeed if the quality of governance is poor (e.g., high levels of corruption, political instability, poor government, and poor policy implementation). MENA countries, including Jordan, Morocco, Tunisia, Sudan, and Egypt have weak governance systems, a situation otherwise referred to as a 'governance deficit' (Kaufmann and Fellow 2011).[1]

Several studies have shown that ICT investment and usage have the potential to boost economic growth. For example, in South Korea, a study by Hong (2017) revealed that ICT investment by the private sector is strongly correlated with economic growth, compared with investment by the public sector. This indicates that public and private sector ICT, along with research and development (R&D) investment, are powerful features of economic growth. Similarly, Vu (2013) reported that ICT investment contributed to the increase of Singapore's GDP by approximately 1 percent during the period 1990–2008. In the US and the EU-15 countries, for the years 1980–2004, ICT investment was a significant factor for GDP growth (Venturini 2009). A recent study by Niebel (2018) on 59 developed and developing countries

[1] See https://www.menatransitionfund.org/portfolio

revealed a positive relationship between ICT investment and GDP growth. However, emerging and developing countries did not enjoy economic growth from investments in ICT, in contrast to developed economies.

Nevertheless, recent developments in ICT have led to a renewed interest in researching the role of modern technologies in shaping economies. Innovations and the rapid expansion of information technology in the past decade—especially the increased speed of the internet and communications technology—have impacted all aspects of life, especially economic systems, worldwide (Al-Khouri et al. 2014). Although some MENA countries—especially the Gulf nations—have made considerable progress in ICT, some countries still have a low percentage of internet usage. As shown in Figure 1.1, Egypt and Sudan have proportionately low numbers of internet users, with less than 50 percent of individuals using the internet. In contrast, other MENA countries have relatively high numbers of internet users. It is noteworthy that countries with relatively high numbers of internet users are high- and upper-middle-income countries.

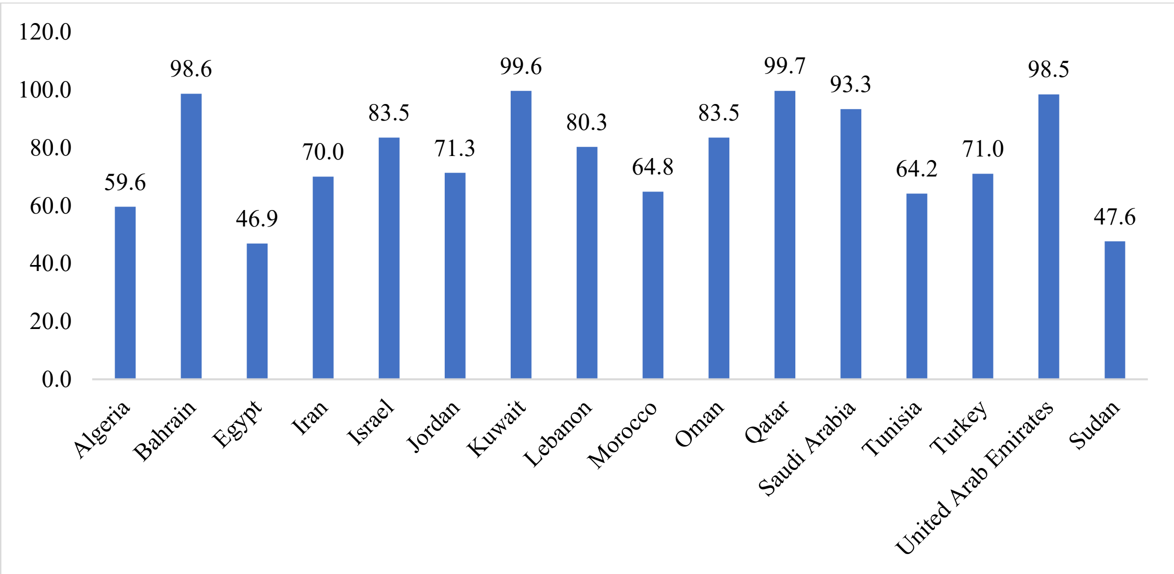

Figure 1.1: ICT Usage in MENA Countries in 2018.

Source: World Development Indicators (WDI) of the World Bank database.

As mentioned earlier, ICT plays an important role in technological progress by simplifying and improving various economic activities' efficiency and productivity (ITU, 2010). Recent literature proposes that the nexus between technology and economic growth is affected by the country’s governance quality. Based on national competence theory, governance quality plays a moderating role in the relationship of macroeconomic variables with economic growth; this explains the ability of a national economy to compete and grow (Delgado et al. 2012).

Overall, the scores of MENA countries are the lowest in the world in terms of governance quality. However, as shown in Figure 1.2, some countries in the MENA region perform well. Governance quality is measured through an average of six indicators of governance (Kaufmann et al. 2011): control of corruption (CC), government effectiveness (GE), rule of law (RL), regulatory quality (RQ), political stability and absence of violence (PV), and voice and accountability (VA).

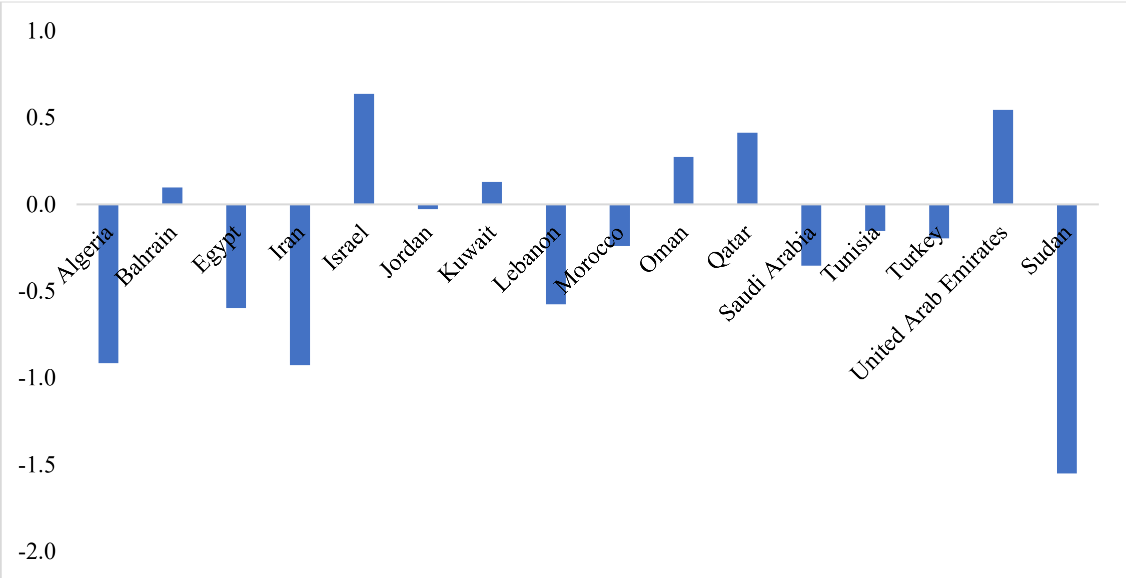

Figure 1.2: Governance Quality in the MENA Countries.

Note: This figure is the average of six indicators of governance throughout 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best). Author's calculations based on Worldwide Governance Indicators (WGI) of the World Bank.

From the discussion above, it can be seen that previous studies suggested that governance quality enhances the growth effects of ICT investment and usage in developed countries. However, the extent of this relationship, particularly in the context of MENA countries, has not been investigated. Although good governance does matter for economic growth, the literature remains equivocal about the working mechanism of governance quality. Therefore, this study examines whether ICT investment and usage have significantly contributed to growth in MENA countries. Moreover, it investigates if governance quality influences the effects of ICT investment and usage on economic growth in these countries.

1.3. RESEARCH CONTRIBUTIONS AND SIGNIFICANCE

Technology and the quality of institutions are important factors for seizing the competitive advantage in the long term. This study utilizes the national competitive advantage theory which demonstrates that these factors are important for economic growth. According to this theory, a national economy will not be able to grow and compete in an environment where poor governance quality prevails. Nevertheless, there has not yet been extensive research investigating the association between ICT and governance quality indicators in developing countries such as the MENA countries. Therefore, this study focuses on Worldwide Governance Indicators (WGI) due to the significance of institutional frameworks for stimulating innovation and boosting economic growth.

Hence, this study contributes to the existing literature by:

1. Expanding our understanding of the effect of governance on the association between ICT investment and usage, and economic growth. This study focuses on these variables due to the significance of institutional frameworks for stimulating innovation and boosting economic growth (Barro 1996a; Barro and Sala-i-Martin 1997; Romer 1990). Technology and institution quality are important factors to ensure the competitive advantage of countries in the long term. The national competitive advantage theory demonstrates that these variables are important for economic growth (Delgado et al. 2012; Romer 1990; Solow 1957). According to this theory, a national economy will not be able to grow and compete in an environment where poor governance quality prevails. Nevertheless, there has not yet been extensive research investigating the association between ICT and governance quality indicators in developing countries.

2. Provides a rigorous investigation of the contribution of ICT to economic growth across MENA countries and offers clear insights into how various governance indicators affect the association between ICT and economic growth in a region where countries suffer from weak governance and good ICT coverage. Therefore, the current study investigates the effect of all governance indicators on economic growth, as examining one or two governance indicators would not be an adequate measure of the real effect of governance in the MENA region. All indicators should be taken into consideration to determine which have the largest impact on economic growth in the MENA region.

3. An important policy implication that flows from this study analysis is that the MENA countries aiming to maximise growth benefits from ICT investment and usage should consider implementing a plan that considers all governance indicators (Humphreys and Banerji 2003; Martínez-Zarzoso and Márquez-Ramos 2019). Such a plan should focus on accountability and inclusiveness, such as the right to participate in choosing a government, the right to government accountability, the right of expression, the right of equality before the law, and many other citizens' rights are important for economic development are important for economic growth (Nabli 2007).

There have been competing propositions regarding the effectiveness of technology in stimulating economic growth when subject to certain levels of governance in developing countries. Much of the empirical literature suggests that the quality of governance promotes the growth effects of ICT investment and usage in developed countries (Cardona et al. 2013; Van Reenen et al. 2010). In contrast, some studies indicate that a lack of good governance hinders economic growth in developing countries (Al-Rawashdeh et al. 2013; Kaufmann and Fellow 2011; Tang and Abosedra 2014), but these studies are inconclusive about the impact of the quality of governance on ICT investment and usage in developing countries. Overall, there is scant and inconclusive empirical evidence on the association between ICT investment and usage and economic growth in the context of developing countries, particularly the MENA region (Niebel 2018; Sassi and Goaied 2013). Thus, the motivation for this study is derived from the fact that few previous studies have employed quality of governance to assess the effect of ICT on economic growth.

The significance of this study is that it provides insights into whether ICT investment and usage can contribute to the MENA countries' economic growth. Furthermore, the study examines the potential effects of the MENA region's governance quality on ICT investment and usage, providing strong evidence that governance quality impacts the association between ICT investment, usage, and economic growth. Using an unbalanced panel dataset covering 16 MENA countries for the period 1995–2018, this study aims to gain better insights into the role of governance quality in shaping the association between ICT investment and usage and economic growth under different levels of governance quality.

1.4. RESEARCH OBJECTIVES AND QUESTIONS

The inconclusive results of previous empirical studies have created ambiguity, particularly in terms of the role of governance quality when examining the association between ICT and economic growth. Consequently, the two main objectives of this study are as follows. First, to empirically investigate the effects of ICT investment and usage on economic growth in MENA countries. Second, to examine the moderating role of the quality of governance on the impact of ICT investment and usage on economic growth in MENA countries and how these effects vary with the level of quality of governance. To achieve these two objectives, this study applies the Autoregressive Distributed-Lagged Model (ARDL) to a panel dataset covering 16 MENA countries over the period 1995–2018.

The results of previous studies have demonstrated that improving economic growth requires improving the quality of governance and upgrading infrastructure facilities. Furthermore, political stability and high governance quality would maximise the benefits of ICT investment and usage for economic growth. In an attempt to identify the effect of ICT investment and usage on economic growth, when subject to the level of governance, the current study considers the following questions:

RQ1: Do ICT investment and usage affect economic growth in MENA countries?

RQ2: Does the impact of ICT investment and usage on economic growth depend on governance quality?

The sub-questions of RQ2 are as follows:

RQ2.1: Does a higher level of Control of Corruption (CC) improve the effectiveness of ICT investment and usage on economic growth in the MENA region?

RQ2.2: Does a higher level of Government Effectiveness (GE) improve the effectiveness of ICT investment and usage on economic growth in the MENA region?

RQ2.3: Does a higher level of Rule of Law (RL) improve the effectiveness of ICT investment and usage on economic growth in the MENA region?

RQ2.4: Does a higher level of Regulatory Quality (RQ) improve the effectiveness of ICT investment and usage on economic growth in the MENA region?

RQ2.5: Does a higher level of Political Stability and Absence of Violence (PV) improve the effectiveness of ICT investment and usage on economic growth in the MENA region?

RQ2.6: Does a higher level of Voice and Accountability (VA) improve the effectiveness of ICT investment and usage on economic growth in the MENA region?

Some of these questions have been addressed in existing literature and tested in countries other than MENA countries. The present study is more comprehensive in that it applies all governance indicators, and it focuses on the MENA region. This study provides an investigation of the impact of ICT on economic growth through different levels of governance quality.

1.5. SCOPE OF RESEARCH

This study is based on annual data from 1995 to 2018 for the 16 MENA countries: Algeria, Bahrain, Egypt, Iran, Israel, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Tunisia, Turkey, and the United Arab Emirates, as shown in Figure 1.3. The study examines a number of economic, ICT, and governance variables in the MENA countries. The data on ICT, economic, and governance variables have been collected from various sources: the World Development Indicators (WDI), the World Bank, the Worldwide Governance Indicators (WGI) of the World Bank, the Euromonitor International database, and the International Telecommunication Union (ITU).

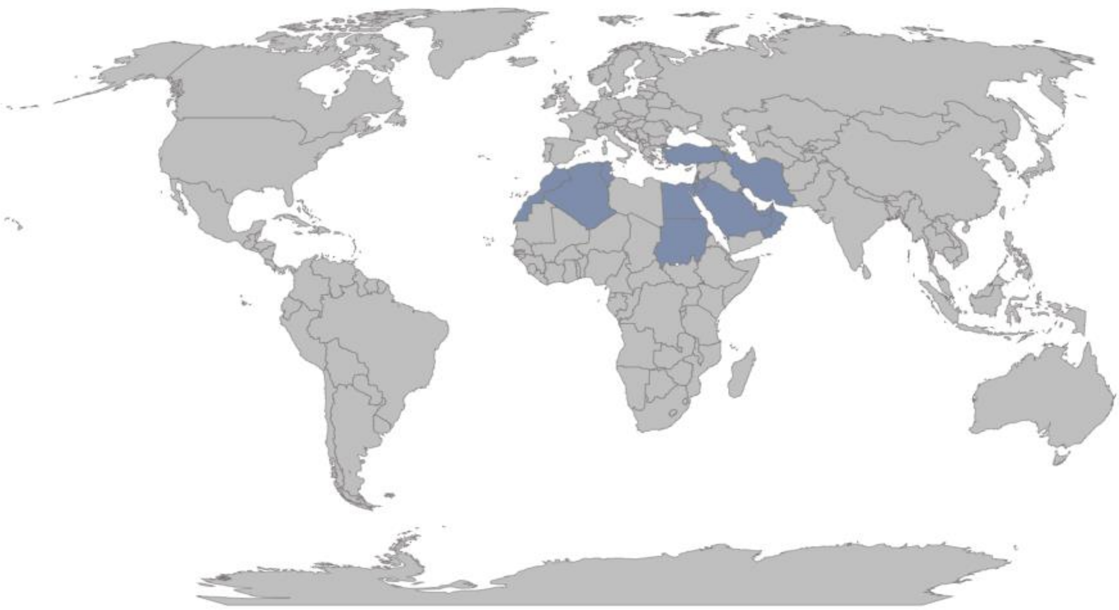

Figure 1.3: Scope of Research.

Note: Djibouti, Iraq, Syria, Yemen, Libya were excluded from this study due to the non-availability of data.

1.6. ORGANISATION OF THE DISSERTATION

The dissertation is structured into nine chapters, including this introductory chapter. Chapter 2 provides an overview of the MENA countries and their economic growth, along with a brief review of ICT and governance indicators in the MENA region. This overview addresses the geographical significance of the region, including the notable unrest from conflicts and the impact on economic growth. The chapter reviews ICT expenditure and adoption, as well as the main governance indicators that have hindered economic growth in this region. This overview will aid in understanding the properties and features of the economic, ICT, and governance variables in the MENA region.

Chapter 3 presents a review of the theory and evidence on the mainstream models of economic growth. It also explains the main similarities and differences among economic growth theories. From this discussion, the chapter identifies the most appropriate economic growth model to be used in this study.

Chapter 4 reviews the empirical literature, which is divided into four sections: Section 1 investigates previous studies of ICT and economic growth; Section 2 examines studies of quality of governance and economic growth; and Section 3 contains a review of the studies that show the moderating impacts of governance quality on economic growth. Section 4 presents the quality of governance indicators which includes definitions, differences, and what does each indicator measure. Further, it discusses the results of the previous studies that have employed these indicators in their studies. Finally, this chapter highlights the shortcomings of existing literature and discusses the main hypotheses.

Chapter 5 discusses the methodology employed in this study. This chapter outlines the data collection procedure, sources, and data description. Chapter 5 also presents the variables used in this study derived from theory and previous studies. This chapter sheds light on the model specifications and some of the initial testing that took place before applying the study model.

Chapter 6 illustrates the results of the descriptive statistics and correlations, the statistical properties of the data, and each variable that is used in the panel unit root tests. The chapter summarises the key research findings. Chapter 6 further analyses the dynamic panel heterogeneity analysis based on the technique introduced by Pesaran et al. (1999). Furthermore, it presents the detail of the ARDL approach.

Chapter 7 discusses the marginal impact of the role of quality of governance indicators on the association between the ICT investment and usage, and the economic growth in MENA countries, and how this impact under different levels of quality governance.

Chapter 8 performs many robustness analyses to confirm the validity of the moderating role of the quality of governance on the impact of ICT investment and usage on economic growth in MENA countries. This study used to conduct two tests to address the robustness analyses: i) classification of the governance indicators; and ii) alternative measures of governance.

The dissertation concludes with Chapter 9, which provides a brief recapitulation of the main results and recommendations based on the findings, as well as suggestions for future directions of research. It reviews how this research contributes to the existing literature and provides implications for policymakers.

CHAPTER 2: OVERVIEW OF MENA COUNTRIES

2.1. INTRODUCTION

The Middle East and North African region is a big and diversified trade and strategic region. The region covers most of sub-Saharan Africa and western Asia. Of all the Middle Eastern countries, Algeria is the biggest in terms of size, while the Gaza Strip is the smallest. Almost every country in the MENA has access to the sea. For example, the Mediterranean Sea lies to the west and is bordered by Turkey, Syria, Lebanon, the Gaza Strip of Palestine, Israel, and Egypt. The Red Sea lies to the southwest and is bordered by Jordan, Egypt, Saudi Arabia, and Yemen.

Additionally, the Arabian Sea is located in the southeast and is bordered by Oman. The Persian Gulf connects many countries, especially the Arab states: the UAE is at the juncture of the Gulf of Oman and the Persian Gulf, while the Sinai Peninsula of Egypt is at the juncture of the Gulf of Suez and the Gulf of Aqaba (Potter et al. 2017). The Suez Canal, the Sinai Peninsula of Egypt, and the Strait of Hormuz are some of the most important shipping routes in the world (Fisher 2013). Jordan and Iraq may appear at first glance to be landlocked, but they too have access to the sea through small strips of land. As for the North African countries, they lie on the Mediterranean Sea.

The MENA region is the original home of various civilisations and some of the oldest cultures in the world. The population of MENA mainly follows three major religions—Judaism, Christianity, and Islam. All three religions originated in the Middle East. Of these three creeds, Judaism was the first, and the Jewish people of Israel still practise it. Christianity came second and makes up 10–15 percent of the population in the MENA region, while Islam now dominates it; indeed, the world's Muslim population is mainly concentrated in the Middle East (Issawi 2013).

The objective of this chapter is to provide an overview of MENA countries through highlighting the main important economic indicators. It also highlights the growth of ICT in the region and sheds light on governance indicators in MENA countries. The rest of this chapter proceeds in the following manner. Sections 2.2 and 2.3 present a general historical overview of the MENA countries. Section 2.4 briefly outlines an overview of economic growth in the MENA countries. Section 2.5 presents overviews of ICT in the MENA countries. Finally, Section 2.5 sheds light on the quality of governance in MENA countries.

2.2. THE 'OLD MIDDLE EAST' AND NORTH AFRICAN COUNTRIES

By the end of the 15th century, the Ottoman Empire had united most MENA countries under one ruler—which had not happened since the Abbasid caliphs—for 400 years. However, the Ottomans gradually lost their advantage in many areas due to rapid European advances in many fields, such as technology, science, and economic development (Hale 2012). By the end of the 19th century, Romania, Serbia, Greece, and Bulgaria had declared their independence from Ottoman hegemony. After this, the French-occupied Algeria, Tunisia, Lebanon, and Syria whilst the British occupied Egypt, Jordan, and the Persian Gulf. By 1912–13, the Ottomans were expelled from virtually the entire European region, and the empire was dissolved following the end of the First World War (Mansfield 2013).

2.3. MODERN MIDDLE EAST AND NORTH AFRICAN COUNTRIES

After the British Mandate expired on the 14th of May 1948, the Zionists proclaimed the State of Israel in Palestine. Since then, the Middle East has changed considerably and experienced many political and military convulsions. Less than 50 years later, following the creation of Israel, the Iran–Iraq War began. The war was triggered when Iraq invaded the Iranian province of Khuzestan in 1980, resulting in a conflict that had killed thousands on both sides by the time it ended in 1988. In 1990, Iraq invaded Kuwait. The United States formed an alliance with Saudi Arabia, Syria, and Egypt as a response to this, which resulted in what is known in the west as the Gulf War (Hinnebusch 2003). In that same year, the Soviet Union and the ideology of communism collapsed, and this had important implications for the Middle Eastern countries. The collapse of the Soviet Union allowed thousands of Jews who had been living there to emigrate to Palestine. It also meant the end of Soviet-era financial and material support for the anti-western Arab regimes. Furthermore, Russia began to supply the west with cheap oil, pushing the price of oil down, and this led to a decline in Arab oil exports (Owen et al. 1998).

In 2003, following a decade of ongoing tensions with Iraq, the United States and the United Kingdom invaded Iraq. This was a very quickly won war, but it had lasting and important effects on the balance of power and economic strength in the region. In particular, the war created new relationships and economic perspectives between those countries that supported the invasion and those that opposed it (Fagen 2009).

The crises and political instability that Iraq is facing today are not the first, and many problems that have occurred in Iraq have affected other Middle Eastern countries. These serious crises include: the Iran–Iraq war in the 1980s, followed by the first Iraq war (1990–1991); Operation Desert Shield (1991) launched by the US-led coalition forces to liberate Kuwait (Farouk-Sluglett and Sluglett 2001); the US–British invasion (2003); and finally, sectarian conflict and the emergence of what is known as the Islamic State of Iraq and the Levant (also known as IS, ISIS or Daesh). These successive crises have caused an influx of Iraqi refugees to flee to neighbouring countries in the Middle East and elsewhere in the world (Hansen-Lewis and Shapiro 2015). Furthermore, the revolutionary uprisings in the mean region—such as the Arab Spring in 2010—led to civil wars in Iraq, Syria, and Yemen (Bhardwaj 2012; Haas and Lesch 2013). In mid-2014, Islamic State made territorial and political gains in some countries inside the MENA region and beyond, prompting many nations to declare a military alliance to defeat the terrorist organisation. The activities of IS have greatly destabilised the economies and security of the MENA states and other countries around the world.

What made the rise of ISIS possible was the Syrian Crisis, which started in 2011 and is ongoing. The sectarian conflict and the intervention of foreign countries inside the region were factors that perpetuated the civil war (Hof and Simon 2013). Another example of unrest in the Middle East was the military intervention by Saudi Arabia, in an operation called 'Decisive Storm,' in Yemen's civil war in 2015, with the help of nine countries from Africa and the Middle East (Hill 2017). The most recent crisis in the Middle East was the Qatar diplomatic crisis, which erupted in June 2017, when some countries, namely Saudi Arabia, Bahrain, Egypt, and the United Arab Emirates, cut off diplomatic relations and imposed an embargo (land, sea, and air blockade) on Qatar. The main reason specified for this blockade was Qatar's alleged support for terrorism in the Middle East (Zafirov 2017). At the beginning of 2021, the sanctions were lifted, and Saudi Arabia and its allies restored diplomatic ties with Qatar.

This brief outline illustrates that the MENA countries have suffered many crises throughout their recent history up to the present day. The region has witnessed many conflicts where resources have been exploited but not for the economic benefit or improvement in people's lives. It is the most unstable region in the world and the results of these conflicts have greatly influenced the political and economic situation in the region, leading to the displacement and killing of thousands of civilians and the restructuring of sovereign systems and authority distribution in the Middle East, as well as a rearrangement of international influence in the region. Moreover, the region suffers from a harsh climate and water scarcity that has caused many civil conflicts and much social disadvantage.

2.4. ECONOMIC GROWTH AND ICT IN MENA COUNTRIES

The economies of the MENA region depend largely on oil exports, especially those of the Gulf countries. Recently, political developments in the region and continued geopolitical tensions have led to a slowdown in economic growth. To apprehend possible disparities between the MENA countries regarding the impact of ICT on economic growth, especially different income levels, as seen in Figure 2.1, I arrange these countries into different income groups according to the World Bank (2019) classification,[2] where each country is categorised as either a high-income, upper-middle-income, lower-middle-income, or low-income country. To facilitate the presentation of this chapter, the classification of the study sample follows the same four groups: the high-income countries are Bahrain, Israel, Kuwait, Oman, Qatar, Saudi Arabia, and UAE; the upper-middle-income countries are Algeria, Iran, Jordan, Turkey, and Lebanon; the lower-middle-income countries are Egypt, Morocco, and Tunisia; and the low-income countries is Sudan.

[2] See https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

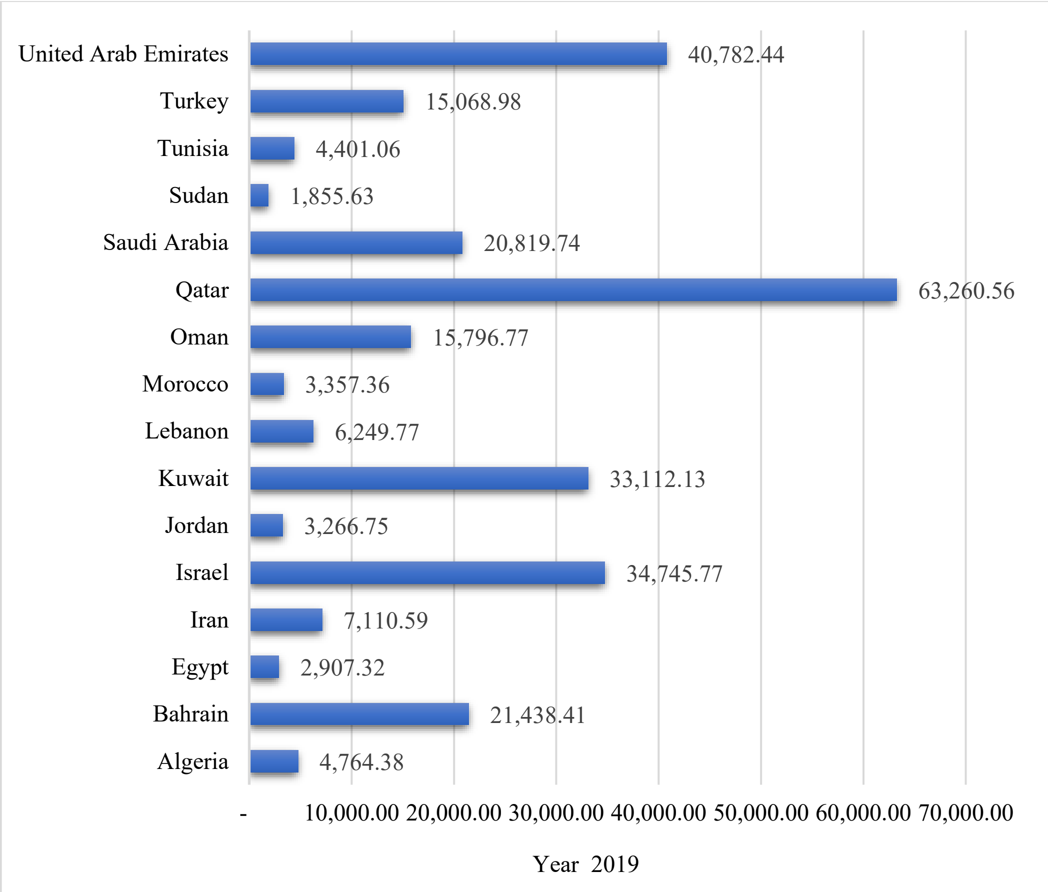

Figure 2.1: GDP Per Capita of MENA Countries in 2019.

Source: World Development Indicators (WDI) of the World Bank database.

ICT in the region has developed over the last three decades and is now capable of providing meaningful data analysis and machine learning that help to reduce administrative and operating costs substantially. The ICT sector has important economic implications for investment and productivity, particularly when aiming to create considerable consumer surplus but with more equal distribution. Government policies in the MENA countries play a vital role in enhancing the performance of ICT (Shirazi 2008; Shirazi et al. 2009). According to Shirazi (2008) and Shirazi et al. (2009), a government should build cross-institutional links for fostering collaboration between education, ICT, industry, science, and technology.

According to the International Telecommunication Union (2020), all technological indicators show that the MENA countries may become the fastest-growing region in terms of technology, which in turn could support significant economic growth, and the region may overtake the Asia-Pacific. Figure 2.2 shows the proportion of households with internet access at home (percentage of population). In MENA countries, the percentage of households with internet access at home increases yearly; in other words, the MENA countries are trying to keep pace with technological development and are seeking to implement broadband capability across their territories.

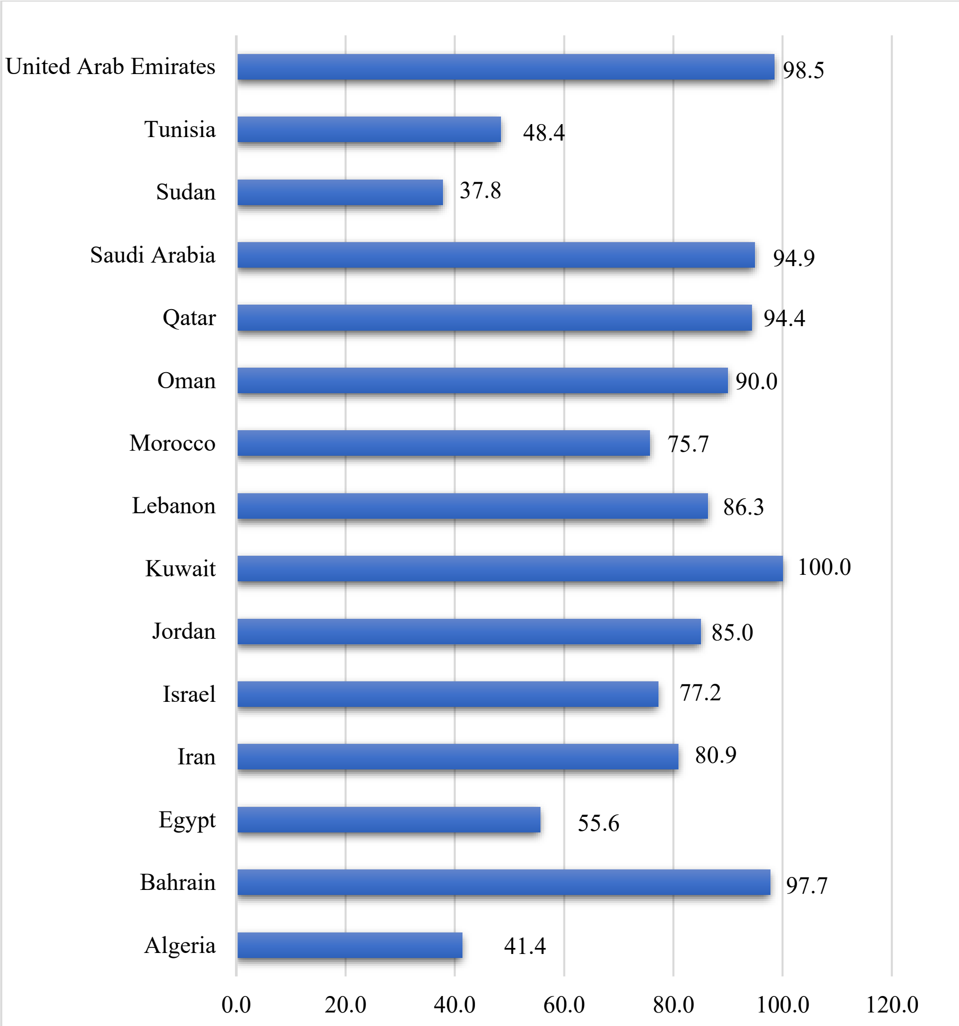

Figure 2.2: Households with Internet Access as a Percentage of Population.

Source: International Telecommunication Union (ITU) database.

Most of the MENA countries have widespread internet coverage, indicating that these nations have started increasing their telecommunications expenditure. This has led to an increase in internet access for households. However, as shown in Figure 2.2, in most MENA countries, more than 50 percent of the population can access the internet at home (except for in Algeria, Sudan, and Tunisia).

2.4.1. High-income countries

2.4.1.1. Bahrain

Bahrain is a small island situated between Qatar and the northeast of Saudi Arabia, home to 1.64 million people as of 2019. The country has a good economy, and it has the second highest-valued currency unit in the MENA region after Kuwait. Oil is the country's biggest export, making up 60 percent of export revenues, 70 percent of government earnings, and 11 percent of GDP (World Bank 2018). Bahrain also has large reserves of aluminium, which is its second-most exported product after oil (Nugent and Thomas 2016).

Bahrain's focus on ICT is relatively new, but it has invested and enhanced the overall structure effectively and efficiently to date. Using transparent and business-supporting policies, Bahrain wants the international community to contribute to its overall ICT growth. Bahrain is in the category of countries that can afford to meet the cost of broadband connections, which amounts to less than 5 percent of Gross National Income (GNI). The country has developed effective and efficient programs to support ICT use, and the value of ICT investment amounted to approximately US$86 million in 2019 (see Figure 2.3 below). Despite recent geopolitical tensions in the Middle East, plans for integrated technologies are being funded to provide a solution. Bahrain ranks number one in the Middle East for the number of individual internet users and is the 14th of the world, according to ITU (2020).

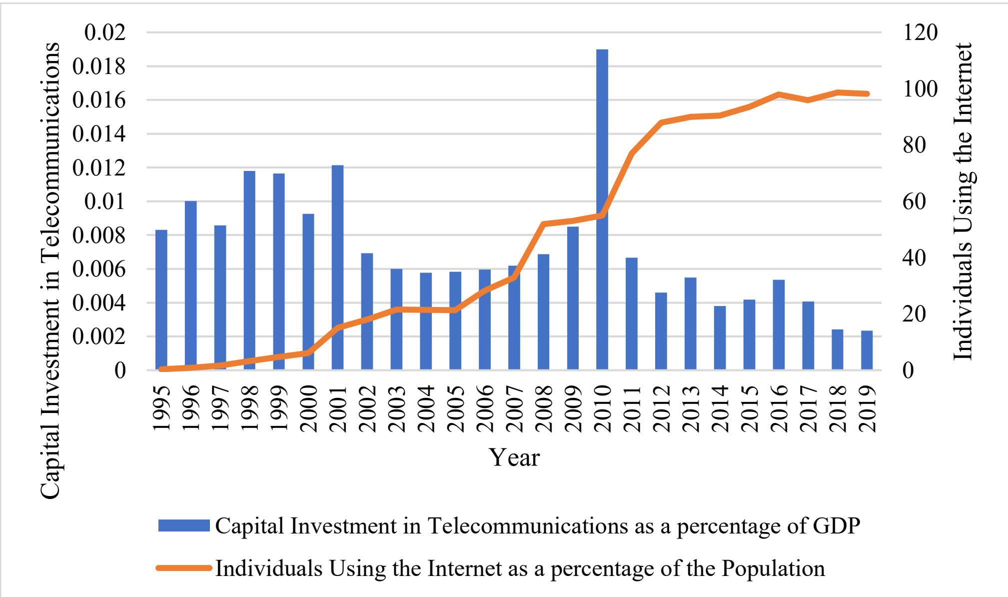

Figure 2.3: ICT Investment and Usage of Bahrain.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.1.2. Israel

The area of Israel is roughly 20,800 km^2. This small country has a strong economy, advanced technology, modern infrastructure, and a high standard of living (Israel Central Bureau of Statistics 2019). The major industries in Israel include advanced technology and manufacturing sectors, as well as one of the world's leading diamond industries, which together amount to 23.2 percent of Israel's exports. Due to its limited natural resources, Israel depends on various imports, such as oil, wheat, raw materials, and production inputs. However, recent discoveries of huge natural gas reserves may soon change Israel's energy importing trends. Solar energy further reduces Israel's need for imported energy (World Bank 2018).

Even though Israel is one of the smallest countries in the world, it has excellent living standards. According to the UN's Human Development Indicator, it was ranked within the top 20 in the world for standard of living (United Nations Development Programme Indicator 2018). Israel is a regional base for some high-tech multinational companies, such as Google, IBM, and Facebook. Further, it has the world's second-largest number of start-up companies after the United States and many NASDAQ-listed companies.

Israel's ICT market depends on a collection of new networks and services. In the next few years, ICT development in Israel will increase in fixed and mobile broadband formats. Investment in the ICT sector—especially in High-Speed Access (HSPA) technology—is enabling the development of a wide range of services. ICT expenditure as a percentage of GDP in Israel was 5.39 percent in 2008. Israel's exports of ICT goods were valued at US$5.8 billion in 2019. The average value of ICT goods exported averaged around US$6.4 billion from 2000 to 2019, and Israel's investment in the telecommunications sector was about US$816.2 million in 2019 (Euromonitor International database 2020). The percentage of individuals using the internet in Israel was around 85.4 percent of the population in 2019 (see Figure 2.4 below).

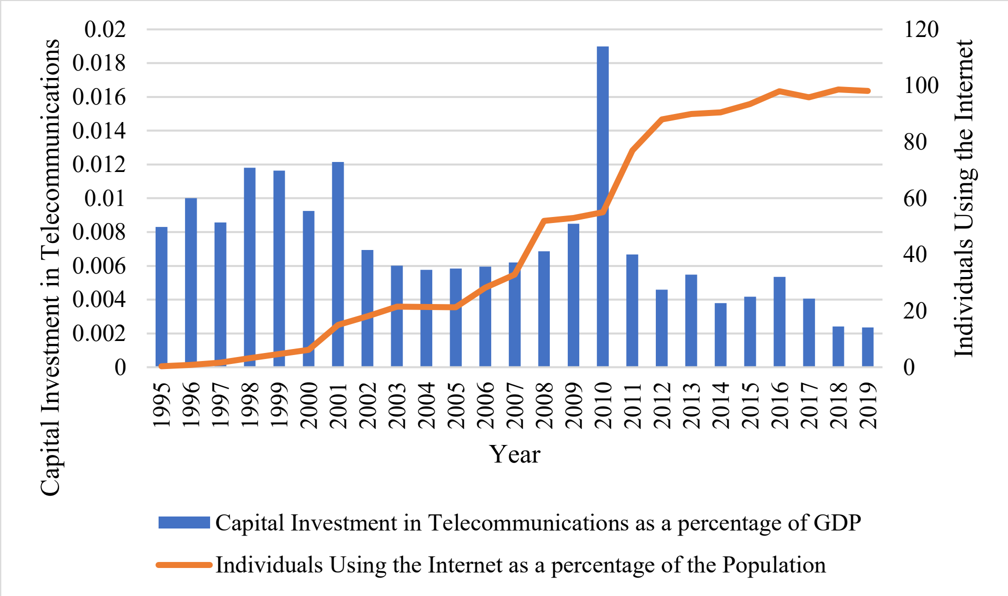

Figure 2.4: ICT Investment and Usage of Israel.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.1.3. Kuwait

The population of Kuwait is 4.207 million, comprising approximately 1.3 million Kuwaitis (30 percent) and 2.9 million expatriates (70 percent) (The Public Authority for Civil Information 2019).[3] Kuwait is the third richest GCC country per capita after Qatar and the United Arab Emirates, boasting the highest-valued currency unit in the world. It has a strong economy powered by the world's sixth-largest petroleum reserves (Crystal 2016), with hydrocarbons accounting for around half of the country's GDP. In 2018, OPEC's decision to reduce oil production meant that oil exports fell. The reduction in oil production weighed down Kuwait's annual real growth of GDP, and it fell by more than 8 percent in 2019, following a 1.3 percent increase in 2018. However, the New Kuwait 2035 Strategic Policy aims to turn Kuwait into a regional, commercial, and financial hub with less dependence on oil as part of a plan for long-term economic improvements (Central Bank of Kuwait 2018).

However, Kuwait is doing much better when it comes to ICT. Under the Kuwait National Development Plan, ICT will be the major driver for non-oil growth in the next few years. The number of different technology incubators is expected to grow and help the technological sector expand and contribute to the overall development of the country (Shirazi et al. 2009).

[3] See the Public Authority for Civil Information: https://www.paci.gov.kw/stat/default.aspx

Furthermore, Kuwait's spending on ICT is expected to expand at a compound annual growth rate of 10.2 percent over the next six years, to reach $10.1 billion by 2024 (Central Bank of Kuwait 2019) (see Figure 2.5 below).

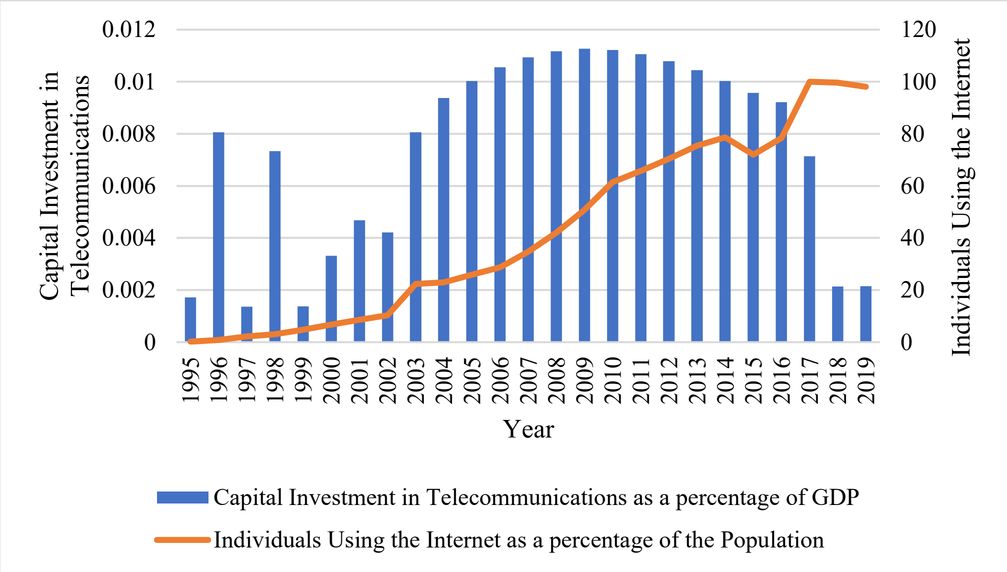

Figure 2.5: ICT Investment and Usage of Kuwait.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.1.4. Oman

Oman is an Arab country located in Western Asia and is the third-largest landmass in the Arabian Peninsula, home to 4.636 million people. It covers a total area of 309,500 km^2 and stretches a coastline of 3,165 km from the Strait of Hormuz in the north to the border with Yemen, overlooking three seas: the Arabian Sea, the Sea of Oman, and the Persian Gulf (also known as the Arabian Gulf). According to the statistics released by the National Centre for Statistics and Information (Oman),[4] the Omani economy is a middle-income economy characterised by evident surpluses. This is due to the presence of oil and gas resources in the Sultanate, where oil accounts for 64 percent of the total Omani export revenues, 45 percent of government revenues, and 50 percent of the GDP. Therefore, the petroleum production sector is one of the most important aspects of the Omani economy. Oman currently has a total of 5.50 billion barrels of crude oil reserves, which accounts for 1.2 percent of the total crude oil in the GCC countries.

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[4] See https://www.ncsi.gov.om/Pages/NCSI.aspx

According to the statistics released by Global Data (Oman)[5], ICT expenditure in Oman is expected to grow at a compound annual growth rate of 11.3 percent, from roughly $3.2 billion in 2019 to $5.6 billion in 2024. Cloud computing revenue is estimated to reach $1 billion, accounting for 17.9 percent of total ICT expenditure. The government has put a high priority on developing the ICT sector through increasing investment. To meet Oman's growing digital needs, the country established the sovereign wealth fund's (SWF) Oman ICT Group (OICT) in early 2019. OICT is an entity comprised of cloud and data services, cybersecurity, and smart applications and is helping to increase the number of individuals using the internet. In 2019, this amounted to approximately 86.8 percent of the population (see the Figure 2.6 below).

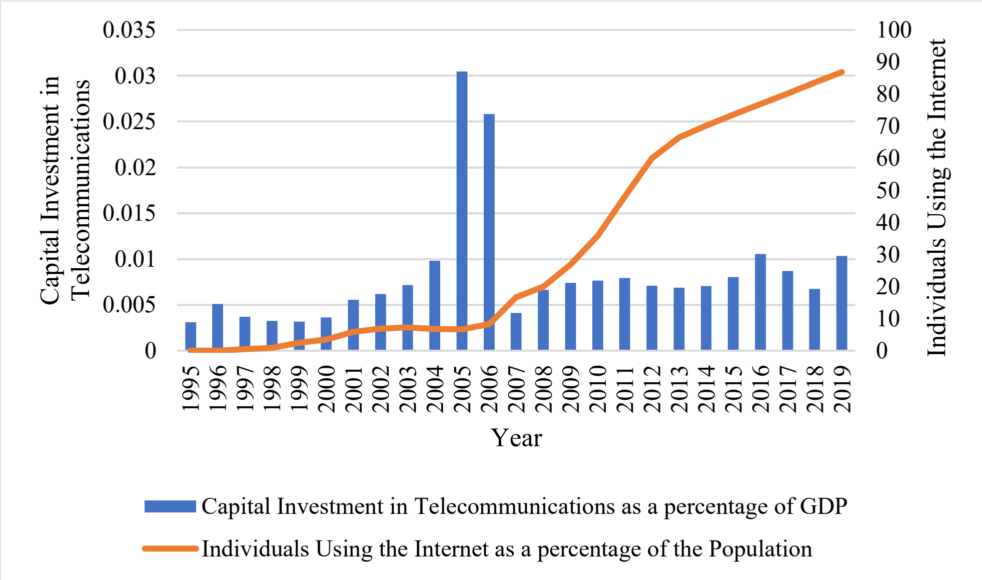

Figure 2.6: ICT Investment and Usage of Oman.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.1.5. Qatar

Qatar is a small country, covering an area of only 11,581 km^2. The total population is 2.8 million; 313,000 are citizens, and the rest of the community consists of 2.5 million expatriates. This small nation has one of the highest rates of GDP per capita in the world. Qatar's economy is dependent on gas and oil, which make up 85 percent of export revenues, 50 percent of GDP, and more than 70 percent of government income (Qatar Central Bank 2018). The country has also become a global financial investor, a donor to and sponsor of humanitarian organisations

[5] See https://www.globaldata.com/ict-spending-in-oman.

all over the world, and an importer of labour from foreign countries (International Monetary Fund 2019).

After Russia, Qatar is the world's most significant exporter of liquefied natural gas (LNG). In 2017, LNG production increased to a record high of 290 million tonnes, up by 12 percent from 2016 (Qatar Central Bank 2018). The government relies heavily on this sector as it accounts for 90 percent of its revenue. Qatar's growth has declined due to its tense diplomatic relations with the GCC and other Arab countries in recent years. However, its huge financial reserves are evident, and this has solidified confidence in the economy and subsequently reduced the effect of sanctions. This small country has the largest GDP per capita of all Middle East countries, at US$63,505.8 (Qatar Central Bank 2018).

Qatar is one of the most active markets for mobile platforms. Telecommunications investment was around US$294.2 million in 2019. ICT subsidies from the Qatar government increased by 47 percent, from US$1.9 billion in 2015 to US$2.8 billion by the end of 2018. The country plans to invest US$9 billion in ICT within the next decade, with an annual growth rate of 9.2 percent (Qatar Central Bank 2018). In addition, the number of individuals using the internet reached 99.8 percent of Qatar's population in 2019, as documented in Figure 2.7 below.

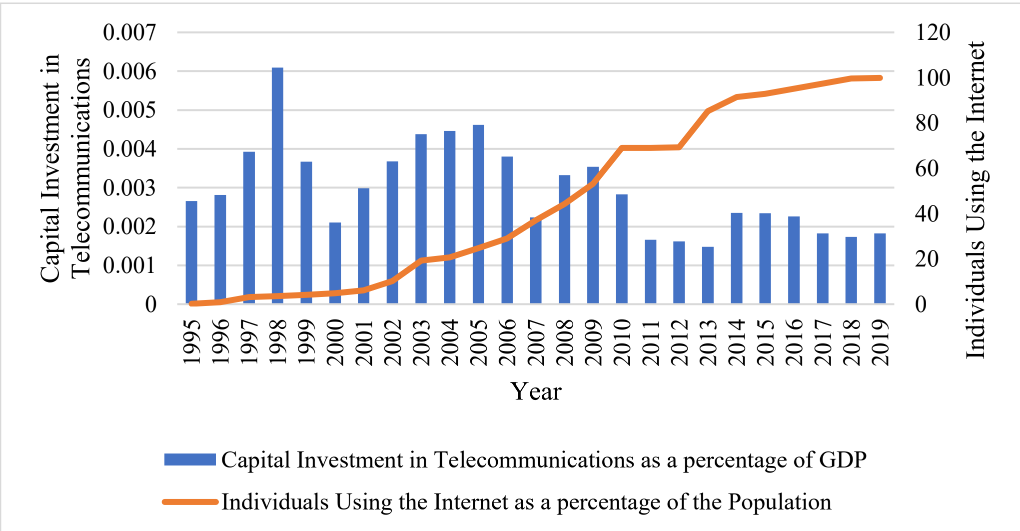

Figure 2.7: ICT Investment and Usage of Qatar.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.1.6. Saudi Arabia

The largest and richest country in the Middle East is Saudi Arabia. Its wealth is made possible by the government's economic policies, government investment strategy, and foreign investments. The Saudi economy chiefly relies on the oil sector (El Mallakh 2015), accounting for approximately 87 percent of the country's budget revenues, 42 percent of GDP, and 90 percent of exports. According to the Organization of the Petroleum Exporting Countries (OPEC),[6] Saudi Arabia has the world's second-largest reserve of petrol, making it one of the largest exporters of oil and the fifth largest natural reserve of gas in the world. It also has many natural resources, estimated at a combined value of US$34.4 trillion in 2018.

Saudi Arabia's economy still depends on its net oil exports despite the recent policy to transform the economy according to the 'Vision 2030' strategy. The nation's dependence on exports exposed Saudi Arabia to the ramifications of the global financial crisis (GFC) that erupted in 2008 (Baumeister and Kilian 2016). More recently, the fiscal deficit declined from 15.8 percent of GDP in 2015 to 16.6 percent in 2016, and the real GDP growth in Saudi Arabia fell to 2.0 percent in 2019 from 2.3 percent in the previous year. In 2019, the GDP per capita for Saudi Arabia was around US$23,139.80 (Saudi Arabian Monetary Authority 2019).

Concerning ICT, Saudi Arabia is the biggest ICT market in the Middle East, having spent almost US$47 billion on ICT infrastructure and ICT industries. According to some estimates, Saudi Arabia spends approximately US$3 billion per year on the enhancement and application of ICT systems. The Saudi Arabian government has placed great emphasis on ICT through a series of transformational actions, including planning for large-scale infrastructure and investments in healthcare and education. These actions are expected to drive demand in ICT investments (Saudi Arabian Monetary Authority 2018).[7] In 2008, Saudi Arabia was the largest investor in the ICT sector in the Middle East. Its digital transformation continues to grow, with reports showing that the Kingdom's ICT expenditure has grown in the last few years, and it is expanded further in 2021 to reach a value of US$32.9 billion, up 1.5 percent on 2020. According to the ITU, Saudi Arabia's ICT has grown rapidly, with internet penetration reaching approximately 93 percent in 2019, which means nearly 32.23 million internet users (see Figure 2.8 below).

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[6] See https://www.opec.org/opec_web/en/about_us/169.htm
[7] See http://www.sama.gov.sa/en-US/Pages/default.aspx

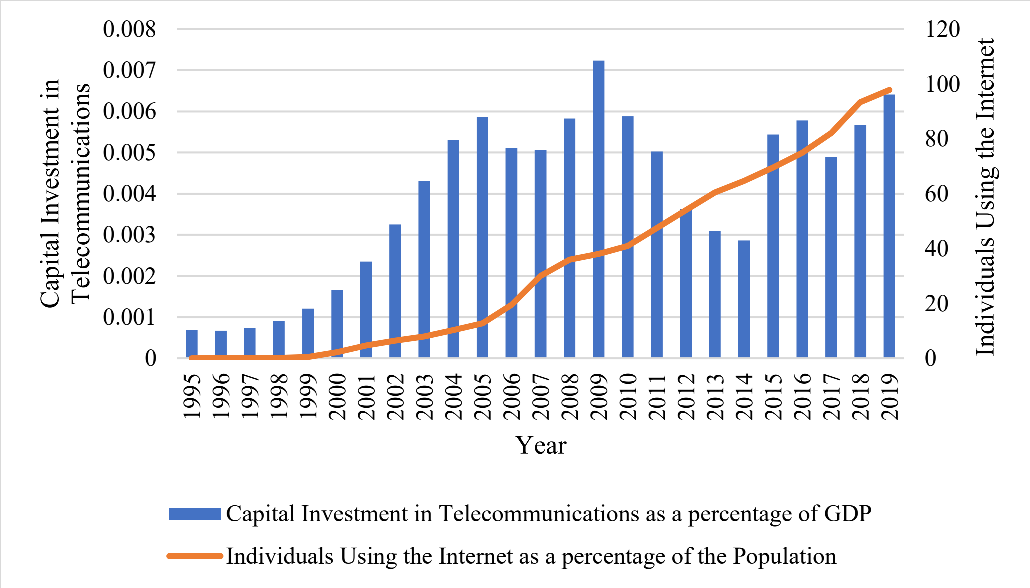

Figure 2.8: ICT Investment and Usage of Saudi Arabia.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.1.7. United Arab Emirates

The United Arab Emirates (UAE) is a union of several cities, with Abu Dhabi serving as the capital. The UAE's population in 2019 was 9.7 million, consisting of 7.9 million expatriates and 1.4 million who were locally born. According to the World Bank report, the UAE is ranked 26th in the world for business activities. Although the UAE has a varied economy, it remains heavily dependent on petroleum and gas revenues (El Mallakh 2014). The proportion of the UAE's budget that comes from petroleum exports is 77 percent, not including Dubai, which has fewer petroleum reserves. The UAE has been successfully diversifying its economy in recent times. Tourism is the most important non-petrol source of revenue, and the country famously boasts several of the world's most extravagant hotels (Sharpley and Telfer 2015). In UAE, the real GDP growth was estimated at 1.7 percent in 2019, down from 3 percent the previous year. The non-petrol sector grew by 4.5 percent in 2019 due to increased public investment and international trade.

Looking at the UAE's ICT, the government has committed US$8 billion to develop its infrastructure projects. In terms of software, it increased its spending by 4.5 percent in 2020. ICT spending in the region will reach close to US$21 billion by the end of 2021, a year-by-year growth of 6.5 percent compared to US$86 billion in 2020 (Central Bank of the United Arab Emirates 2020). The demand for ICT goods and services in the UAE is due to the rise in the use of new technologies as well as the increase in household computers. Moreover, individual use of the internet reached around 99.04 percent of the population (see Figure 2.9 below).

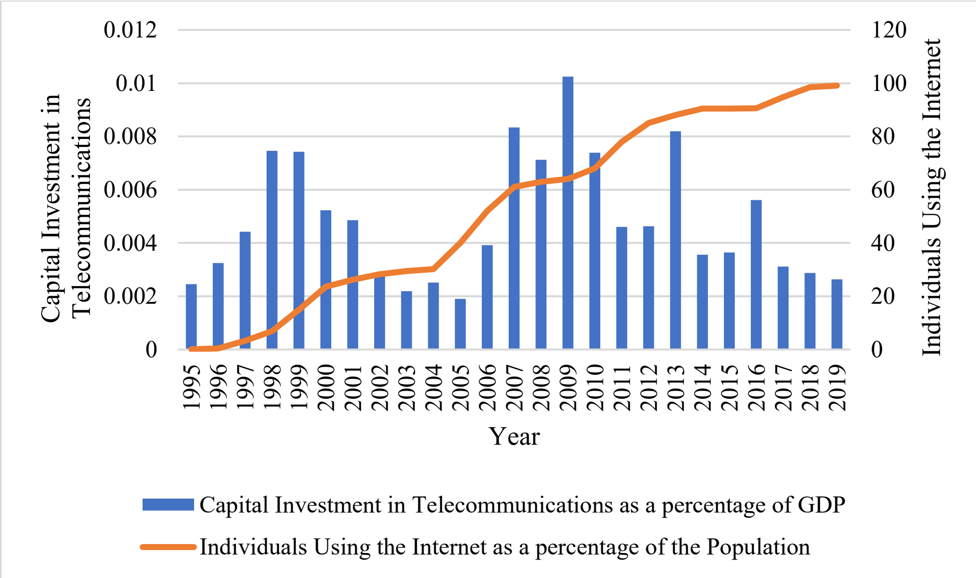

Figure 2.9: ICT Investment and Usage of UAE.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.1.8. Summary

To sum up, these countries have a high-income level compared with other MENA countries, translating as the most substantial economic growth in the region. It is evident that most of the high economic growth in the MENA region has occurred in the oil-exporting countries, except Israel. In addition, these countries have placed a high priority on developing ICT and are well positioned for growth in the coming years.

2.4.2. Upper-middle-income countries

2.4.2.1. Algeria

Located in North Africa with an area of 2.41 million km², Algeria has an estimated population of 43.05 million people. It is the fourth largest exporter of natural gas in the world, and the third-largest oil producer in Africa, with oil and gas accounting for about 98 percent of export revenues. Government revenues account for about 40 percent of the country's GDP (International Monetary Fund 2018). According to the International Energy Statistics database,[8] Algeria's oil reserves amount to 12 billion barrels, of which 1.885 million (2.52 percent) are exported daily.

According to ITU, the internet penetration rate in Algeria reached 59.6 percent in 2018, an increase and a significant improvement over the previous five years, and it reached 66.7 percent in 2019. This improvement is due to technological progress achieved by Algeria in recent years. Moreover, the number of internet users in 2019 reached 33.5 million, a 62 percent increase from 2018. This dramatic rise in one year can be attributed to the Algerian government's move to digitalise the country's business (see Figure 2.10).

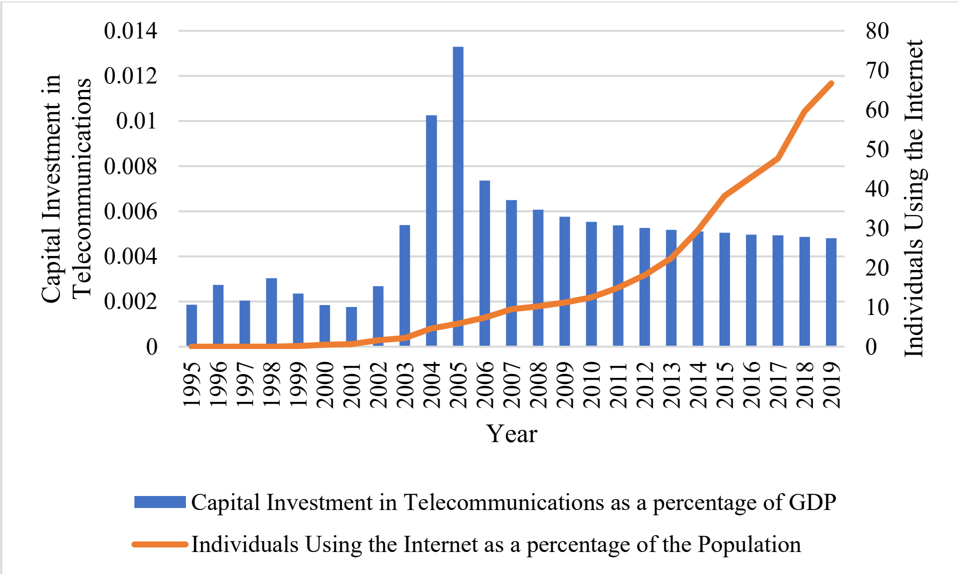

Figure 2.10: ICT Investment and Usage of Algeria.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.2.2. Iran

Iran covers a total area of 1,648,195 km^2, making it the second-largest country in the Middle East and a central location in Western Asia and Eurasia, giving it invaluable geographical significance (World Bank 2018). Today, its population is estimated at 82.91 million after many decades of conflicts and emigration. The Iran–Iraq war from 1980–1988 temporarily weakened Iran's economic growth (Gause Iii 2002), forcing the government to spend about US$6 billion a year, which accounts for two-thirds of the state's overall budget. However, its high income from oil, gas, and other products has altered the economic balance for Iran. It has the second-

[8] See https://www.eia.gov/.

largest supply of natural gas reserves in the world, and its economy greatly depends on such exports. Other profitable industries include agriculture, which accounts for 23 percent of Iran's GDP and employs approximately 28 percent of the population. Only about 25 percent of the land can be cultivated because of the severe water shortage, meaning that Iran must import much of its food. Wheat and barley are grown on about 75 percent of cultivated land. Manufacturing accounts for about 18 percent of Iran's GDP and absorbs around 25 percent of employment (World Bank 2018).

According to the ITU database, there were 28 million broadband subscribers in Iran by the end of 2019. Iran's ICT sector provides about 150,000 jobs and contributes 1.3 percent of its GDP. The Iranian government is expanding its technological services in all regions and in rural areas. In 2019, the value of the ICT market was about US$19.5 billion. Further, the individuals using the internet reached to around to 75 percent in 2019 (see Figure 2.11 below).

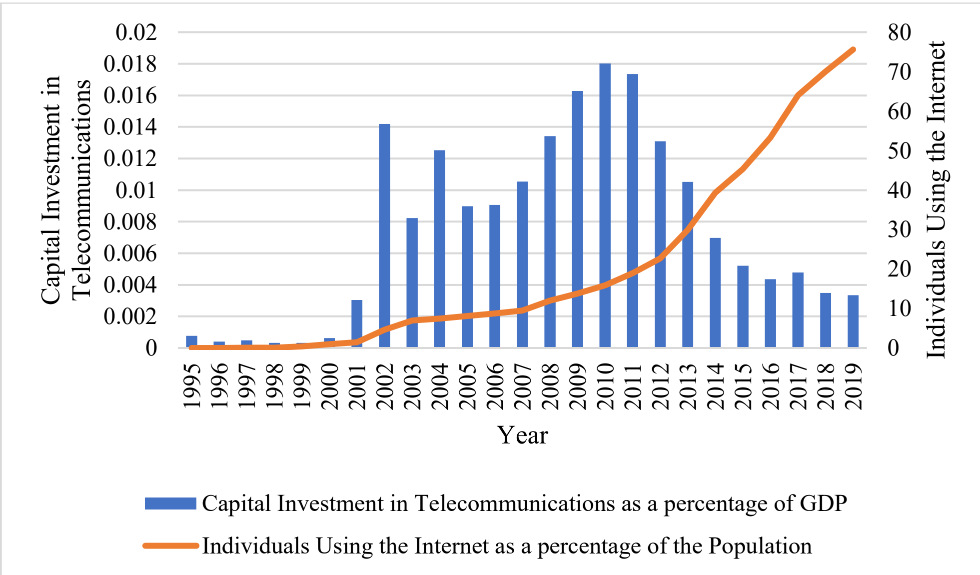

Figure 2.11: ICT Investment and Usage of Iran.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.2.3. Jordan

Jordan is a small country covering a geographical area estimated at 89.342 km^2, home to 10.1 million people as of 2019. Jordan shares its borders with Iraq in the north-east, Palestine and Israel in the west, Saudi Arabia in the south, and the Republic of Syria in the north. It is one of the countries that has been the most affected by various Middle East crises, including conflicts in Palestine in 1945, Iraq in 2003, and Syria in 2011 (Fakih and Ibrahim 2016). Because of such conflicts, Jordan is not performing well economically, and it is clear that a recovery will not occur anytime soon, as the regional struggle and displacement of people will continue to influence the economy (Central Bank of Jordan 2018).

This small country with limited resources houses the world's second-biggest refugee population compared to its population, around 89 refugees per 1,000 inhabitants. More than 2 million Palestinians are registered as refugees, along with 666,294 Syrian refugees, 66,823 Iraqis, 11,477 Yemenis, 4,211 Sudanese, and other nationalities constituting around 2,470 people.

ICT is now recognised as one of Jordan's most actively growing sectors of the economy. In 2012, the sector grew by 25 percent. According to the ICT Association of Jordan, it accounted for 14 percent of GDP.[9] ICT sector revenue was US$ 2.3 billion in 2018, a 5% increase compared to 2017 (Central Bank of Jordan 2018). Central Bank of Jordan is suggested that Jordan's public and private sectors should work carefully to improve infrastructure and services. According to the ITU, in 2019, internet users reached 75 percent, or 8.9 million, of Jordan's population. In addition, Jordan has increased capital investment in telecommunications in the last four years, which reached US$ 215 million in 2019 (see Figure 2.12 below).

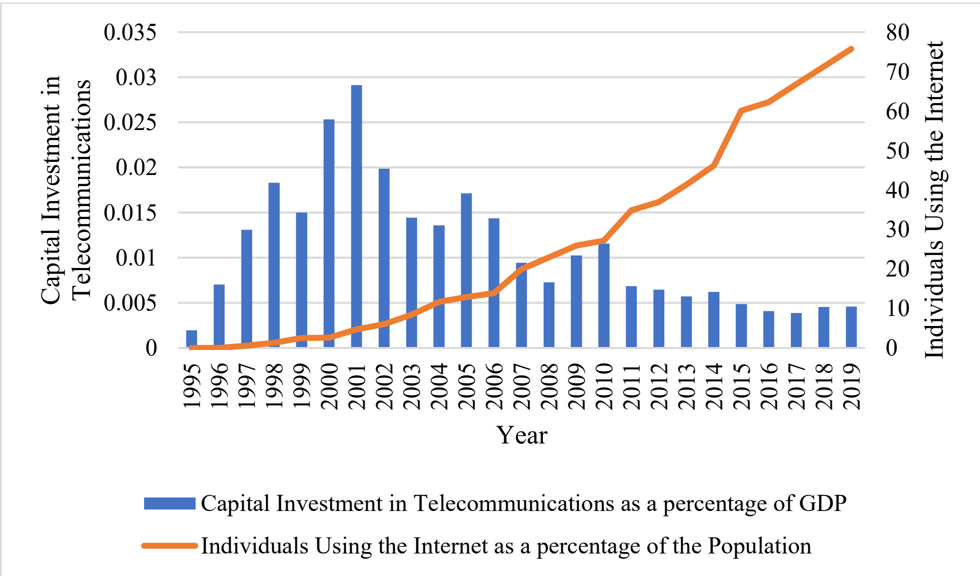

Figure 2.12: ICT Investment and Usage of Jordan.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

[9] See https://intaj.net/

2.4.2.4. Lebanon

Lebanon had a population of 6.856 million inhabitants in 2019, living across a total area of 10,452 km2 (Banque du Liban 2019).[10] Lebanon is not an oil-exporting country and depends on agriculture and limestone for its economic prosperity. One of the main issues impacting Lebanon's economy is the aftermath of the Syrian crisis, which erupted in 2011. As many as 1.5 million Syrians are refugees, accounting for around one-quarter of the Lebanese population. This issue is a source of great concern for its economy. Extreme poverty has registered a threefold increase from 8% in 2019 to 23% in 2020 (World Bank 2020). Investments have declined, and tourism has shrunk as a result of the deteriorating security situation. The number of tourists fell by 8.3 percent in 2019 compared with the previous year. Many exports transported by land were damaged by the conflict in Syria, while low levels of economic activity and internal political instability have put the government under great pressure. The annual real growth of GDP decreased from 0.3 percent in 2018 to -6.5 percent in 2019.

According to the ITU, the ICT sector in Lebanon has witnessed a huge leap in terms of improvement and expansion in recent decades. Various factors have driven the growth of the ICT sector, including a drop in device prices, and improvements to infrastructure. Lebanon's ICT sector has been developed by increasing investment in infrastructure, expanding the scope of the internet (especially broadband), increasing its speed, and increasing the labour force skilled in this sector.[11] In 2018, Lebanon's ICT sector was valued at US$480.7 million, and it had grown at an annual rate of 9 percent from 2014–2018. By the end of 2017, ICT exports comprised around 6.9 percent of total service exports,[12] and the sector contributed US$1.4 billion to Lebanon's GDP. Further, internet users have increased to approximately 82 percent of the population in 2019 compared with 73 percent in 2015. An increased impact of the ICT sector on GDP is expected for the years to come, as seen in Figure 2.13.

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[10] See http://www.bdl.gov.lb/statistics-and-research.html
[11] See https://www.bankmed.com.lb/BOMedia/subservices/categories/News/20150515163840628.pdf
[12] See https://investinlebanon.gov.lb/en/sectors_in_focus/information_technology

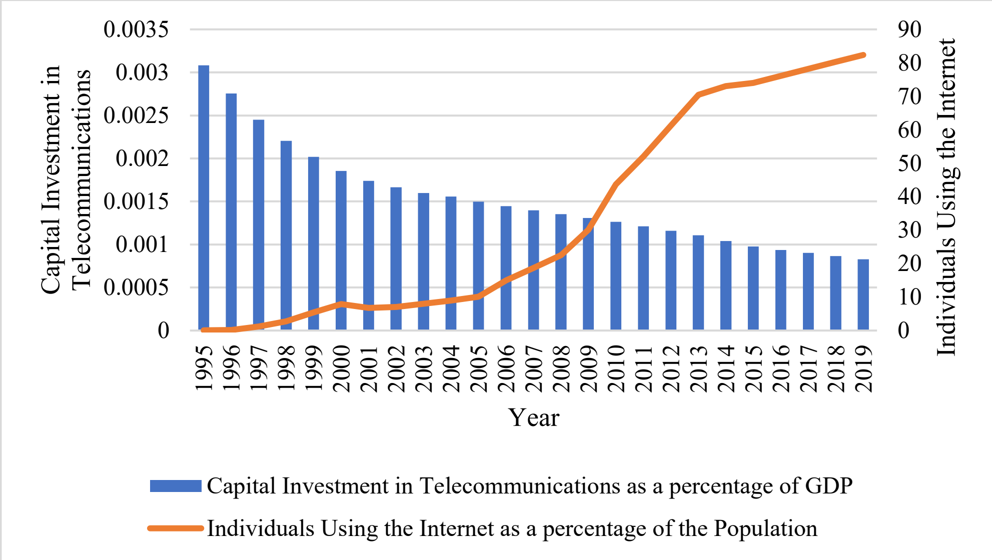

Figure 2.13: ICT Investment and Usage of Lebanon.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.2.5. Turkey

The population of Turkey is estimated to be 82 million. Approximately 70–80 percent of the country's citizens are Turkish, and about 20 percent of the population are Kurds; other ethnic minorities include Arabs, Albanians, and Circassians. Turkey does not rely on one source of income, unlike the Gulf countries, which depend mainly on oil (Central Bank of the Republic of Turkey 2017). Turkey is one of the world's biggest producers of agricultural commodities, clothes, cars, ships, and other means of transportation. It also has other sources of revenue that are important to the economy, such as the tourism sector, which has experienced rapid growth in recent years (World Bank 2018). Turkey attracted approximately 42 million foreign tourists in 2014, making it the sixth-ranked public tourist destination in the world (Sharpley and Telfer 2015). However, tourism numbers reduced to around 36 million in 2015; in 2016, they deteriorated further, to approximately 25 million, and they continued to drop in 2017 due to regional uncertainties and political instability in the Middle East, according to the UN World Tourism Organization (UNWTO 2017).

Since 1995, Turkey has been trying to improve various sectors of its economy. Its performance has been impressive in terms of fiscal stability and macroeconomics, making Turkey an upper-middle-income country and enabling increased incomes and employment (Hale 2012). The poverty rate halved over the period 2002–2015. Throughout this time, Turkey largely changed its economic policy and embarked on a dramatic urbanisation strategy. It opened foreign trade with Europe and the rest of the world and implemented trade and economic laws that complied with European Union (EU) standards (Central Bank of the Republic of Turkey 2018). In 2002, the GDP per capita was US$3,660, which nearly tripled to US$10,672 in 2010. In 2019, the GDP per capita surpassed US$9,126, and the Turkish economy increased by 3.7 percent. In the same year, the economy had a decrease in the growth rate of 8 percent. In 2020, Turkey faced an economic shock, which was the collapse of the value of the Turkish lira compared with the US dollar (World Bank 2020). Escalating geopolitical tensions throughout the Middle East region are also predicted to slow Turkey's economic growth (Central Bank of the Republic of Turkey 2020).

The government of Turkey has made ICT its principal priority for improving the business sector. In 2018, the government's expenditure on ICT was US$27.5 billion. This sector helped to increase employment by creating 113,000 jobs. Additionally, Turkey's exports from software and hardware technology have generated approximately US$1 billion to date. Turkey's telecommunications investment was approximately US$1.9 billion in 2020 (Central Bank of the Republic of Turkey 2020). ICT expenditure in Turkey grew, and the market size increased by 7 percent in 2020. Further, ICT spread increased, and internet users were 76 percent of the population in 2019 (see Figure 2.14 below).

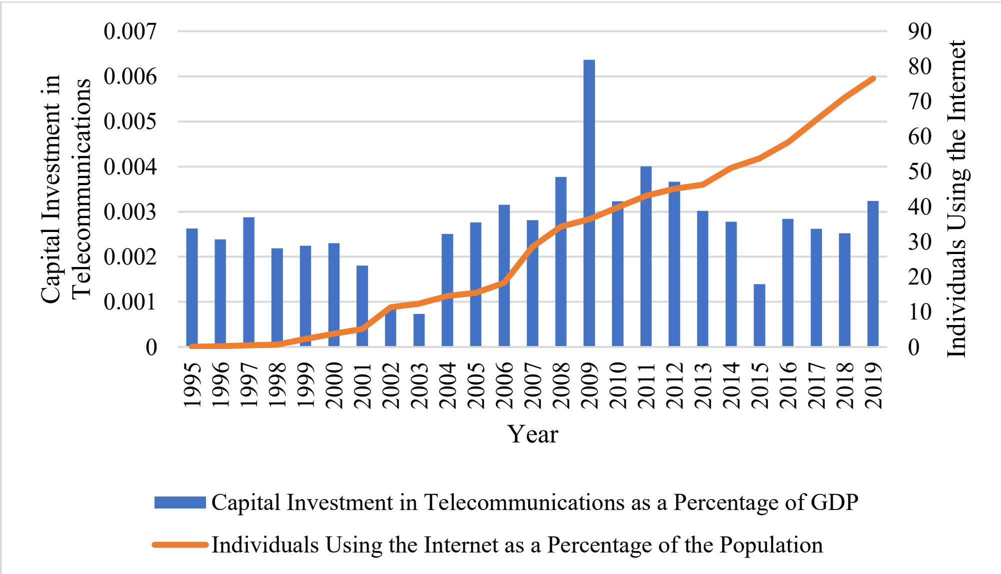

Figure 2.14: ICT Investment and Usage of Turkey.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.2.6. Summary

Based on the above discussion, it can be seen that these countries are trying to increase ICT diffusion through increasing investment in ICT.

2.4.3. Lower-middle-income countries

2.4.3.1. Egypt

In 2019, Egypt had a reported population of 100 million people, living across an area of 1.01 million km². The Egyptian economy is the second-largest economy in the Arab world after Saudi Arabia but faces the problem of an escalating population. Despite the Egyptian government implementing economic reforms to reduce extreme poverty and jump-start its economy, the World Bank (2018) reported that 40 percent of the population is poor, and this number is increasing. Egypt has one of the most diversified economies in the Middle East, where agriculture, industry, tourism, and services account for similar proportions of the economy. The most important parts of the Egyptian economy are agriculture, Suez Canal revenues, tourism, taxes, culture-related production, media, and oil exports (Central Bank of Egypt 2019).

Egypt is one of the world's largest cotton exporters and has a huge textile sector. Other industries include cement, iron, steel and chemicals. Although agriculture employs about one-third of the workforce, most arable land is used to grow cotton, with the country importing about half of its food needs. Egyptian economic growth witnessed moderate growth over the decade up until the Arab Spring of 2011, when the Egyptian GDP fell. The economy recovered at the end of 2014 after the presidential elections were held.

The ICT sector in Egypt, according to the indicators of economic performance announced by the Ministry of Planning, Follow-up and Administrative Reform and a World Bank report, achieved a record growth rate for the sector, reaching about 12.5 percent during the fiscal year 2016–2017. The sector contributed 4.9 percent to Egypt's exports of telecommunications and information technology services, which amounted to an increase of US$1.87 billion in 2018. Investments reached US$1.28 billion during the fiscal year 2017–2018 compared with US$895 million for the 2016–2017 fiscal year, meaning that ICT investments rose by 38 percent in 2018 (World Bank 2018). Ministry of Communications and Information Technology [13] announced

[13] Ministry of Communications and Information Technology see https://mcit.gov.eg/

that the number of companies established during the period from January to September 2018 was 999, with capital valued at US$58 million, in addition to the implementation of 12 projects worth US$7,748,934 million. The value of exports of ICT services exceeded US$4.1 billion (International Telecommunication Union 2020). Furthermore, according to the ITU database, internet penetration in Egypt stood at 48 percent at the end of 2019, up from 23 percent five years before that (see Figure 2.15 below).

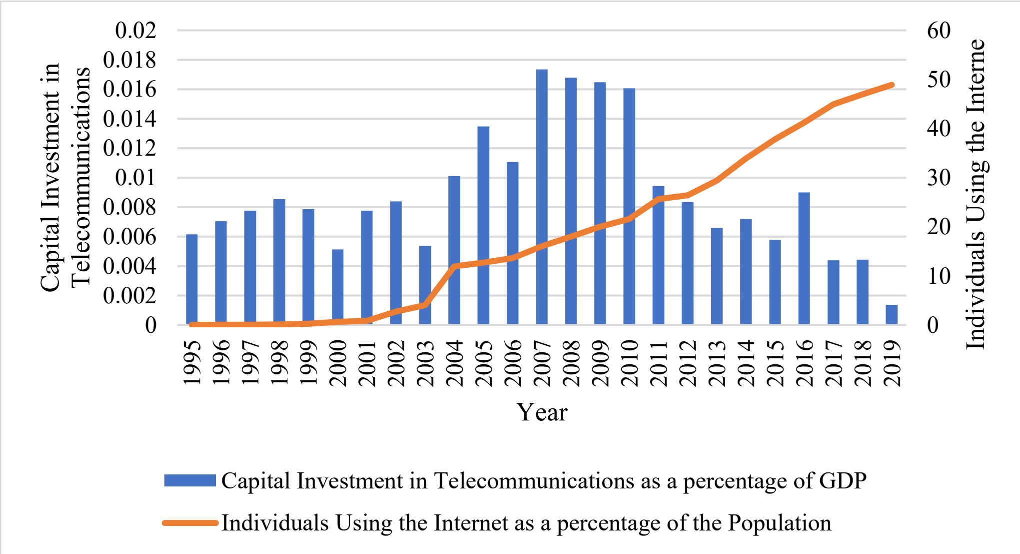

Figure 2.15: ICT Investment and Usage of Egypt.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.3.2. Morocco

Morocco's population of 36.47 million (as of 2019) is spread over a geographical area of approximately 44,655 km². In 2017, the GDP was estimated to be US$119.7 billion, an average of US$3,204 per capita. In the past, Morocco's economic reform has been hampered by several factors, including: high rate of population increase, unemployment, size of the public sector, an agricultural production compromised by extensive drought, and excessive dependence on phosphate exports and imported energy (Central Bank of the Kingdom of Morocco 2018).

Morocco has significant mineral resources. It is the world's third-largest producer of phosphate and the source of about 20 million tons each year. The country contains stocks of iron and other metals such as barite, lead, manganese, cobalt, copper, and zinc. However, Morocco's energy sources are minimal. The country's production of nitrates and natural gas covers barely 20 percent of the people's needs, forcing Morocco to import. The industrial sector contributes about 28 percent of the GDP (Adom et al. 2012), while agriculture accounts for about 40 percent of Morocco's working population and contributes about 17 percent to the gross national product. Higher prices for imported energy significantly affect Morocco's economy, seeing the annual real GDP growth decrease from 3.1 percent in 2018 to 2.4 percent in 2019.

Morocco is one of the countries that has invested heavily in the ICT sector, from 1995 up to 2019. In 2019, internet users were around 70 percent of the population. A rapid increase in the number of mobile subscribers and rising consumption of voice and data services have boosted Morocco's ICT sector. Turnover for the telecoms sector was around $4.6 billion in 2019, and that industry accounted for 3.5% of Morocco's GDP and 5% growth in 2020, as documented in Figure 2.16 below.

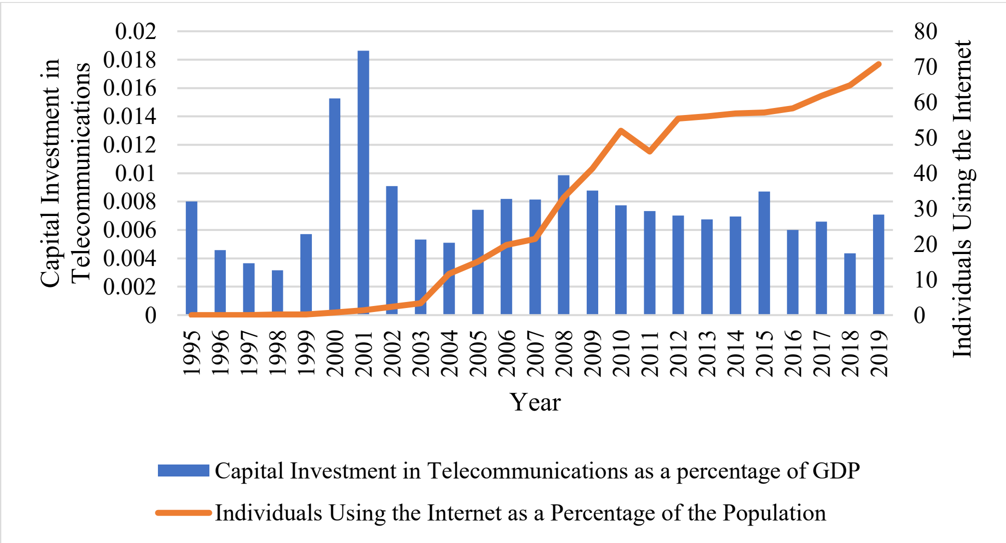

Figure 2.16: ICT Investment and Usage of Morocco.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.3.3. Tunisia

Tunisia's population of 11.69 million, as of 2019, is the smallest country in the Maghreb region of North Africa. The Tunisian economy is experiencing deep-seated problems. It suffers from public sector spending pressure, scarcity of natural resources, worsening external debt, and weak annual economic growth. Tunisia is also still recovering from the authoritarian and economically failing regime of Zine El Abidine Ben Ali, who was overthrown on January 14, 2011. A revolution had erupted over fuel prices but was also a stand by many people against rising unemployment, poverty, marginalisation, and corruption (Schraeder and Redissi 2011).

Tunisia is an important agricultural country, with cereal cultivation across all regions, covering an area of 1.5 million hectares (Central Bank of Tunisia 2018). Industry in Tunisia has driven the economy since the country's independence; its current industrialisation policy is a more liberal one designed to boost the economy. Industrial projects have been established thanks to important investments based on national and foreign private capital. The number of jobs in Tunisian manufacturing has doubled between 1995 and 2018, from 25,000 to 50,000 workers (Central Bank of Tunisia 2018). Tunisia's economic growth is bolstered by its oil, tourism, and phosphate industries. Economic planning resulted in moderate but continued growth for over a decade, up until the Arab Spring of 2011, when Tunisia's GDP fell to around -1.9 percent. After the Arab Spring, the economy recovered, with a one percent GDP growth in 2019 (World Bank 2020).

The ICT sector in Tunisia recovered revenues up to nearly US$1.8 billion in 2018. In addition, in the same year, investment in the ICT sector rose by 68.5 percent, or about US$620 million. According to the ITU, the internet penetration rate was 48.4 percent at the end of 2019, a rise of 35 percent over the past five years. This is due to the support and development projects undertaken by the Tunisian government to support the ICT sector. However, a notable percentage of the rural population does not have access to telephone lines or the internet, with rural access amounting to 39 percent in 2019, as seen in Figure 2.17.

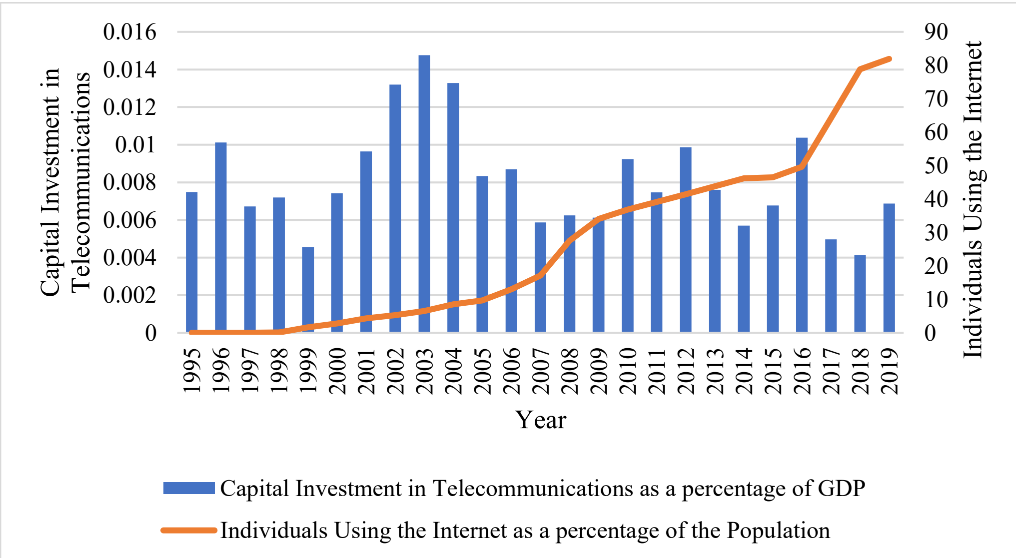

Figure 2.17: ICT Investment and Usage of Tunisia.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.3.4. Summary

It is notable that all the lower-middle-income countries in the MENA region are non-oil producing countries, which may explain their slow economic growth and ICT diffusion. Further, the Arab Spring negatively affected some countries in terms of ICT investment.

2.4.4. Low-income countries

This section reviews economic growth and ICT development at low-income countries. The overview of low-income countries such as Syria and Yemen show that there was an information shortage after 2011 concerning Syria and from 2014 to 2018 concerning Yemen. These countries are therefore excluded from the study sample.

2.4.4.1. Sudan

Sudan is located in the North-East Africa region. It is bordered by many countries, including Chad, Eritrea, Egypt, Ethiopia, Libya, the Central African Republic, and South Sudan. Sudan covers a geographical area estimated at 1,886,068 km^2 and has a population of 42.81 million as of 2019.[14]

In 2010, before the secession of South Sudan, Sudan was the 17th-fastest-growing economy in the world.[15] However, due to the secession of South Sudan, which contains more than 80 percent of Sudan's oilfields, Sudan has entered into an economic recession, GDP growth has decreased, and the inflation rate has increased. Sudan's GDP dropped from US$40.852 billion in 2018 to US$30.51 billion at the end of 2019. The unemployment rate in Sudan increased after the secession of South Sudan, and it remains a major issue, estimated to be as high as 9.5 percent (World Bank 2018). The agricultural sector is the most important sector in Sudan, employing more than 80 percent of the workforce and contributing 39 percent of GDP. However, Sudan is the fifth hungriest nation in the world and one of the poorest countries in the world, with 45 percent of the population living on less than US$3.20 per day.

ICT investment over the past five years has declined significantly, falling to US$57.4 million in 2019, which is a drop of US$20.7 compared with 2018. Regional instability and civil conflicts may be responsible for the country's downturn. Internet use is still low, at less than

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[14] See *"The World Factbook – Central Intelligence Agency"*. https://www.cia.gov/library/publications/resources/the-world-factbook/geos/su.html

[15] See https://www.afdb.org/en/countries/east-africa/sudan/sudan-economic-outlook

30 percent of the population. However, ICT infrastructure in Sudan is better than that of many other African countries, and this infrastructure boosts ICT accessibility and uses in order to boost the country's GDP growth (see Figure 2.18 below).

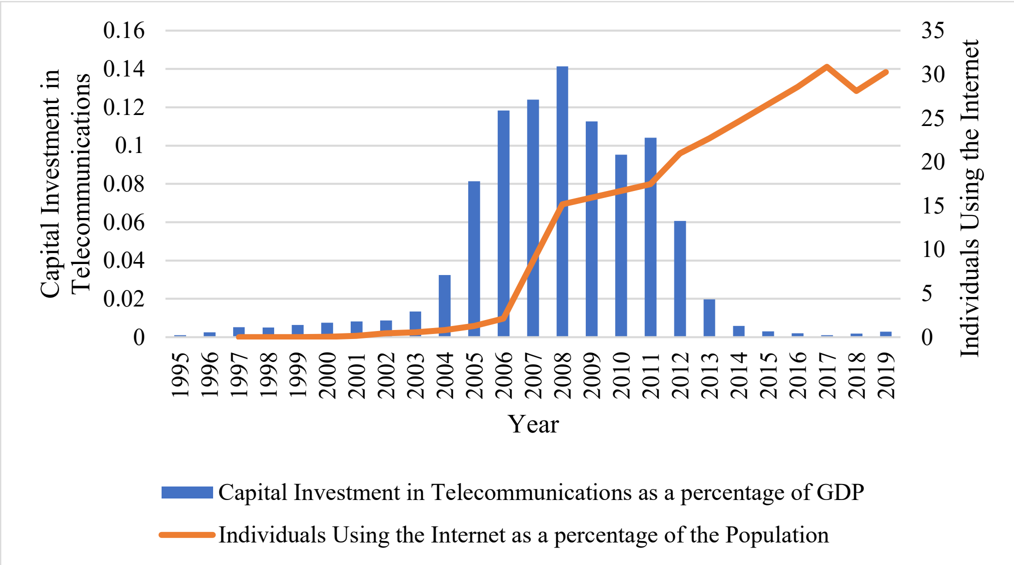

Figure 2.18: ICT Investment and Usage of Sudan.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

2.4.4.2. Summary

Notably, all the low-income countries in the MENA region have dropped from being lower-middle-income countries due to civil wars. War leads to extensive destruction of a country's infrastructure, and therefore, wars and political instability have negatively affected ICT investment and usage and economic growth in these countries (see Figure 2.27).

In the following section, this study explores how the quality of governance has an impact on the growth of the economies in the Middle East and North Africa.

2.5. QUALITY OF GOVERNANCE IN MENA COUNTRIES

Over the course of the year 2011, the political status of the MENA region changed due to the Arab Spring (Springborg 2011). This led to significant political instability in some countries in the region, which in turn affected economic growth (Asongu and Nwachukwu 2016). The region suffered from instability and lack of freedom both before and after the Arab Spring, and historically is the least free area in the world (Byrne et al. 2013). The Arab Spring brought about the downfall of longstanding leaders in the region, as well as the rise of citizens' voices and demands for the governments to take note of their issues. This created new opportunities for trying to reform policies and was a chance to find a way to implement a democratic transition in the area (Campante and Chor 2012). Unfortunately, this did not eventuate. Rather, the Arab Spring carried with it devastation, civil wars, and struggles over influence and power in most MENA countries.

2.5.1. High-income countries

2.5.1.1. Bahrain

According to the Freedom House report,[16] political parties are illegal in Bahrain, and there are no democratic elections in the country, except for the parliament council elections. Internet freedom remains restricted in Bahrain from 2017, when the government ordered the monitoring of all websites, launched a large-scale arrest campaign and imprisoned dozens of activists from social networking sites to suppress unrest and protests. In 2016, the Bahraini government launched a campaign against religious Shiite organisations and closed many sites that represented this branch of Islam. Bahraini law does not protect people's rights of expression because the Bahraini king is a ruler who personally controls the judiciary. The rights of some internet users were violated, and they were arrested and detained; many are still awaiting trial on charges of insulting the king and criticising the government. A law was also passed allowing civilians to be tried in military courts.

[16] See "Bahrain," *Freedom on the Net 2018*, https://freedomhouse.org/report/freedom-net/2018/bahrain

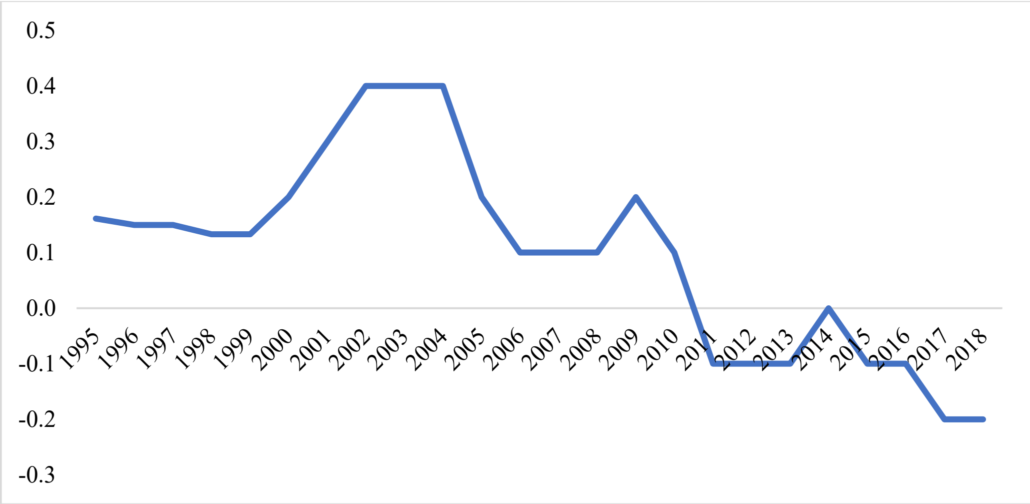

Figure 2.19: Average of Quality of Governance (Bahrain).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source:** Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.19 shows Bahrain's average quality of governance for 1995–2018. Overall, it can be seen that the quality of governance was good between 1995 to the end of 2010 when the Arab Spring started. After the Bahraini uprising at the beginning of 2011, which involved anti-government protests, its government declared a state of emergency. In addition to this, the government repressed the revolt by the use of force with the support of the Gulf Cooperation Council. Since then, Bahrain has changed from being seen as a country that was a democratic model in the MENA region to being seen as a state that disrespects citizens' rights. Nowadays, Bahrain is classified as one of the worst governance countries in the region.

2.5.1.2. Israel

According to the Freedom House report,[17] Israel is the only country in the MENA region that enjoys a high level of freedom in all sectors of society. It is a democratic, multi-party country, which allows the people to select the prime minister and the members of the Israeli parliament. Furthermore, the rule of law is not under government control, meaning that the judiciary is an authority that is independent from the political powers.

[17] See "Israel," *Freedom on the Net 2018*, https://freedomhouse.org/report/freedom-world/2018/israel.

Israel permits peaceful demonstrations, and its media is free to criticise policies, not being subject to any control by the government. In 2017, the court system issued rulings to shut down some websites featuring possibly criminal content.

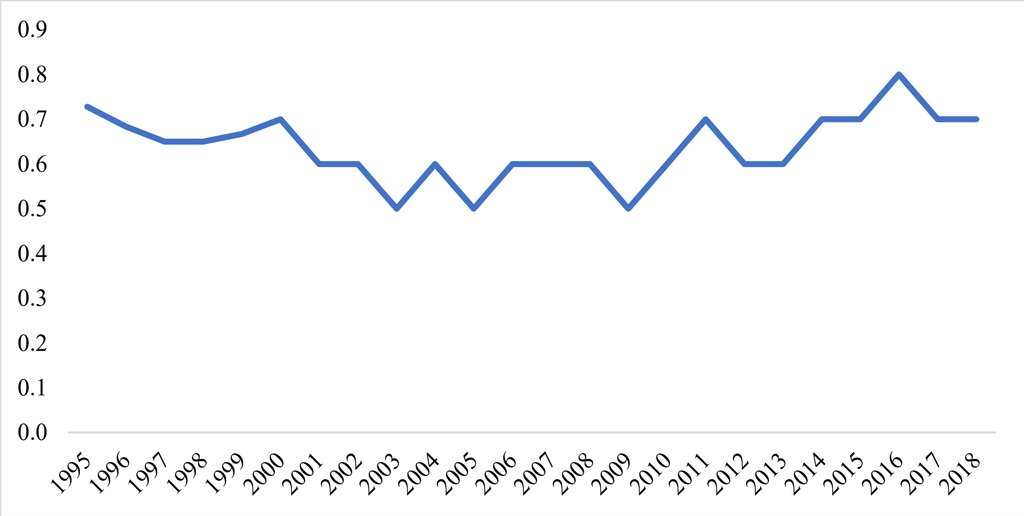

Figure 2.20: Average of Quality of Governance (Israel).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source:** Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.20 illustrates the average of six indicators of governance over the period of 1995–2018. It is apparent that the average quality of governance in Israel in 1995 was around 0.7; after this, the average gradually decreased, reaching approximately 0.5 in 2005. After this, the average increased to about 0.8 until 2016. Since then, the average quality of governance has slightly decreased. However, Israel still has one of the best qualities of governance of the MENA countries based on Freedom House classifications.

2.5.1.3. Kuwait

The Kingdom of Kuwait is a state ruled by the Al-Sabah family, which has executive power and controls the judiciary. According to Human Rights Watch,[18] the prince appoints all judges, and he is directly responsible for judicial promotions. Courts often rule in favour of the government, especially in political cases.

[18] See "Kuwait" Human Right Watch, https://www.hrw.org/world-report/2019/country-chapters/kuwait.

The Prime Minister is appointed by the king. The legislature is the elected parliament, and yet despite challenges to the government on numerous decisions, its politicians often ignore calls to investigate corruption. Recently, the government-imposed sanctions and restricted freedom of expression and freedom of assembly for citizens. According to the Freedom House report,[19] Kuwaiti's government limits freedom of the press. The law punishes any person who publishes material that insults the ruling family or the government or publishes any information calling for the regime to be overthrown. Journalists are at risk of arrest and imprisonment if they insult and/or criticise the government.

Figure 2.20: Average of Quality of Governance (Kuwait).

Note: This figure is the average of six indicators of governance over the period 1995-2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source:** Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.21 shows the average of the indicators of governance from 1995 to 2018. It can be seen that the quality of governance was good from 1995 to the end of 2011. Once again, the Arab Spring affected the governance indicators—in Kuwait, it had a negative impact, seeing all indicators decrease after 2011. The quality of governance gradually decreased until the end of 2018, with the country becoming one of the worst countries in the MENA region for governance according to the Freedom House classifications.

[19] See "Kuwait," *Freedom on the Net 2018*, https://freedomhouse.org/report/freedom-world/2019/kuwait.

2.5.1.4. Oman

In Oman, political parties are not permitted, and its authorities do not tolerate other forms of organised political representation. According to the Freedom House report,[20] a 2014 law allows the revocation of citizenship for Omanis who join organisations deemed harmful to national interests. In the Sultanate of Oman, the structure of the political regime excludes any possibility of changing the government through elections since the Sultan reserves all political power. Furthermore, freedom of speech is very limited, and no authority is allowed to criticise the Sultan. Peaceful assembly is not allowed, and all public gatherings need official permission from the government in advance. The judiciary is not an independent authority. The sovereign has total control of the internet and the ability to block websites and prosecute journalists.

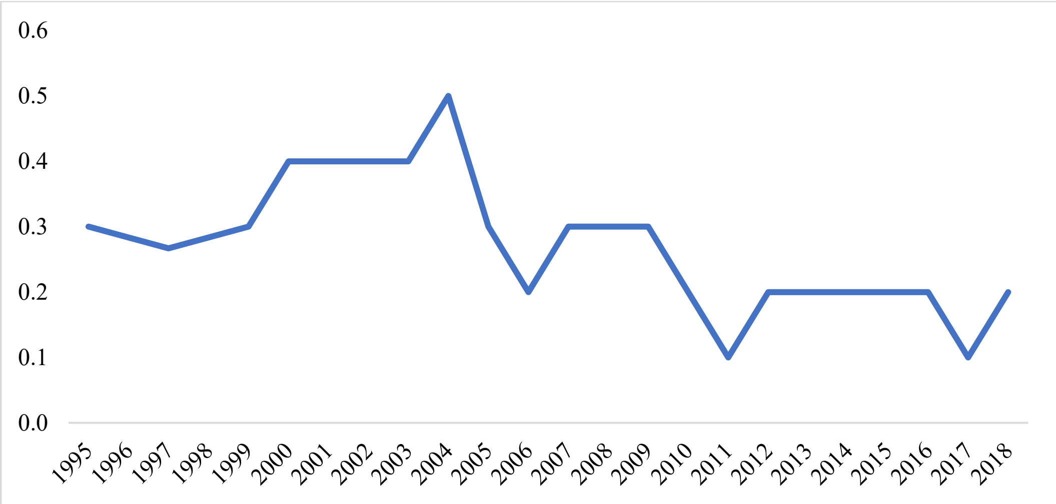

Figure 2.21: Average of Quality of Governance (Oman).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source:** Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.22 shows the quality of governance in Oman for the period of 1995–2018. Overall, Oman has a good level of governance compared with the rest of the MENA region. The figure shows that the quality of governance gradually increased until 2004, before falling slightly at the end of 2006 and rising again between 2007 and 2008. Approaching 2011, the line gradually decreased in conjunction with the Arab Spring until Sultan Qaboos realised the need to ease the pressure exerted on citizens. In this case, the Arab Spring positively affected

[20] See "Oman," *Freedom on the Net 2018*, https://freedomhouse.org/report/freedom-world/2018/oman.

the quality of governance. But all political rights and civil liberties remain under the control of the regime.

2.5.1.5. Qatar

The Emir of Qatar's enjoys all the sovereign powers of legislative and executive authority, and there is no elected legislature to balance executive power. According to a Freedom House report,[21] the Emir controls the judiciary, appointing the judges, and most judges are expatriate workers whose contracts are renewed periodically and/or annually. Political parties are not allowed, and there are no democratic elections in the country, except for the advisory municipal council elections. Qatar's government does not allow political parties, so the municipal council's elections are run with independents standing. All audio and print media are subject to government censorship, including the internet.

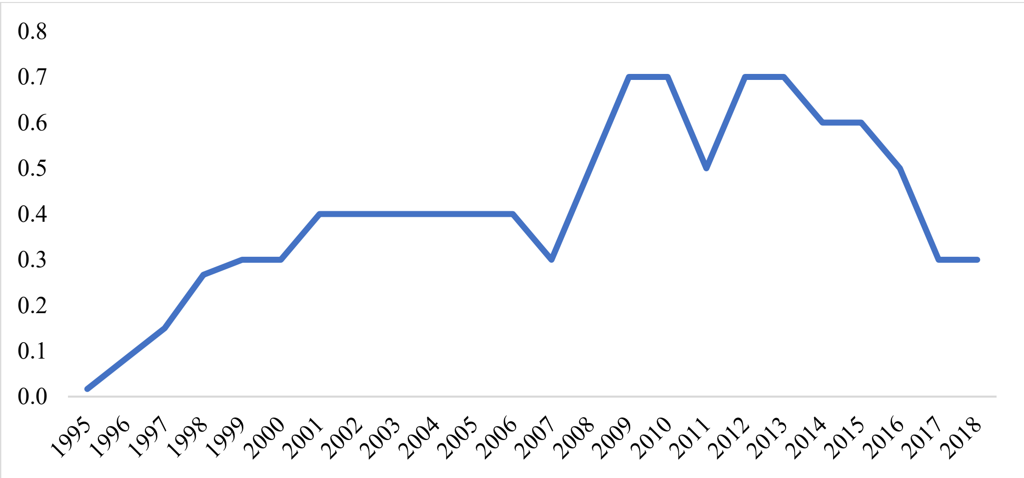

Figure 2.22: Average of Quality of Governance (Qatar).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.23 shows the average of quality of governance in Qatar for 1995–2018. At a glance, the quality of governance in Qatar is located toward the better end, based on Freedom House classifications. The quality of governance in Qatar slightly increased from 1995 to 2006, then decreased in 2007, and sharply rose again from 2008 to 2009. After some initial fluctuation

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[21] See "Qatar," *Freedom on the Net 2018*, https://freedomhouse.org/report/freedom-world/2018/qatar.

during the 2011 Arab Spring, the governance quality gradually increased. The Emir of Qatar continues to hold ultimate executive, legislative, and judicial power.

2.5.1.6. Saudi Arabia

Saudi Arabia is a monarchy and does not have political parties. There is no elected legislature. The Prime Minister is appointed by the king, as are judges. The judiciary is not independent of the king's decisions.

The Saudi government, according to Alkasir.com,[22] closely monitors the content of the internet, filtering out and closing electronic newspapers and social networking websites if any insult the ruling royal family or if any anti-government comment is made. According to the Freedom House report,[23] the Saudi government has some of the most powerful restrictions on internet users in the world. Those who breach this, including human rights defenders, can be imprisoned for up to 11 years.

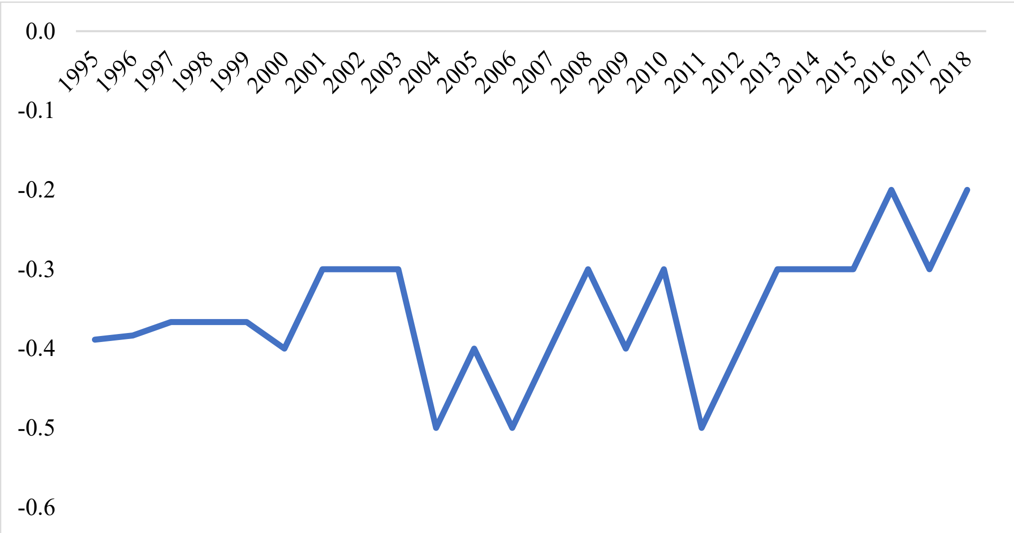

Figure 2.23: Average of Quality of Governance (Saudi Arabia).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

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[22] According to the Alkasir.com, which provides information on blocked websites, the URLs acpra6.org and anhri.net are blocked in Saudi Arabia: "Cyber-Censorship Map," Alkasir, accessed on March 2, 2013, https://alkasir.com/map.

[23] See "Saudi-Arabia," *Freedom on the Net 2018*, https://freedomhouse.org/report/freedom-net/2018/saudi-arabia.

Figure 2.24 illustrates the quality of governance in Saudi Arabia for 1995–2018. It can be seen that the quality of governance line is located in the negative numbers on the Freedom House classifications, and the line has a general downward trend. Saudi Arabia's absolute monarchy restricts almost all political rights and civil liberties. From 1995 to 2010, the line showed clear fluctuation, but when the Arab Spring occurred in 2011, the quality of governance declined sharply. In the middle of 2011, the Saudi monarchy realised the need to reduce the restrictions that it imposes on its citizens. In 2015, King Salman ascended to the throne, and ever since, Saudi Arabia has sought to raise the level of freedom in all aspects of peoples' lives. This includes the return of public cinema, an end to the ban on women driving, and increased empowerment for women in society.

2.5.1.7. United Arab Emirates

According to the Freedom House report,[24] the UAE government has full control over social media and communications, blocking and closing websites that criticise the government and/or the ruling family. The Cybercrime Panel Code punishes those responsible for transmitting what is deemed to be hate speech and violence. In 2017, the government introduced laws to restrict freedom of expression, leading to a substantial decline in internet freedom—an infringement of online users' rights.

The Emir of UAE is the political authority and controls the judiciary by appointing the judges. Political parties are not allowed, and there are no democratic elections in the country except for parliament members.

[24] See "United Arab Emirates," *Freedom on the Net 2018*, https://freedomhouse.org/report/freedom-net/2016/united-arab-emirates.

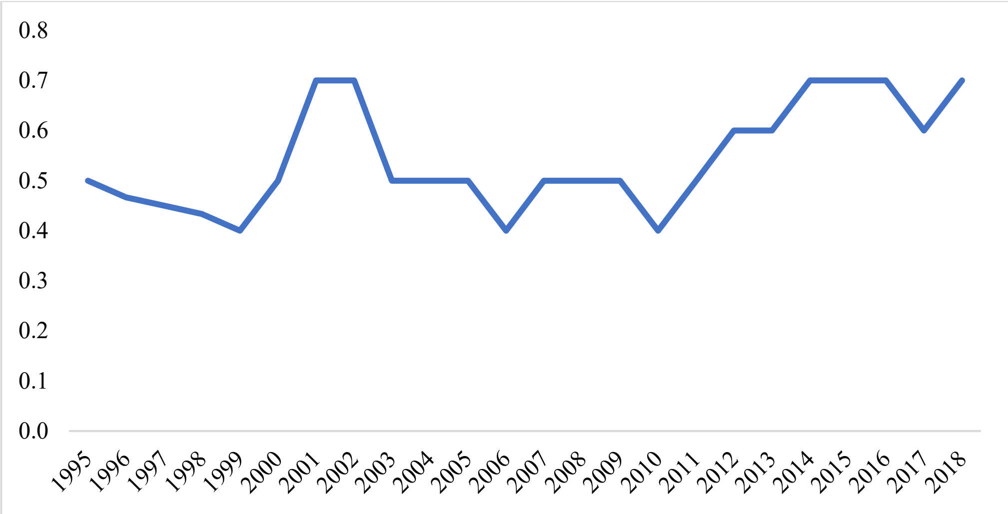

Figure 2.24: Average of Quality of Governance (United Arab Emirates).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

As shown in figure 2.25, the quality of governance in the United Arab Emirates is good based on Freedom House classifications. The figure illustrates that, after 2002, governance quality gradually decreased and fluctuated until the Arab Spring at the end of 2010. The quality of governance has since been improving in the United Arab Emirates. However, the country continues to suffer from human rights violations, through repeated arrests and imprisonment of parties and activists opposed to the ruling authority.

2.5.1.8. Summary

Most of the high-income countries, except Saudi Arabia, possess good governance quality. As shown in Figure 2.26, Saudi Arabia has a proportionately low level of governance quality compared with other high-income countries that have relatively a good governance quality level. It is noteworthy that Saudi Arabia's absolute monarchy restricts almost all political rights and civil liberties.

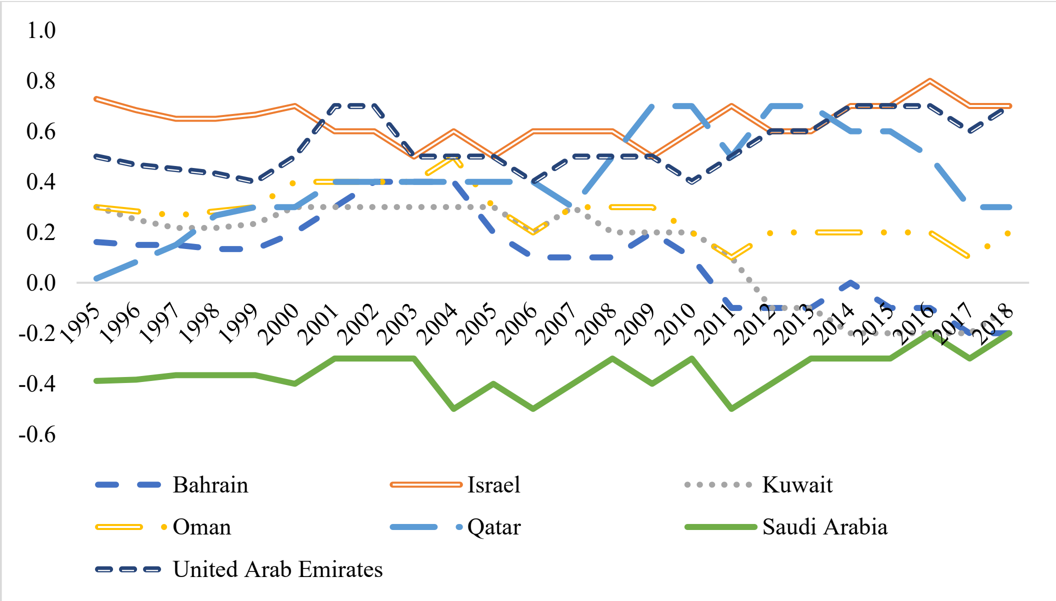

Figure 2.25: Average of Quality of Governance (High-income countries).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

2.5.2. Upper-middle-income countries

2.5.2.1. Algeria

According to the Freedom House report,[25] in Algeria, the ruling party and the army (the National Liberation Front), led by Abdelaziz Bouteflik, dominated the political scene from 1991 until the beginning of 2019, when the most recent election was held. In the Bouteflika era, fraud in the presidential elections was evident. In terms of censorship, the government continues to use various means to put pressure on the media and suppress protests in the street. The establishment of parties is not permitted without government consent, and there is no role for opposition parties because of the pressure exerted by the government on all political alternatives. Judicial authority is under the control of the political powers. No executive, legislative or judicial powers are independent authorities from the decisions of the ruling party.

[25] See "Algeria," *Freedom on the Net 2017*, https://freedomhouse.org/report/freedom-world/2018/algeria.

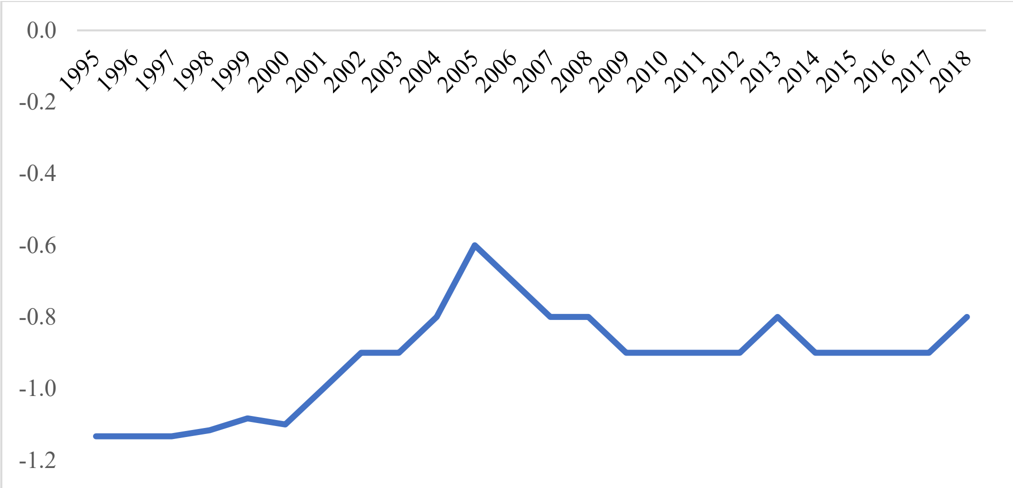

Figure 2.26: Average of Quality of Governance (Algeria).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.27 shows that the quality of governance in Algeria is low. However, the governance trend from 1995 to 2018 has significantly risen. As shown, the average increased from 1995 to 2005. Following this, the average of governance quality gradually decreased until the Arab Spring at the end of 2010. Around this time, the Algerian government afforded some freedom to institutions, especially press freedom. Furthermore, President Bouteflika terminated the monopoly over radio and TV and reduced corruption inside these institutions. Since then, governance quality has fluctuated.

2.5.2.2. Iran

Iran is one of the lowest-ranked countries in the world in terms of freedom of speech and use of the internet. According to the Freedom House report,[26] the Iranian government has imposed a series of strict laws on news channels and people who criticise the government, and there are still many news channels and news sites that are censored. Furthermore, the government has reduced access to tens of thousands of international websites, particularly those of religious, ethnic and opposition groups. Due to the weakness of the rule of law in Iran, many political activists and journalists—especially online journalists—have been subject to violations of their rights, with many arrested and imprisoned, and sometimes kidnapped or attacked by militias.

[26] See "Iran," Freedom on the Net 2016, https://freedomhouse.org/report/freedom-net/2018/iran.

The Iranian government has also blocked some international websites, such YouTube, Facebook, and Twitter.

Iran is a non-partisan country, meaning that there are no organised political parties. Citizens pick the president for the country for a four-year term, but the ultimate authority rests with the Supreme Leader, as the president can be dismissed by the Supreme Leader, who controls everything. Iran's judicial system is completely subordinate to the Supreme Leader and the president.

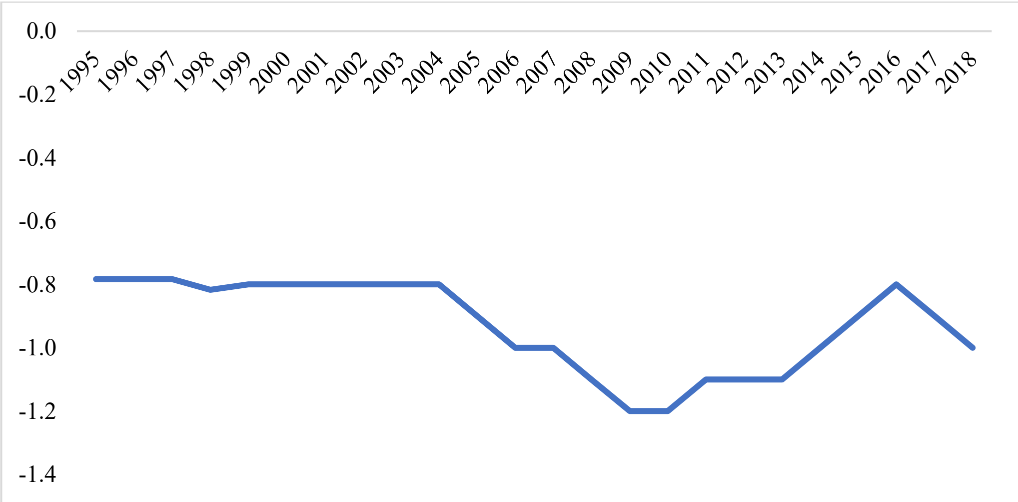

Figure 2.27: Average of Quality of Governance (Iran).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.28 shows that Iran has one of the lowest scores regarding the average quality of governance in the MENA region for 1995–2018. There is a general downward trend in the numbers. The poor quality of governance in Iran is due to the country's policies restricting freedoms (such as freedom of speech). The army and regime control most of the sensitive institutions in the country, such as the security forces and the judiciary.

2.5.2.3. Jordan

Jordanian authorities are increasingly using extra-legal means to censor critical coverage, blocking and closing news sites without transparent legal authorisation. The Jordanian constitution provides for the protection of freedom of speech, but this is not implemented in practice. The Jordanian penal code also punishes any perceived insult to the royal family, Islam and Jordanian symbols, and any speeches aimed at provoking sectarian strife and racism.[27] Jordan is ruled by a monarchy, so the head of state is the King. The king of Jordan appoints the executive and the judiciary in the country. Jordan is a partisan country, meaning that it has political parties, but the parties are not allowed to choose the prime minister, who is appointed by the Jordanian king. The citizens elect parliament and municipality members. The executive and the judiciary are not independent from political authority.

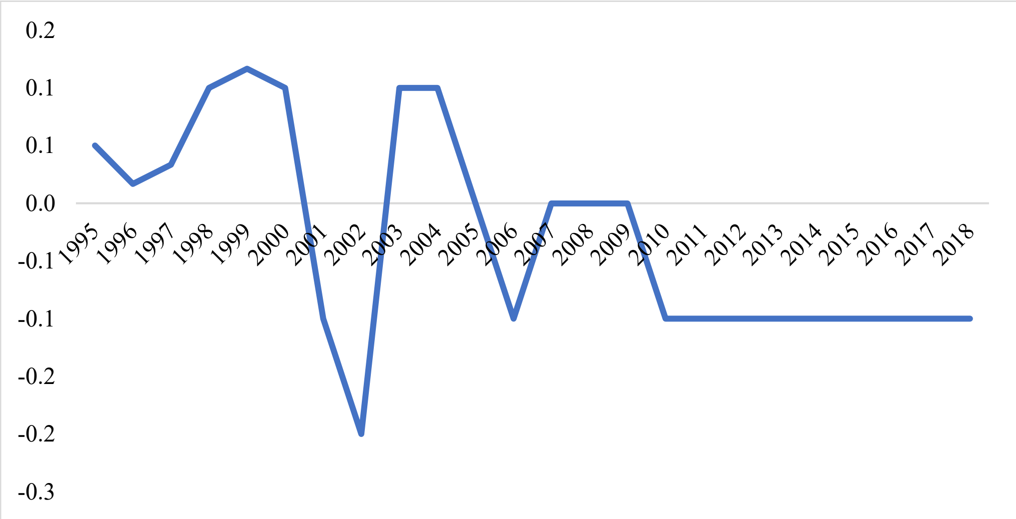

Figure 2.28: Average of Quality of Governance (Jordan).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.29 shows the average of six indicators of governance over the period of 1995–2018 in Jordan. The average quality of governance fluctuated over this period. In 1995, the average was around 0.1, but it then experienced a sharp decline, reaching approximately -0.2 in 2001. As a result of policies such as restriction of freedom of speech, there is no control of corruption. Following this, the average returned to the same point it had in 1995, at about 0.1. Leading up to 2006, the quality of governance gradually decreased to around -0.1; after this, the average increased to just less than 0.1. Since then, the quality of governance has remained steady at a low level of governance quality.

[27] "Jordan: Talking is Not a Crime. A Campaign to Repeal Article 11 of Cybercrime Law", Al Araby Al Jadeed [in Arabic], March 5, 2016 http://bit.ly/1T4jjTR.

2.5.2.4. Lebanon

According to the Freedom House report,[28] Lebanon is a partisan country, and the legislature is elected. Lebanon's political system guarantees its media freedom of expression and some civil liberties. That is, Lebanese journalists can write reports criticising corruption and government institutions in the country. However, the law punishes any person who publishes material that insults the president or army. The judiciary is not independent, and the government has an influence on judicial appointments.

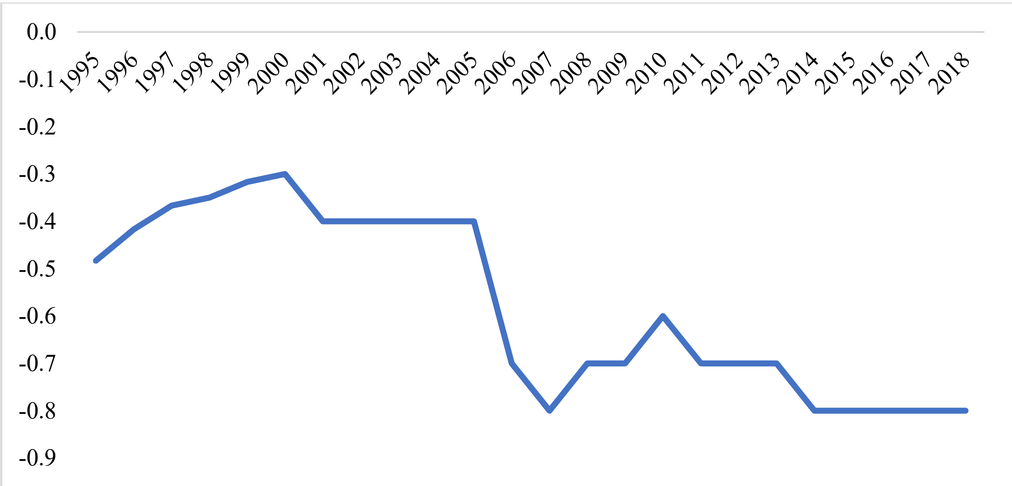

Figure 2.29: Average of Quality of Governance (Lebanon).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.30 shows the quality of governance in Lebanon from 1995 to 2018. It can be seen that Lebanon has a low quality of governance. The average decreased from 2005 until 2007, and then dropped suddenly as a result of the assassination of former Prime Minister Rafik Hariri. The country soon declared a state of emergency which saw the rise of the popular anti-Syrian movement, which forced Syria's withdrawal from Lebanon in April 2005. The second downward trend in the quality of governance started at the beginning of 2010, due to the Israel–Lebanon border clash and the influx of Syrian nationals entering Lebanon, and then due to the political revolt surrounding the Arab Spring, which started at the end of 2010. These combined factors led to the deterioration of governance quality. Within this challenging environment, Lebanon's economy in the last seven years has been rushing toward a disaster that may lead to

[28] See "Lebanon," Freedom on the Net 2019, https://freedomhouse.org/report/freedom-world/2019/lebanon.

bankruptcy. It may prove to be the case that the government does not succeed in implementing reform plans designed to cut back money spent on state institutions, fight corruption and revive falling economic indicators. In recent years, Lebanon has faced two problems: the first is linked to the rise in public debt—which is 152 percent of the country's GDP—and the second is a widespread weakness in economic growth. It is a situation in which jobs are scarce, infrastructure is poor, and the country's foreign currency imports are virtually disappearing (International Monetary Fund 2019).

2.5.2.5. Turkey

Turkey is a partisan country, and the president is elected by the people. The judiciary is not independent of the president's decisions. In 2016, following a coup attempt against the Erdogan regime, according to the Freedom House report,[29] the government made many arrests, amounting to tens of thousands of people allegedly linked to the coup attempt. Several websites were blocked or closed. Since the coup attempt, nearly 50,000 people have been arrested and more than 140,000 dismissed from employment. Furthermore, internet freedom was restricted for a period until the end of 2017.

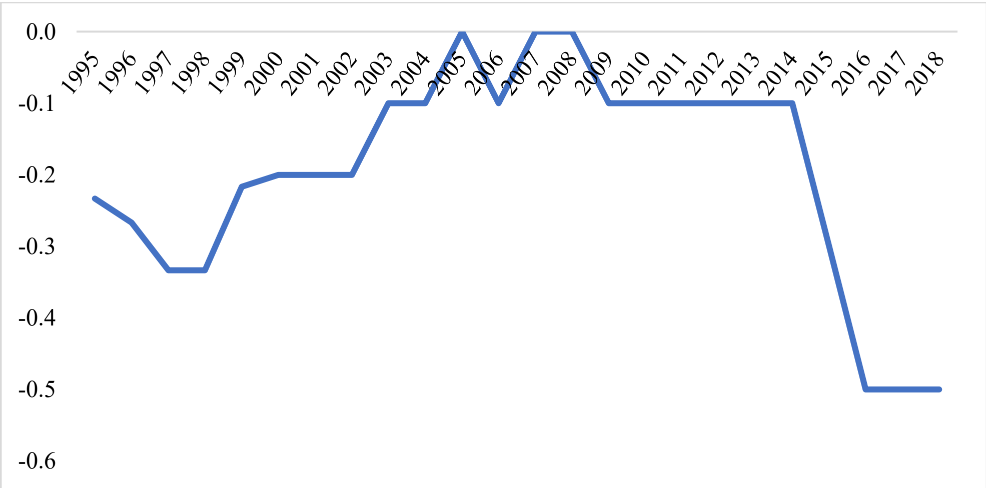

Figure 2.30: Average of Quality of Governance (Turkey).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of -2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

[29] See "Turkey," Freedom on the Net 2018, https://freedomhouse.org/report/freedom-net/2018/turkey.

Figure 2.31 shows the average of governance quality in Turkey over the period 1995–2018. At first glance, the quality of governance in Turkey is very low. The value slightly increased from 1995 to 2005, then decreased in 2006. During 2008 the rate gradually decreased until the end of 2010, when the Arab Spring started, the average slightly decreased. In 2011, the government banned all political opposition as well as press freedom and expression. In 2014, President Erdogan assumed leadership of Turkey, and since that time, all governance quality indicators have witnessed a noticeable decline, as a result of Erdogan's policy to ban all political opposition and restrict the press freedom and expression.

2.5.2.6. Summary

As shown in Figure 2.32, the quality of governance in the upper-middle-income countries is low. Some countries are based on the prime minister, and some are based on presidential systems. Some don't have any elections. Further, the presidents of some of these countries appoint the executive and the judiciary, and therefore the executive and the judiciary are not independent from political authority.

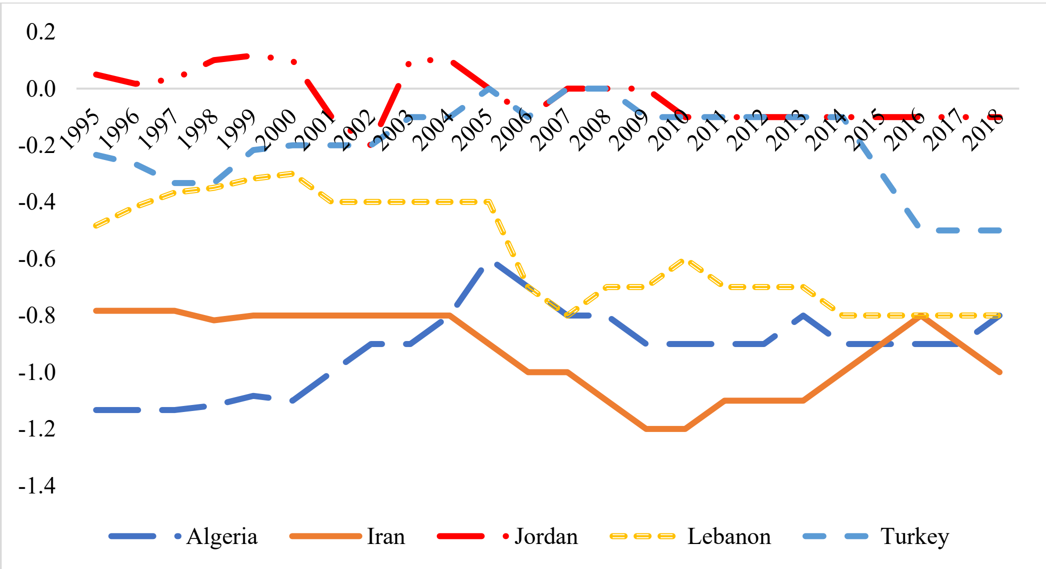

Figure 2.31: Average of Quality of Governance (Upper-middle-income countries).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

2.5.3. Lower-middle-income countries

2.5.3.1. Egypt

Egypt is a non-partisan country; political parties are not allowed, and there are no democratic elections in the country. The Egyptian judiciary is not an independent authority, as it obeys the orders of the president and the army.

According to the Freedom House report,[30] after the Arab Spring in 2010 and the coup in 2013, the resulting Egyptian government blocked around 21 news sites on charges of conspiracy against the government and promoting terrorism. By the end of 2017, over 100 websites were blocked, leading to a significant reduction in internet freedom. Freedom of speech online is very low, especially since an anti-terrorism law was introduced in 2015. Since this law came into effect, many people have been arrested on charges of insulting the president or provoking sedition.

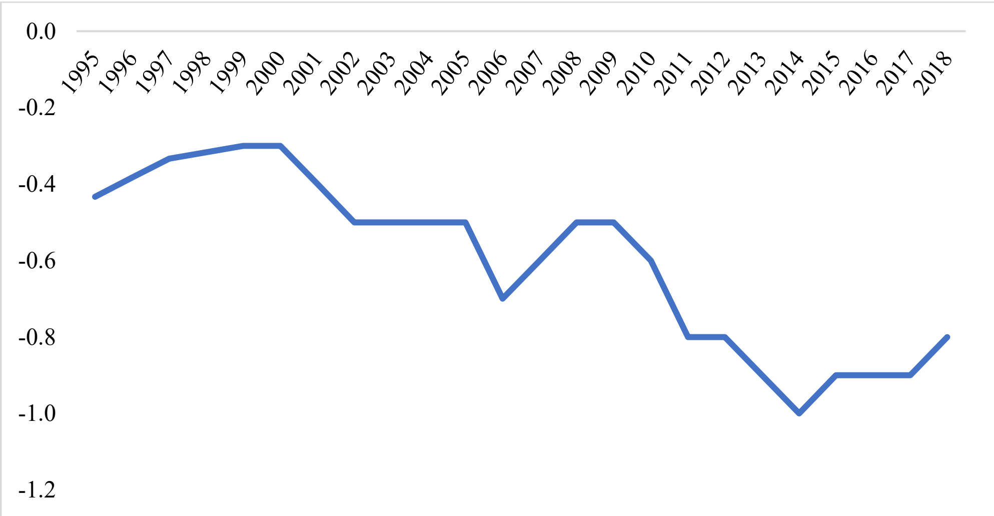

Figure 2.32: Average of Quality of Governance (Egypt).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.33 shows the quality of governance in Egypt from 1995 to 2018. It can be seen that Egypt has a low quality of governance. The average decreased from 2000 until 2006, then steadily increased up to 2009 before it dropped suddenly again at the end of 2009. The Arab

[30] See "Egypt," *Freedom on the Net 2016*, https://freedomhouse.org/report/freedom-net/2017/egypt.

Spring also had a significant impact on quality of governance indicators in Egypt. In 2011, Egyptian citizens demanded the overthrow of Hosni Mubarak. Another revolution started in 2012, this time targeting President Mohamed Morsi. In response to these events, the Egyptian government instituted control of the press and banned political opposition in order to reduce agitation within the country and regain government control.

2.5.3.2. Morocco

Morocco is a non-partisan country, and the citizens are not allowed to choose the prime minister, who is appointed by the Moroccan king. The people can do the election by choosing the parliament members. However, there are no democratic elections (transparency) in the country. Meanwhile, the government has a role to choosing the parliament members that they have a loyalty to the government. The judiciary is not an independent authority, as it obeys the orders of the king.

The Moroccan authorities use various means to limit and violate the rights of internet users and to limit online content. Sometimes the government blocks websites and tries to prosecute journalists as a means to limit the online media.[31] Moroccan laws also restrict freedom of speech. The law does not allow for imprisonment of journalists, but it does administer large fines for dissent. In 2017, internet freedom declined due to the government's crackdown on online activists, and internet voice protocol was blocked to prevent coverage of anti-government demonstrations and sit-ins.[32]

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[31] Ilhem Rachidi, "In Morocco, press freedom shrinks with Hirak protests," September 1, 2017, https://www.al-monitor.com/pulse/originals/2017/08/morocco-rif-hirak-journalists-violations.html, and Fatim-Zohra El Malki, "Morocco's Hirak Movement: the People Versus the Makhzen," *Jadaliyya*, June 2.

[32] See "Morocco," *Freedom on the Net 2016*, https://freedomhouse.org/report/freedom-net/2017/morocco.

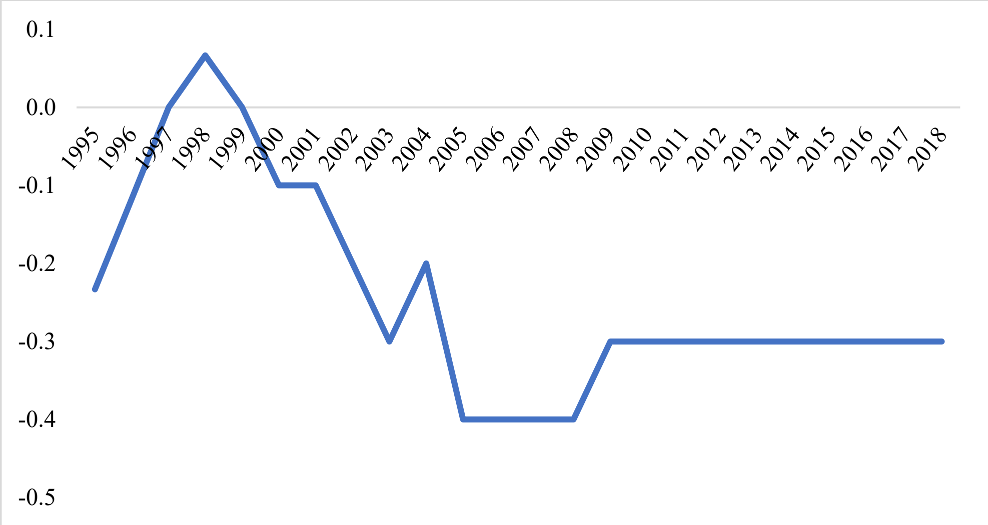

Figure 2.33: Average of Quality of Governance (Morocco).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

The average of governance indicators for Morocco, as shown in Figure 2.34, is low. Overall, the quality of governance has significantly decreased from 1995 to 2018, with many fluctuations over this period. However, Morocco is one of the few countries that experienced positive change as a result of the Arab Spring. In 2011, the people called for political reform and the limitation of the king's powers. The king submitted to the demands and re-defined his constitutional powers.

2.5.3.3. Tunisia

After the overthrow of the regime of Zine El Abidine Ben in 2011, Tunisia started a period of democratic change in which, according to a Freedom House report,[33] citizens have enjoyed unprecedented freedoms and political rights. However, despite these new freedoms, there is still some restriction on journalists and social media. The country is still politically unstable and suffers from some internal problems, such as corruption and security threats. The judiciary is only partially independent in Tunisia; since the Ben Ali era, judges have remained in the judicial system. Tunisia is a partisan country; the political parties and people have the ability

[33] See "Tunisia," *Freedom on the Net 2019,* https://freedomhouse.org/report/freedom-world/2019/tunisia .

to select the president through democratic elections. In 2019, the first president of the democratic era was elected.

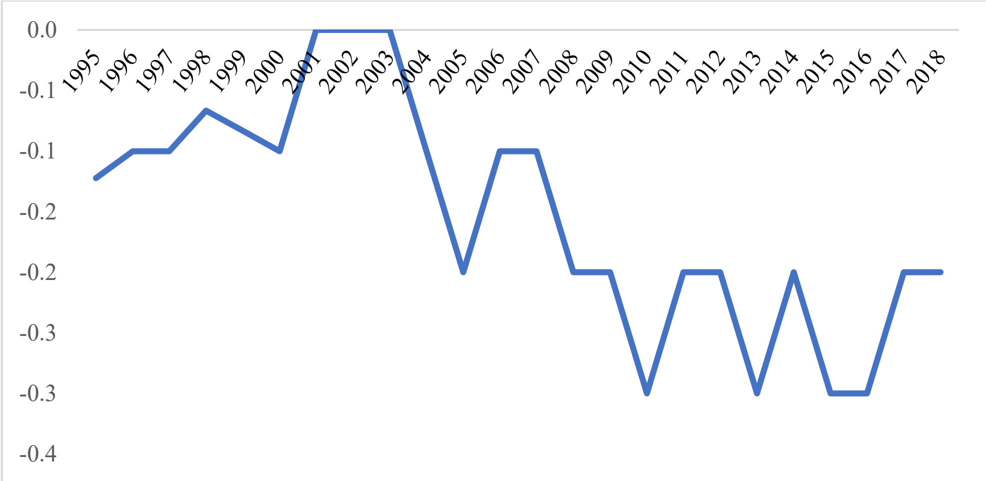

Figure 2.34: Average of Quality of Governance (Tunisia).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

Figure 2.35 illustrates the quality of governance in Tunisia over the period of 1995–2018. Tunisia had good governance until the end of 2003. Following this, governance experienced many fluctuations until 2018. In 2004, President Ben Ali won a fourth term and only exited when he was overthrown at the end of 2010. After that, the country was ravaged for four years. In 2014, the political parties and people were allowed to select the president. Beji Caid Essebsi became president after the democratic elections. Since then, the quality of governance has begun to improve and increase gradually. In 2019, based on the Freedom House classification, Tunisia was one of the few countries in the MENA region to have improved on the governance scales.

2.5.3.4. Summary

The Arab Spring negatively affected some of the lower-middle-income countries, such as Tunisia and Egypt, in terms of governance quality. As shown in Figure 2.36, the average governance quality is low. In addition, these countries are non-partisan countries, and the citizens are not allowed to choose the government, with the exception of Tunisia.

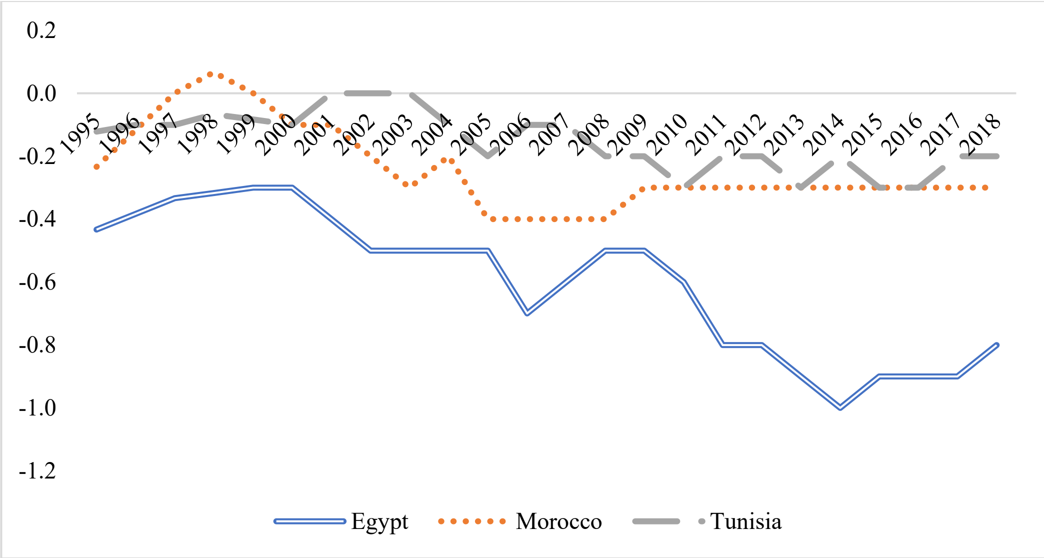

Figure 2.35: Average of Quality of Governance (Lower-middle-income countries).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

2.5.4. Low-income countries

2.5.4.1.Sudan

Sudan's political system was dominated by an authoritarian president, Omar al-Bashir, until 2019, when he was deposed in a coup. The regime violently repressed regional, religious, and ethnic groups that did not share its narrow nationalist vision. Civil society encountered severe restrictions, religious rights were not respected, and the media was closely monitored.

The Sudanese authorities use various means to limit and violate the rights of internet users and to limit online content. Sometimes the government will block websites and try to prosecute journalists as a means to limit online media. Sudanese laws also restrict freedom of speech. In 2017, internet freedom declined due to the government's crackdown on online activists, and internet voice protocol was blocked to prevent coverage of anti-government demonstrations and sit-ins.

The judiciary is not independent. Lower courts provide some due process safeguards, but higher courts are subject to political control. Special security and military courts do not apply accepted legal standards.

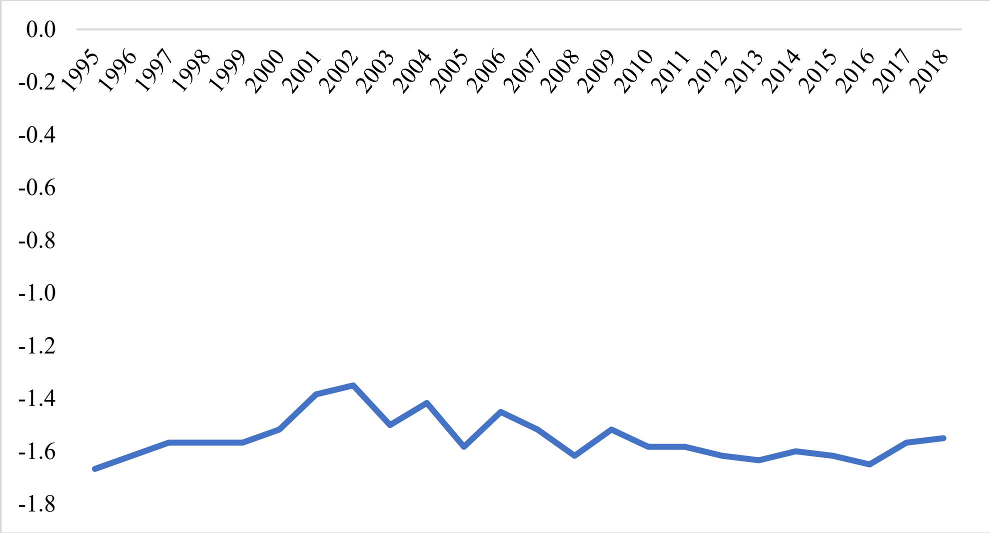

Figure 2.36: Average of Quality of Governance (Sudan).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

The average of governance indicators for Sudan, as shown in Figure 2.37, is low. Sudan experienced many sharp fluctuations from 1995 to 2018. South Sudan gained independence from Sudan in 2005, but hostilities and civil wars between the two nations continued to the end of 2011. Though warfare at the societal level has finished, internal strife still affects the country's stability. In 2019, resident al-Bashir stepped down, following months of protests, which has led to a reduction in the disputes and civil conflicts in the country.[34]

2.5.4.2. Summary

The MENA region has witnessed many conflicts, which have greatly influenced the political and economic situation in the region. The average of governance indicators for and Sudan, as shown in Figure 2.38, is low. This country is among many countries in the region that has been affected by conflict, which has led to the displacement and killing of thousands of civilians and the restructuring of sovereign systems and the redistribution of authority in these countries.

[34] Independence of South Sudan | United States Institute of Peace (usip.org); https://www.usip.org/programs/independence-south-sudan

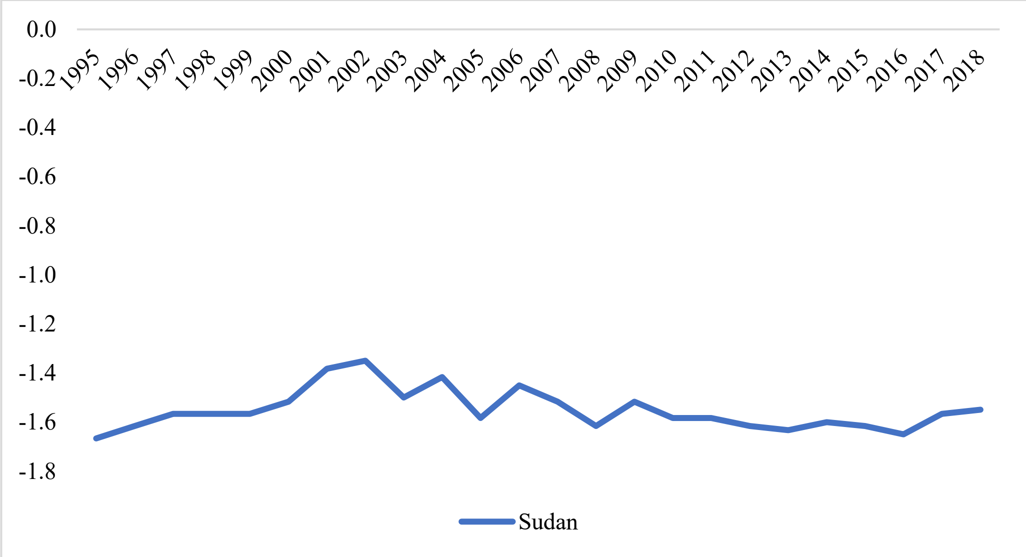

Figure 2.37: Average of Quality of Governance (Low-income countries).

Note: This figure is the average of six indicators of governance over the period 1995–2018. These scores are on a scale of - 2.5 (worst) to 2.5 (best), respectively. **Source**: Worldwide Governance Indicators (WGI) of the World Bank and author's calculations.

2.6. CONCLUDING REMARKS

To summarise, there are elections held in some MENA countries, such as Israel, Tunisia, and Turkey. Furthermore, there are genuine political parties in these countries that enable the people to select their government. However, political parties are not allowed in most MENA countries, and there are no democratic elections.

This preliminary review has shown that the MENA region suffers from a lack of quality of governance, except for Israel, the United Arab Emirates, Qatar, and Oman, which have some good quality indicators of governance. Poor quality of governance affects and hinders ICT usage and accessibility and reduces economic growth (Kaufmann and Fellow 2011; Tang and Abosedra 2014).

In addition, this chapter has shown the averages of ICT investment and usage in the MENA countries. Despite massive ICT investment and a boost in ICT usage in the last few years, the restrictions imposed by many MENA countries, such as limited freedom of the press, lack of independence of law, and rampant corruption, have limited the use of this technology. The objective of this study is to investigate whether the quality of governance impacts ICT investment and usage in the MENA region. The next chapter discusses the theoretical background and provides a literature review related to economic growth, ICT and quality of governance.

CHAPTER 3: REVIEW OF ECONOMIC GROWTH AND GOVERNANCE THEORIES

3.1. INTRODUCTION

A growing body of literature has investigated the effects of ICT on economic growth. Technology has been shown to be the main driver that boosts economic growth by scholars such as Solow (1956) and Romer (1986, 1990). Romer (1990) illustrates how private and public resources can improve ideas and new products, and in turn, accelerate economic growth. The neo-Schumpeterian models of Aghion et al. (1998) confirm Romer's findings. They all agree that increases in productivity from improved or new products and procedures, such as ICT, will directly and indirectly lead to increased revenue for capital investment and thus result in rising GDP. Recently, ICT usage, especially internet and mobile phones usage, has increased in many economic institutions and international corporations, to facilitate the process of production and communication between sectors, ultimately improving the economic performance of countries (International Telecommunication Union 2020).

A variety of econometric models and cross-country data were used in many previous studies, many of which were carried out in developing countries, to investigate the relationship between the expansion of ICT and economic growth. Based on earlier research, this study adds on it (Pradhan et al., 2018). Researchers disagreed on whether the advent of ICT had a substantial economic impact in developing countries. Consequently, additional investigation into this subject is necessary in the MENA region. Sassi and Goaied (2013) report that the MENA and SSA regions were two developing regions examined in their research on the effects of ICT diffusion on economic development. As indicated by indicators such as the number of fixed-line and mobile-cellular subscribers, Internet users, and broadband subscriptions, the enormous growth in ICT usage in most MENA and SSA nations over the previous several years has increased interest in ICTs (World Bank 2017). In recent years, numerous studies have suggested that the nexus between technology and economic growth is affected by a country's governance quality. National competence theory indicates that governance quality plays a moderating role in any relationship with economic growth. According to Delgado et al. (2012), national competence is an important factor in a national economy's capacity to grow and compete; therefore, national competence theory deals with governance quality as a major dimension of a country's economic competitiveness. Many studies have demonstrated this important role of governance quality in economic growth (Acemoglu and Robinson 2012; Kaufmann et al. 2009; Nawaz 2015; among others).

The objective of this chapter is to present a review of major theories of economic growth. Most mainstream models utilise the main explanatory variables, such as labour, capital, and technology to estimate economic growth. Following this introduction, the remainder of this chapter proceeds as follows: Section 3.2 outlines the theoretical background that includes theories of economic growth; Section 3.3 discusses the similarities between the economic growth models; Section 3.4 explains the differences between the neo-classical and Romer models; Section 3.5 outlines the theoretical background that includes theories of economic growth governance and economic growth; Section 3.6 discusses why do institutions differ?; Section 3.7 discusses national competence theory, which postulates the importance of governance quality and its moderating role in relationships with economic growth. A conclusion to this chapter is provided in Section 3.8.

3.2. THEORETICAL BACKGROUND

This section reviews economic growth theories such as classical and neoclassical based models to investigate the role of ICT and governance in economic growth.

3.2.1. The theoretical foundations for the study of innovation and growth

This section presents the four theoretical questions that I will use to compare evolutionary and new growth theories. These six aspects, I believe, are the major theoretical foundations for the study of innovation and growth, and thus the relevant characteristics to compare different approaches. The section defines the main concepts and briefly traces their origins in economic thought. Not to discuss the theoretical origins of modern theories of innovation and growth, but to define key concepts and introduce the analysis to be developed in the following sections.

3.2.1.1. What is the main level of aggregation?

The level of aggregation chosen as the fundamental starting point for the construction of theories of innovation and economic growth is one of the most important distinguishing characteristics of these theories. It is possible to distinguish three major positions throughout the history of economic thought:

(i) *Methodological individualism*: the classical and neo-classical economists take this approach to their research.[35] The entire economic system must examine its constituent parts; macroeconomic theory must necessarily be micro-founded. Thus, the aggregate properties of the economy must be studied by beginning with an examination of the microeconomic behaviour of consumers and firms.

(ii) *Methodological holism* (Hodgson 1993, p.238): this is the Karl Marx approach, later adopted in economic sociology and heterodox macroeconomics.[36] The social and macroeconomic structure determines economic agents' behaviour. Furthermore, the microeconomic element is highly dependent on the macroeconomic structure.

(iii) *Non-reductionism*: previous positions are 'reductionist' in that they only consider one-way relationships between levels of aggregation: either micro determine the macroeconomic or vice versa. Veblen proposed a long-standing alternative to reductionist views in modern economic theory (1899 and 1919).[37] He argued that the formation of individual habits of thought and aggregate institutional regularities are intimately linked. Individuals' actions determine macroeconomic and social regularities, but macrostructure influences economic agents' actions. There is no single dominant level of aggregation, but each level that interacts with the others is referred to as 'nonreductionism' (Hodgson 1993, p. 246-248).

3.2.1.2. Representative agent or heterogeneous individuals?

When it comes to (micro) economic agents, this question is concerned with how they are represented in the theoretical framework. It is possible to distinguish between several major different approaches throughout the history of economic thought:

(i) *Neoclassical typological thinking:* Since the marginalist revolution, this position has taken the position of neo-classical typological thinking, defined as "representative agent" or "economic agent" whose behaviour can be studied by analysing the behaviour of other economic agents. An economic agent is typically described as a rational maximizer of utility/profits under given constraints and

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[35] It is well known that Schumpeter was the first to use the expression 'methodological individualism'.
[36] See Swedberg and Granovetter (1992).
[37] For more details please see Hodgson (1998).

perfect information in the most basic and standard version of the neo-classical metaphor.

(ii) *Smithian typological thinking*: based on Adam Smith and Herbert Spencer's theories, in the production process and the division of labour, there are differences in skill sets because people learn "by doing," even though they are all genetically the same. In this case, heterogeneity is not a precondition for economic growth but rather a result of it. Economic agents do not inherit this trait; rather, it is a skill they have developed over the course of their careers.

(iii) *Marxist typological thinking*: capitalists and proletarians, according to Karl Marx, are at odds with one another on a fundamental level, and this is something that must be acknowledged. These two classes are distinguished by their relationship to the means of production, and their interests and goals are inextricably linked to one another. Individuals, on the other hand, are homogeneous within each class. To put it another way, Marx implicitly assumes the existence of a duality between social classes at the macroeconomic level but does not assume the existence of heterogeneity among individuals at the microeconomic level.

(iv) *Schumpeterian typological thinking*: the microeconomic description of economic agents in Schumpeter (1934 and 1939) is a little unusual in comparison to other economists. On the one hand, there is a group of individuals, the entrepreneurs, who have been genetically endowed with unique psychological characteristics; they are the ones who determine the growth process, and they are the true agents of transformation. For their part, all other economic agents are ordinary and indifferent individuals, not dissimilar from the representative agents of neo-classical theory, who react in a deterministic manner to changes in the process as it evolves through the course of time. As such, it appears to be a middle ground between traditional neo-classical typological thinking and evolutionary biology's concept of 'population thinking.'

(v) *Veblen's population thinking*: an evolutionary approach to economic change relies heavily on the heterogeneity of economic agents, as demonstrated, for example, by the work of Thorstein Veblen (1899). Inspired by developments in evolutionary biology, Veblen was convinced that individuals' cognitive processes and habit formations are fundamentally heterogeneous, and that this variety is an important precondition for economic growth and social change. Economic theory cannot ignore population heterogeneity because it is the primary source of novelty (innovation) in economic development, which can be equated to "population thinking," which uses the biological metaphor to apply to economics.[38]

3.2.1.3. What is the mechanism of the creation of innovation?

The mechanism of introducing innovation and new variety into the economic system is the main source of economic growth in modern theories of innovation and growth. I can summarise the following mechanisms of technical change using classical authors:[39]

(i) *Manna from heaven*: Neoclassical representative firms are described as having flawless and comprehensive knowledge of the greatest technology accessible at any given time, and they are always capable of adopting it. Static, codifiable technological information is not affected by the economic environment in which enterprises make technological decisions. Because of this, even the smallest of businesses may quickly learn from and apply the most cutting-edge tactics employed by larger, more creative corporations. Knowledge is immediately available to all economic actors without additional restrictions. In the most simple neo-classical paradigm, technical change is external and unexplained.

(ii) *Learning by doing*: This is the mechanism originally proposed by Adam Smith. He suggested that because of the production process's increased specialisation and division of labour, economic agents learn through doing things and producing goods while engaged in their daily work activities. Because it is a necessary consequence of the production process, innovation is endogenous, and it is mostly incremental and ongoing in nature.

(iii) *Labour saving technical change*: this is the mechanism identified by Marx, according to which capitalists promote labour-saving technological improvements in order to reduce labour expenses while simultaneously increasing profits, is as follows: However, in the Marxian view, it is still unclear how new technology gets

[38] For more detailed discussion of the concept of "population thinking" please see Andersen (1994) and Hodgson (1993).

[39] Freeman (1994) and Dosi (1997) present critical surveys of the different mechanisms of technical change in economic theory.

invented, selected, and adopted by capitalists in a capitalist society.[40] It follows that the true mechanism of technological change is exogenous and unexplained.

(iv) *Schumpeterian innovation*: Schumpeter was the first author to employ a wide idea of innovation that embraced both technical and organisational changes, and he was the first to place innovation at the centre of the economic development explanation. Focusing on radical rather than incremental breakthroughs, he advanced the notion that 'new combinations' are presented by entrepreneurs, who are persons who have been endowed with distinctive psychological traits and creative abilities, as opposed to employees (Schumpeter 1934).

(v) *Veblen's idle curiosity*: "The human drive towards experimentation and creative innovation" (Hodgson 1993, p.127), according to Veblen, is a significant source of diversity that is constantly in opposition to the inertial nature of habits of thought and institutions. Veblen coined the term "idle curiosity" to describe this propensity, and he considered it to be a human genetic attitude that is a pre-condition for the process of growth rather than a result of it (as in Smith and Spencer). He saw 'idle curiosity' as akin to mutations in Darwinian evolutionary biology and thus as a constant source of change and renewed variety in the economic system that existed on a continuing and permanent basis in the economic system.

3.2.1.4. Towards equilibrium or never-ending?

What is the end result of the economic process? Does it tend to a final state of long-term equilibrium, or does it change continuously and continue to move indefinitely without reaching a definite end point in the process? For the most part, it is possible to distinguish between two major opposing viewpoints on this fundamental characteristic of economic theory:

(i) *Towards equilibrium*: A final state of rest, equilibrium, and increased economic welfare is the goal of the economic growth process in the long term. This was the point of view held by Adam Smith and Herbert Spencer, as well as Karl Marx (who believed that "communism" is a final state of rest in which all conflicts and dualisms are finally resolved). In economics, the equilibrium view became more explicitly dominant following the marginalism revolution, which took place during the late

[40] For more discussion of the role of technical change theory, please see Elster (1983) and Hodgson (1993), which they offer a critical examination of Karl Marx's theory of technological change.

nineteenth century. Recent developments in economic theory, such as the neo-classical theory of growth (e.g., Solow 1956), have extended this static concept of equilibrium to include the analysis of long-term dynamics by presuming the existence of a steady state' towards which the economic system will tend over time.

(ii) *Never-ending process*: It has been frequently criticised by economists who are not part of the mainstream economic establishment. Several economists have asserted that economic growth is a never-ending and constantly changing process that does not tend towards a steady state of balanced growth. The German Historicists, Schumpeter and Veblen, were among those who have expressed this point of view in the past, among others. In the latter's words, economic evolution is "a continuous chain of cause and effect." A theory of consecutive change that has been discovered to be self-continuing or self-propagating as well as to have no final term is described as follows: "It is a scheme of blindly cumulative causation in which there is no trend, no final term, and no consummation [...] (Veblen 1919, p. 36-37).

3.2.2. Evolutionary growth theorizing

This section discusses the main approaches to long-wave theory, technology gap, Nelson and Winter-like evolutionary theory, and National Innovation Systems framework. This section comprises two parts: A brief introduction to the approach, followed by an in-depth examination of its theoretical foundations by answering the six questions presented in the previous section. Because these four approaches share a large number of theoretical foundations, they can be thought of as different strands of research within the evolutionary economic paradigm.

3.2.2.1. Neo-Schumpeterian long-wave theory

According to Schumpeter's book Business Cycles (1939), there are long waves of economic growth. The neo-Schumpeterian approach to economic growth borrows heavily from this theory. When he first started out, he wanted to emphasise the importance of basic (radical) innovations in creating such long waves because he believed their impact on the economy could be profound. Schumpeterian insights showed no significant impact on economic thought on the importance of radical innovations in the macroeconomic growth process in the following four decades. Since the mid-1970s, however, there has been a renewed interest in the central role of innovation as a major source of economic growth in the mainstream economics approach to the relationship between technological change and economic growth.

Kuznets' (1940) critique of Schumpeter's Business Cycles sparked the debate (1939). Kuznets argued that his long-wave theory did not explain the timing of the occurrence of basic innovations in the depression phase of the wave, nor why they tend to cluster over time. During the depression phase of the long wave, the lag between invention and innovation is shortened (the so-called 'depression-trigger hypothesis'), according to Mensch (1979). Research on the timing of basic innovation clustering is well-documented in the empirical literature (e.g. Kleinknecht 1981; Van Dujin 1983). There is a lack of empirical evidence to support the idea that basic innovations are clustered in the depression phase of a wave, as noted by Freeman, Clark & Soete (1982).

During the 1980s, the second stream of literature based on neo-Schumpterian concepts and ideas emerged, which helped to strengthen the long-wave theory's theoretical foundation. Unemployment and Technical Innovation Freeman et al. (1982) was the first of these conceptually oriented contributions, followed by works by Freeman (1983, 1984, and 1987), Perez (1983, 1985), and Freeman and Louca (1983).

Schumpeterian development "unfolds within the economic sphere conceived as a self-regulating organism which provokes its own disturbances (innovations) and absorbs its impacts by constantly striving towards new higher equilibria," as Perez (1983, p.355) explains. The primary cycle's causation mechanism does not take into account the social or institutional context. Hence, "Schumpeter does lay the foundations for a theory of the cyclical nature of the capitalist economy but not of long waves" (Perez 1983, p.359). Neo-Schumpeterian scholars believe that the capitalist system is made up of two subsystems: the techno-economic and the socio-institutional. There are long waves in nature because the ‘mode of development' is determined by how these subsystems interact and change over time.[41]

According to this viewpoint, it is not important when a set of fundamental innovations is introduced, but rather that these radical innovations are strictly interconnected and pervasive, i.e. that they have the potential to drive the growth of a large number of rapidly growing sectors of the economy. It is possible to refer to such a collection of interconnected fundamental innovations as a 'technological system' (Freeman et al. 1982), a 'technological paradigm' (Dosi 1982), or a 'technological style' (Perez 1983). When a new technological style emerges, the techno-economic subsystem is highly motivated to adopt the new best practise technology.

[41] For a more detailed discussion of the concept of " long waves in nature " please see Perez (1983).

However, the techno-economic system is more open to change, whereas the socio-institutional system may take longer to adapt. The mismatch between the two sub-systems may slow the adoption of the new paradigm because it requires social, organisational, and institutional changes before they can spread across the economy. The 'harmonic complementarity' between the two systems gradually returns, and a new development mode emerges. Thus, the primary cycle of Schumpeter (1939) may determine the longwave pattern: rapid diffusion of the new paradigm, incremental innovation over its 'natural trajectory' (Nelson and Winter 1977), creative destruction, and thus the upswing and prosperity phases. Increasing competition and market saturation, decreasing revenues from new technologies, and decreasing profits characterise the recession and depression phases of the long wave.

To conclude, the first question that this critical study review examines is the aggregation level of the approach. Sectoral differences are heavily studied, with a particular emphasis on the more technologically advanced and rapidly expanding sectors, which are responsible for driving the economy's overall growth. On the other hand, a sectoral analysis is carried out for the primary purpose of assessing the macroeconomic impact of sectoral patterns. When it comes to innovation and growth, a neo-Schumpeterian long-wave theory is a macroeconomic approach that examines the evolution of a country (or a group of countries) over time. Neo-Schumpeterian theory, on the other hand, differs from Schumpeter's in that it does not explicitly microfounded. They show how Schumpeterian macroeconomics can have its key features without having to adhere to methodological individualism.

Because the microeconomic level is not described, the notions of heterogeneity and population thinking are not explicitly considered. Recent long wave studies increasingly recognise the fundamental role of heterogeneity and the evolutionary foundation of such an approach (Freeman and Louca 2001). Iwai (1984) and Silverberg and Lehnert (1994) proposed an evolutionary type of modelling in which heterogeneous agents interact to determine long wave patterns. The future extension of this model family may make the evolutionary foundation of neo-Schumpeterian studies more explicit.

Similar to all of the other theoretical frameworks discussed in the previous section, innovation serves as the primary driver of economic growth. The historical and institutional context in which technological and organisational innovations take place is carefully considered in neo-Schumpeterian works (Castellacci 2007). However, the exogenous nature of the innovative process is highlighted by the fact that it is dependent on the science and technology system, which is acknowledged as being important but not explicitly investigated. Instead of being an exogenous activity determined by firm R&D investments, innovation is an endogenous activity that is linked to demand and production growth through learning by doing, dynamic economies of scale, and embodied technical progress in a later phase of the long wave.

An important source of economic growth in this framework is innovation, but it does not support the claim that long-wave theory is technologically driven. Because the socio-institutional characteristics required to compete in an emerging long wave period in the wake of a new technological paradigm are largely determined by changes in the techno-economic system, this criticism is valid (Castellacci 2007). As a result, the characteristics of the new mode of development are greatly influenced by changes in the technological and economic systems. Innovation is more likely to hit the market during the long wave's downswing phase because businesses and consumers are more willing to take a chance and try out new solutions. A new technological paradigm is more likely to spread during a downturn, when consumers' expectations, firms' animal spirits, and social and political changes are all at their peak. Due to the fact that changes in socio-institutional systems can have an impact on the techno-economic, it is inappropriate to argue that neo-Schumpeterian long-wave theory relies on a simple and technologically deterministic view of economic change (Castellacci 2007).

In the long run, the creation and diffusion of interconnected innovations determine long waves of economic growth, each of which is characterised by an initial acceleration (upswing) followed by a slowing down phase (downswing). According to Schumpeter's theory, the process's dynamics are disruptive, irregular, and characterised by structural and irreversible change, among other characteristics. When it comes to long wave theory, precise regularity and strict periodicity are not assumed; instead, the process repeats itself over time, but rather irregularly (Freeman et al. 1982). Long waves recurring over and over again, according to this interpretation, does not necessarily imply that those waves are all the same. The coevolution of technological and socio-institutional changes and their importance for economic growth is the only recurrent mechanism; however, the precise form that these changes take in each historical phase is constantly changing and always different. Every occurrence is distinct and one-of-a-kind in the context of historical time.

The long wave approach is often criticised for its ‘mechanistic' flavour. The long wave process is assumed to follow a more or less automatic and mechanistic pattern, closely resembling the Schumpeterian primary cycle. Considering the entire long-wave sequence, the described process is non-deterministic and unpredictable. The outcomes of science and technology are unpredictable, as are the socio-institutional changes that will ensue. It is impossible to predict which technological and organisational innovations will characterise the next historical phase or when they will occur.

Finally, with regard to the sixth theoretical question, it should be noted that the neo-Schumpeterian process of growth is dynamic and never-ending, not monotonous. The economic system, like Schumpeter's, is never in equilibrium, with constant forces determining new movements. Innovation constantly disrupts the circular flow of economic activity, determining the system's inherent disequilibrium.

3.2.3. Traverse model

Classical economists studied the forces that would restore the economy to its natural position. Instead of equilibrium, they looked at 'centres of gravitation' (à la Smith). In their analysis, the traverse describes the economy's adjustment to these centres. The forces that restored prices to their natural positions were normally thought of as a tendency towards uniform profit rates. Because capital was free to move, it responded to any deviation from the uniform rate of profit.[42] A higher profit rate than average would attract capital, increasing supply and decreasing both price and profit rates. This adjustment would continue until the sector's profit rate matched the overall profit rate. A tendency towards uniform profit rates ensured that market prices tended to natural prices. Demand played no role in their view of the determinants of price gravitation (natural prices). As a result, the analysis of what happened when natural and market prices diverged focused on 'actual' values rather than 'conjectural' values. In other words, because demand is irrelevant in determining natural prices, trading outside natural (equilibrium) prices are permitted. In determining value, with the analysis occurring in historical time. Classical economists analysed a dynamic system with shifting gravitational centres. The forces that caused the convergence to natural positions were not path-determined (Harcourt 1981).

In recent years, a small group of economists known as the 'New Classical Macroeconomists' has gained widespread acceptance for a radical new method of analysing economic behaviour that effectively eliminates disequilibrium and, as a result, the traverse.

[42] It should be noted that, despite superficial similarities, this process is quite different from the neoclassical concept of adjustment in a perfectly competitive market. See Eatwell (1982) and Harris (1988)

Overall, the 'New Classical Macroeconomics' (NCM) movement emerged as an answer to the fruitless debates that had raged between neo-classical Keynesians and monetarists about the efficacy of monetary policy during the 1960s and 1970s. Essentially, both groups agreed that the economy was moving towards a long-run full-employment equilibrium, but the 'Keynesians' argued that there were short-run impediments to full employment, which could mean that unemployment would persist for a longer period of time in the short run.

According to the NCM, expectations are determined in the same way as other economic variables, that is, by rational economic agents making optimal use of the resources and information at their disposal. They are essentially assuming that economic agents "are aware of the values of the variables affecting the market where they currently are, and of the true probability distributions governing the future state of this market and the present and future states of all others" (Lucas 1983, p.158). In conjunction with the postulate of continuous market clearing, this assumption effectively eliminates the distinction between the short run and the long run, in that if agents are aware of the equilibrium values of all variables, then they will always act on that information, and thus will act to ensure that "prices and quantities are assumed to be in equilibrium at all times " Lucas (1983, p.287). In other words, "New classical economists defy the convention and interpret the equilibrium price as the actual price," as stated in the article (Klamer 1984, p.15). So much so that even the business cycle is regarded as an example of equilibrium.[43]

These are classified as equilibrium models because, according to the definition, "in these models, the concepts of excess supply and demand play no observational role and are identified with no observational magnitudes" (Lucas 1983, p.287).[44] Clearly, because the analysis is predicated on the assumption that agents are always and everywhere in equilibrium, there is no role for the traverse that can be considered.

Classical political economists used the traverse extensively when examining the forces that pushed the economy towards its "natural values." As a result, these forces have an entirely different nature than natural values, which are primarily determined by the cost to produce as well as the value of the labour required to produce them. As a result, the forces that drive market prices to their natural values did not affect those values. In other words, the forces driving the

[43] See Lucas (1983, p.179–240, p.271–97): and Lucas in Klamer (1984:40–2).
[44] See also Lucas in Klamer (1984, p.38). For the definition of equilibrium in NCM see Sargent in Klamer (1984, p.68–9).

economy towards its natural values did not affect those because they are determined in fundamentally different ways.

It is unclear whether an endogenous natural adjustment path is driven entirely by microeconomic decisions based on technological or population changes. These questions arose early in the political economy. Ricardo and Barton discuss whether or not the economy can re-employ workers displaced by new technologies. Ricardo had initially expected a positive outcome, but he later changed his mind (Samuelson 1988). Until the third edition of his Principles, Ricardo had argued that the introduction of machinery would have no long-term impact on unemployment. Ricardo changed his mind in the third edition and now accepts that the introduction of machinery, while beneficial to capitalists and landlords, would be "very injurious to the interests of the class of labourers" (Ricardo [1817] 1951, 388). He claimed his original error stemmed from his "supposition that whenever the net income of society increased, its gross income would also increase". He realised that while machinery could increase profits and rents (nett income), it could reduce total output and thus employment. Ricardo considers the impact of new machinery on employment, including lowering the cost of necessities. [45]

3.2.3.1. The Lowe Traverse and Economic Growth

John Hicks developed the traverse concept essentially for critical purposes, that is, to show that prices are not much guidance for dynamic non-steady-state processes. The two-sector model's production coefficients do not meet the early 1960s neo-classical requirements outlined by three Japanese mathematical economists, Shinkai, Inada, and Uzawa (Gandolfo 1971). These are known in the literature as the Inada-Uzawa conditions state that for smooth neo-classical adjustment to occur, the capital goods sector must be more labour intensive than the consumption goods sector.[46] But Hicks omitted the principle of effective demand from his analysis. Also, in his most problematic neo-Austrian version of the traverse, Capital and Time (Hicks 1973), the issue of effective demand is never raised, despite Harrod's concerns about

[45] Eltis has argued that Ricardo's analysis of the impact of increased mechanization foreshadows Hicks's traverse in Capital and Time (Eltis 1985, p.266–67).

[46] Interestingly, the Inada-Uzawa conditions and the outcome of Hicks's classical traverse show that the accusation made against Sraffa—that the absence of demand function in the determination of prices is a consequence of fixed production coefficients—is plainly wrong. It is equally interesting to observe that the most faithful Sraffians did not notice the help that, only five years after the publication of Sraffa's book, they were receiving from the inventor of temporary general equilibrium theory.

the stability of the full employment path. Several classical and post-Keynesian scholars have addressed the issue (Halevi 1992, Halevi and Kriesler 1991, Henry and Lavoie 1997, Lavoie and Ramirez-Gaston 1997, Nell 1998). Unlike Hicks, Adolph Lowe (1893–1995) developed a traverse analysis to identify the structural phases required for undertaking a transition process (Lowe 1976). Although Lowe acknowledges Hicks' contribution in his 1976 book, the first Lowe traverse was published in 1952, with a revised version appearing in a groundbreaking volume on capital formation edited by Moses Abramovitz (Lowe 1952, 1955).

When analysing the "path of economic growth," Lowe went on to further develop the traverse concept, which was an explicit return to the concerns of classical political economy in the process. Rejecting the notion that growth is typically associated with steady-state equilibrium, he focused his investigation on the traverse and the resulting structural change. As a result, shifts in the structure of production become the focus of attention, with the intersectoral relationships that result having a significant impact on the path of the economy's development.

Economic decisions, particularly investments, are non-reversible in Lowe's model. Capital goods were viewed as essentially heterogeneous in his analysis,[47] and the specificity of capital goods was a significant factor. To capture this concept, Lowe came up with a three-sector model, with a consumption goods sector supplemented by two distinct capital-goods-producing sectors. Consumption goods were produced by one capital goods sector, while capital goods for both were produced by the other. The capital goods in this latter sector "are for the industrial sector what seed wheat and the reproductive system in animals are for agricultural production" (Lowe 1976, p.30).

In order to formulate the theory of the traverse, Hicks had to answer the question of whether it was possible to make a smooth endogenous transition from one steady-state growth path to another in the first place. There has been a negative response to this question. According to Lowe, the traverse, which was first proposed in 1952, was conceived to consider the question of what should be done in order to ensure that the transition is successful. By formulating the problem in this manner, the connection between the traverse and the problems of realisation and effective demand is established in a manner that is more similar to Kalecki's approach than to Keynes's approach.

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[47] Kaldor, in a much-neglected article ([1938] 1960), explicitly addresses the problems caused by the specificity of factors of production.

3.2.3.2. The Traverse and Macroeconomics

Keynes's General Theory (1936) is widely regarded as the beginning of modern macroeconomics, with subsequent developments in the field largely reflecting differing interpretations of and reactions to, Keynes and his Cambridge colleagues' approach to macroeconomics. He stressed that his analysis was not based on the concept of stationary equilibrium, even though it has been widely used in the context of the Walrasian-style equilibrium framework:

> "Or, perhaps, we make our line of division between the theory of stationary equilibrium and the theory of shifting equilibrium—meaning by the latter the theory of a system in which changing views about the future are capable of influencing the present situation….We can consider what distribution of resources between different uses will be consistent with equilibrium under the influence of normal economic motives in a world in which our views concerning the future are fixed and reliable in all respects—with a further division, perhaps, between an economy which is unchanging and one subject to change. Or we can pass from this simplified propaedeutic to the problem of the real world in which our expectations are liable to disappointment and expectations concerning the future affect what we do today" (Keynes 1936, p.292–93).

When it comes to economic activity, Keynes (1936) claimed that expectations are constantly shifting and that the economic machine is occupied at any given time by overlapping activities, all of which are caused by different states of expectation. There are no surprises so that what happens during the period falls sufficiently within the range of what is expected that expectations do not need to be revised expectations, as John Hicks (1979) observed when equilibrium under the circumstances described by Keynes is only perceived narrowly in terms of states where there are no surprises. Hicks cautioned against using the IS/LM in formulating policy implications despite the fact that this strict interpretation of equilibrium may leave some maneuver or reconsideration.

> "When one turns to questions of policy, looking toward the future instead of the past, the use of equilibrium methods is still more suspect. For one cannot prescribe policy without considering at least the possibility that policy may be changed. There can be no policy change if everything is to go on as expected—if the economy is to remain in what (however approximately) may be regarded as its

> existing equilibrium. It may be hoped that, after the policy change, the economy will somehow, at some time in the future, settle into what may be regarded, in the same sense, as a new equilibrium; but there must necessarily be a stage before that equilibrium is reached. There must also be a problem of the traverse. For the study of a traverse, one has to have recourse to sequential methods of one kind or another".[48] (Hicks 1980–81, p.153).

To put it another way, a "sequential method" for describing economic movements over time in the context of equilibrium reference points is a formidable challenge. The Marshallian cost controversies of the 1920s, in which Allyn Young (1928) made a significant contribution, show that economic change is progressive and propagates itself in a cumulative way, echoing Veblen's perspective:

> "The economic life history of the individual is a cumulative process of adaptation of means to ends that cumulatively change as the process goes on, both the agent and his environment being at any point the outcome of the last process" (Veblen 1898, p.391).

Kalecki's later analysis relies on this understanding of the traverse's cumulative nature. "In fact, the long-run trend is but a slowly changing component of a chain of short-run situations; it has no independent entity, and the [analysis] should be formulated in such a way as to yield the trend-cum business cycle phenomenon" (Kalecki [1968] 1991, p.435). Kalecki was never interested in analysing equilibrium positions because he rejected the concept of equilibrium. When it came to determining economic activity and employment, Kalecki and Keynes both looked to aggregate demand. As a result, he focused on the demand structure in his research. It was his view that a fundamental issue in economic adjustment was how incomes were distributed during the cycle, and how that affected the demand for products. Kalecki, like Lowe, disaggregated the economy into three sectors, or departments, but his disaggregation served a different purpose than Lowe's disaggregation did. Workers' consumption was separated from capitalists' consumption by Kalecki, who divided the economy into a capital goods sector and two consumer goods sectors.

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[48] However, note Shackle's reservations: "In his 'explanation' Sir John still does not seem to me to acknowledge the essential point: the elemental core of Keynes' conception of economic society is uncertain expectation, and uncertain expectation is wholly incompatible with the notion of equilibrium" (Shackle 1982, p. 437–38).

Investment's dual impact on effective demand was of particular importance. Short-term investment directly influenced effective demand, resulting in a direct increase in employment and output when the investment was increased in a given period. The higher investment was in any period, the more difficult it would be to achieve full employment in the following period because new capital was produced, and thus additional capacity was created. When it comes to the capitalist system, "The tragedy of investment is that it causes crisis because it is useful. Doubtless, many people will consider this theory paradoxical. But it is not the theory, which is paradoxical, but its subject—the capitalist economy" (Kalecki 1939, p.148–49). Kalecki and Harrod both emphasised path determinacy in their economic growth and cycle analyses because they wanted to reconcile the two aspects of investment: "the rate of growth at a given time is a phenomenon rooted in past economic, social, and technological developments rather than determined fully by the coefficients of our equations as is the case with the business cycle" (Kalecki [1968] 1991, p.450).[49]

3.2.3.3. The Traverse and Further Developments

Following the influence of the pioneers of post-Keynesian analysis, many post-Keynesians have worked on dynamic growth analysis, which is characterised by path determinacy as a key characteristic. Many of the contributions to this Handbook serve as excellent examples of how to accomplish this. Also, of importance is the emphasis placed on path determinacy in the work of evolutionary economists, who believe that the economy and its components evolve in response to changes in the economic environment while simultaneously causing changes in the economic environment. There are significant overlaps between the work of evolutionary economists and that of many post-Keynesians, with evolutionary processes and complex dynamics playing key roles in the works of both; see, for example (Velupillai 2013, Rosser 2002, 2013, and Hart 2013).

Lavoie has studied the problem of the traverse in Kaleckian models in a number of papers (Lavoie 1996, Lavoie and Ramirez-Gaston 1997). According to Lavoie (1996), the economy must undergo an adjustment process in order for the rate of capacity utilisation over the long term to be equal to the "normal rate" of utilisation. Within the model, such an adjustment process is plausible, but both the resulting "fully adjusted position" and the “normal rate of

[49] Halevi and Kriesler (1992) and Kriesler (1999) have more in-depth discussions of Kalecki and the traverse.

capacity utilization" "can be shown to depend on the path taken during the traverse, i.e. on the adjustment process during the transition"(Lavoie 1996, p.144).

It is clear that the traverse is closely linked to concepts such as path dependency, hysteresis, and cumulative causation, all of which highlight the importance of time for economic analysis, as recognised by Marshall, Keynes, Hicks, and Joan Robinson. A key post-Keynesian analysis principle is that "Once we admit that an economy exists in time, that history goes one way, from irrevocable past into the unknown future, the conception of equilibrium…becomes untenable" (Robinson [1973] 1979, 172), and the traverse becomes the key object of economic analysis.

3.2.4. Classical growth theories

Several theories have been developed to explain the nexus between economic growth and technology. In his well-known book, *The Wealth of Nations* (1776)[50], Adam Smith inspired modern growth theories. Smith posits that economic growth depends on many factors, such as technological change, division of labour, the role of government, human capital, land, increasing returns to scale, and institutional constraints on domestic and international trade (Ucak 2015).

According to a study by Barro and Sala-i-Martin (2004), many other scholars and economists have historically provided the fundamentals that appear in modern theories of economic growth. Such scholars include Thomas Malthus in 1798, David Ricardo in 1817, and later, Frank Ramsey in 1928.

Rostow and Kennedy (1992) expanded upon the main factors of Smith's original growth theory—those factors being labour (technology growth), land and capital growth.

Smith's production function, according to Rostow and Kennedy (1992), is:

$$Y = f(K, L, N) \tag{3.1}$$

where K is the capital growth, L is the labour growth, and N is the land.

[50] Please see Smith, A, 1776, *The Wealth of Nations*, Modern Library, New York, pp. 740.

Solow (1956) introduced his model of economic growth with significant inputs including capital, population (labour) growth and technological change. Neoclassical economists were the first to recognise the idea of technological change unequivocally and consider it a driver of economic growth and the most significant driver of economic dynamics. It is suggested that the technology factor complements capital and labour in the sense that it brings productivity gains in production through new knowledge and innovations.

According to the Solow (1956) model, both capital and labour contribute to production. Labor-augmentation technology has the same influence on labour availability as economic expansion, which is proportional to the economy's growth. Exogenous influences determine the rate of technological growth, which raises long-term production per capita and labour productivity. Because technological innovation is exogenous to these models, economic development is ignored. For analyzing the pace of technical advancement, the canonical model gives a method (growth accounting) called as Solow residual growth (or total factor productivity (TFP) growth (Haung et al. 2020). The gap between output growth and the growth rates of capital and labour inputs is known as TFP. It certainly is a "measure of our ignorance" because it is still around (Erken et al. 2018). So, various factors, such as technology advancement and organizational and institutional change, can impact production function.

Solow's model predicted that countries with larger populations are more likely to possess larger and stronger economies. Solow (1956) outlines the model of exogenous growth as follows:

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha} \tag{3.2}$$

where Y_t represents growth, K_t is the capital, L_t is the labour, and A_t represents the indicator of technology.

The neoclassical growth model involves the growth of labour (L) and capital (K) over time. This model seeks to combine labour and capital in a production process that can be profitable to the owner of capital. Some terms and definitions are necessary to understand the behaviour of this model. The term "national product" represents the value of the aggregate output of the nation, while the term "national income" is the total income earned by the nation (Solow 1956, 1957). The growth in the economy's capital stock throughout the year is referred to as "net investment", whereas "net savings" refers to an increase in the net worth of household economies (Solow 1956, 1957).

In addition to the terms above, the following assumptions are put forward by the neoclassical growth model: first, technological improvements are non-existent, and thus technology is constant; second, all consumer and capital goods making up the national product can be described by a single average production function; third, all transactions of a particular commodity take place at a given moment in time in a central location presided over by a specialist called an auctioneer.

$$A_t = A_0 e^{gt} \tag{3.3}$$

$$L_t = L_0 e^{nt} \tag{3.4}$$

$$\Delta K = sY - \delta K \tag{3.5}$$

In the above equations (3.3) and (3.4), Solow presumes that (g) and (n) are the exogenous rates for technology and labour growth, respectively. Equation (3.5) introduces the capital stock (ΔK). Solow supposes that savings are a constant ratio (s) from the output of capital stock. This is subject to the decreasing returns of equation (3.2). Meanwhile, δ is the depreciation effectiveness rate for capital stock. Solow assumes that technological change is exogenous to his model's framework. He included a "sources of growth analysis" model in determining how much of an effect each of his inputs has on economic growth. He considers technological change to be a major factor in the economic growth of countries (Solow 1956, 1957).

Most of the neoclassical economic growth theories are based on the Cobb-Douglas production function that defines the national product Y during the year t as follows:

$$Y_t = BK_t^{\alpha} L_t^{(1-\alpha)} \tag{3.6}$$

where B is a scaling constant used to convert labour and capital into a national product, K_t is the capital and L_t is labour. This equation displays constant returns to scale and diminishing returns to proportions, as is evident in the output per capita equation. All the inputs must, therefore, be increased or decreased proportionally to avoid a reduced return to proportions, means that the capital/labour ratio must remain constant (Solow 1956, 1957). Dividing the production function by N yields the production per capita function Y. This function implies that an increase in labour not followed by an increase in capital stock will result in a decline in output per capita, which is defined by the following equation:

$$Y_t = (BK_t^{\alpha}) L_t^{-\alpha} \tag{3.7}$$

The only way to increase output per worker—consequently increasing the national product—is to increase the capital and labour ratio. This can be achieved by increasing the capital stock, which grows through investments at a faster rate than human labour (Solow 1956, 1957).

Capital deepening refers to the level of investment that would result in a rising capital and labour ratio (Solow 1956, 1957). The increase in population causes a shift in the capital/labour ratio, which can be returned to its optimal ratio by supplying the new workforce with the same amount of capital stock as the people who are already working. Some properties of the neoclassical model are: capital stock per capita, output per capita, and consumption per capita; all reach equilibrium even if the population continues to grow. All three of the above reach equilibrium—aggregate national product, aggregate capital stock and aggregate consumption—and grow at the same rate as the population, except that the rate of growth of aggregate national product may differ from the population growth rate in the short term. Finally, a reduction in consumption will not affect the equilibrium growth rate of aggregate output.

The neoclassical model has at least two conceptual shortcomings. First, it makes it difficult to explore the determinants of technological changes. Second, it fails to explore the high variations in the growth rates in countries with analogous technological evolution (Schumpeter 2017). In other words, the theory fails to demonstrate the essence of the main advantages of technological changes. Moreover, it fails to quantify the contribution of technological changes to production growth at the national level in an acceptable manner, even though the technology is a necessary element of neoclassical theory. Furthermore, it assumes that technological improvements are exogenous (Sredojević et al. 2016).

Towards the end of the twentieth century, the emphasis was placed on internal explanations and the institutional development of economic growth. The prevailing view was that knowledge, which led to technological change (innovation), was a key factor in countries' economic progress. Theories of endogenous growth have developed new approaches, holding that the main growth drivers are technology diffusion, R&D activities, and international technology transfer.

One of the most prominent economists who proposed the endogenous growth theory is Paul Romer (1990). Romer's model explains the difference between ideas and objects. He defines output as depending on knowledge and labour at the same time, and in the meantime, the production function has a fixed return to scale in objects and increases ideas (knowledge). He concludes that new ideas depend on previous ideas, the number of workers producing them, and their actual productivity. He divided the population (labour) into two kinds: workers producing ideas and workers producing output. Based on his assumptions, this makes the model endogenous rather than exogenous.

Romer (1990) based his model formulation on two propositions. The first proposition is that technological change greatly influences economic growth because it increases production per hour worked. The second proposition is that technological improvement is intentional. These advances are made in part due to market incentives. This assumption makes the model endogenous rather than exogenous. Romer (1990) outlines the model of endogenous growth as follows:

$$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta} \qquad (3.8)$$

The main inputs of this model include capital (K) which is measured in units of consumption goods; labour services (L) in the form of skills provided by healthy individuals, measured in counts of people; human capital (H) that is provided by people with formal education and measured in counts of people; and finally, the level of technology (A), which is measured in the number of designs. Here, technology is measured by the number of designs given that each new unit of knowledge leads to the design of a new good.

There are a number of important assumptions intrinsic to Romer's (1990) model and findings. The first assumption rules out varying the population, which leads to varying amounts of labour available by making both the supply of labour and population constant. This assumption also allows each person to participate as much as the next one while providing the same amount of labour, hour after hour. The second assumption is that the amount of human capital present in the population is also fixed. The other assumptions that he made do not deal with the main inputs of the model but with their outcomes. For instance, capital goods are produced in a separate sector with the same technology as the final output sector. Another assumption deals with the fungibility of capital; forgoing consumption is the same as relocating the resources that have been achieved by the final goods sector to the capital sector.

Romer assumes the estimate of production from labour using the following equation:

$$L_{yt} = \left(1 - \bar{l}\right)\bar{L} \qquad (3.9)$$

$$L_{at} = \overline{l\,L} \quad (3.10)$$

where L_{yt} measures the worker production, L_{at} measures the worker producing ideas, and $\bar{L}$ represents labour when the resources are constant, as shown in the following equation:

$$\bar{L} = L_{yt} + L_{at} \quad (3.11)$$

Romer supposes $\bar{l}$ when the worker produces the ideas, and $1 - \bar{l}$ when the worker produces the output. He then uses the equation below to discover the level of production using the knowledge and worker:

$$Y_t = A_t L_{yt} \quad (3.12)$$

The following equation represents how to find the ideas by using the knowledge and worker:

$$\Delta A_{t+1} = \bar{z} A_t L_{at} \quad (3.13)$$

where $\bar{z}$ is a parameter representing the productivity of workers generating ideas. Romer estimates the output per person based on the assumption that this output depends on the total knowledge created by using the following equation:

$$y_t \equiv \frac{Y_t}{\bar{L}} = \frac{A_t L_{yt}}{\bar{L}} = A_t\left(1 - \bar{l}\right) \quad (3.14)$$

After that, he assumes the growth rate of knowledge is constant as in the equation below:

$$\frac{\Delta A_{t+1}}{A_t} = \bar{z} L_{at} = \bar{z}\overline{l L} \quad (3.15)$$

where $\frac{\Delta A_{t+1}}{A_t}$ represents the growth rate of knowledge and $\bar{z}\overline{lL}$ are constant. Then he concludes that the stock of knowledge depends on the initial value of knowledge, and he describes this assumption through the following equation:

$$A_t = \bar{A}_o(1 + \bar{g})^t \bar{g} \equiv \bar{z}\overline{lL} \quad (3.16)$$

where A_t at the stock of knowledge, $\bar{A}_o$ is the initial value of knowledge, and $\bar{g}$ represents the growth rate of knowledge.

Romer's model finds that the output per person grows at a constant rate as follows:

$$y_t \equiv \frac{Y_t}{\bar{L}} = A_t\left(1-\bar{l}\right) \; and \; A_t = \overline{A_o}(1+\bar{g})^t y_t = \bar{A}_o(1-\bar{l})(1+\bar{g})^t \qquad (3.17)$$

From equation (3.18), when we look at the endogenous variables, we find an increase in the returns of labour and ideas together. Furthermore, the return of ideas is unrestricted, which is unlike the Solow model, where the ideas are not in conflict:

$$\Delta A_{t+1} = \bar{z}A_t L_{at} \qquad (3.18)$$

Romer asserted that any increase in the percentage of the population (labour) leads to a rise in the growth rate per capita of output (any growth rate of population leads to an increase in the growth rate of knowledge), as the following equation states:

$$\bar{g} = \bar{z}\bar{l}\bar{L}\, y_t = \bar{A}_o(1-\bar{l})(1+\bar{g})^t \qquad (3.19)$$

As shown in the equation below, if the people (labour) work to produce ideas, this situation leads to a decline in the number of workers required to produce the output. However, this effect is only a short-term one. In the long term, the growth rate will rise, and then the output per person will also rise:

$$\bar{g} = \bar{z}\bar{l}\bar{L}y_t = \bar{A}_o(1-\bar{l})(1+\bar{g})^t \qquad (3.20)$$

The increase in people producing ideas, *ceteris paribus*, will lead to an increase in the growth rate of knowledge.

3.3. SIMILARITIES OF NEOCLASSICAL AND ROMER MODELS

These two models (Solow and Romer) share some properties. Both of their production functions display constant returns to scale and diminishing returns to proportions (Romer 1994). Diminishing returns to proportions means that all the production inputs must rise or fall proportionately to avoid a decline in production. If one input increases while the others are held constant, then the average output per worker will decrease (Romer 1994). The equation that clearly explains this behaviour for the neoclassical model is presented in equation 3.8. That output per worker decreases in Romer's production function is shown in the equations below:

$$Y = (H_Y)^{\alpha} L^{\beta} A^{\alpha+\beta} (K)^{1-\alpha-\beta} \eta^{\alpha+\beta-1}$$

$$\frac{Y}{H_Y} = \frac{(H_Y x)^{\alpha} L^{\beta} A^{\alpha+\beta} (K)^{1-\alpha-\beta} \eta^{\alpha+\beta-1}}{H_Y}$$

Let $Y = \frac{Y}{H_Y}$

$$Y = (H_Y)^{\alpha-1} L^{\beta} A^{\alpha+\beta} (K)^{1-\alpha-\beta} \eta^{\alpha+\beta-1} \tag{3.21}$$

Since $\alpha < 1$

$$Y = \frac{L^{\beta} A^{\alpha+\beta} (K)^{1-\alpha-\beta} \eta^{\alpha+\beta-1}}{(H_Y)^{\alpha-1}}$$

Constant returns to scale imply that an increase in the input is followed by a proportional increase in output. It also means that both equations are homogenous of degree one. The growth rate for the gross national product—which is the output of the neoclassical model—and consumption growth rate are both equal to the interest rate. This property is also shared by Romer's model; both consumption and output have the same exponential growth rate (g).

The neo-classical model (Solow model) for economic growth focuses on the capital/labour ratio to explain what is happening in the economy. An increase in this ratio raises the output per worker, which raises the national output—thus, in turn, increasing the standard of living (Solow 1956). One of the ways to change this ratio in an economy that is not producing enough is through investment in the economy such that the capital/labour ratio is increased—this is referred to as capital deepening. Once the output has increased sufficiently such that the optimal standard of living has been reached, then the level of investment that is used to maintain the capital/labour ratio is referred to as capital widening (Solow 1956). Equilibrium in the neo-classical model involves a constant capital/labour ratio, and it is reached irrespective of a growing population. Since technology in this model is introduced exogenously, the effects of improved technology are to make labour more effective and increase output. Romer presents a growth model that is better than previous ones simply because technology grows endogenously rather than exogenously. However, his model is primarily focused on the production aspect of the economy (Romer 1990). He also draws attention to the importance of human capital to the growth of the economy, which implies the same thing that Solow suggests: countries with larger populations are also more likely to have larger economies.

The main similarities between Solow's and Romer's models are: i) they agree on the importance of human capital to economic growth while diminishing returns to proportions means that all the inputs of production must rise or fall proportionately to avoid a decline in production; ii) they use the same factors to determine the production function, capital/labour ratio and technology.

To conclude, capital investment, technology and labour are the main causes of economic growth according to economic theories. The endogenous economic growth theories (Barro and Sala-i-Martin 1997; Romer 1986) attribute economic growth to innovations and creativity, rather than capital formation, as suggested by previous theories. The endogenous theory showed that continuous technological progress is required to improve and sustain long-term economic growth. In addition, endogenous economic growth theories are the dominant models that have long been utilised in the literature to investigate the effect of ICT on economic growth. The present study considers ICT investment and usage as an independent variable to investigate its impact on economic growth.

3.4. DIFFERENCES BETWEEN NEOCLASSICAL AND ROMER'S MODEL

As mentioned, despite the similarities stated above, there is an important distinction between the two models in that Romer introduces technology endogenously (as internal factors to predict economic growth), and the neo-classical Solow model introduces technology exogenously (as external factors to predict economic growth) (Mankiw et al. 1992). The level of technology (A) in Romer's model is measured by the number of designs that are created with the use of new and existing knowledge. This technology is then applied to the production of producer durables.

With the neo-classical model, however, technology is given as the growth rate of q per year. Technology here serves to increase the efficiency of labour, thereby forcing the production function to use the units of effective labour (N_t^*) rather than ordinary units of labour (N) that are available in the economy. The new growth rate of labour then changes from n to $(n + q + nq)$ per year, all due to the introduction of technology exogenously. Furthermore, the population in the neo-classical model is expected to grow at 5 percent per year, like the growth rate that is experienced. Romer, however, assumes a constant population for simplicity. The level of technology in Romer's model is expected to grow exponentially and at the same rate (g) as consumption and output, whereas the neo-classical model gives technology its growth rate (n) since it is a set independent from the model.

3.5. GOVERNANCE AND ECONOMIC GROWTH

The previous sections show that the traditional neoclassical growth models explain variations in income per capita by looking at how different factors accumulate over time. Factor accumulation in (Solow 1956; Cass and Koopmans 1965)'s models can be explained by differences in saving rates, preferences, or other exogenous parameters, such as total factor productivity growth. Growth theories, such as Romer (1986) and Lucas (1988), endogenize steady-state growth and technological progress, but their explanation for income disparity remains the same as older theories. A country may be more prosperous than another if it devotes more resources to innovation, according to Romer (1990), but what determines that are the primary preferences and properties of the technology for creating 'ideas.'

Though this theoretical paradigm is still active in economics and has produced numerous insights into the mechanics of economic growth, it has long appeared incapable of providing a fundamental explanation for economic growth. The variables we have enumerated, including innovation, economies of scale, education, capital accumulation, etc., are well known as growth. According to North and Thomas's (1973, p. 2) statement: “the factors we have listed (innovation, economies of scale, education, capital accumulation, etc.) are not causes of growth; they are growth”. So, based on the North and Thomas’s suggestion, the accumulation and innovation factors are only drivers of economic growth. The underlying rationale for comparative growth is the differences in institutions.

North (1990, p. 3) defines that: “Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction.” He continues by underlining the key implications of institutions as, “In consequence, they structure incentives in human exchange, whether political, social, or economic.”

Economic institutions in society, such as the structure of property rights and the presence and perfection of markets, are of vital importance for economic outcomes. Economic institutions influence the structure of economic incentives in society. If property rights are abolished, individuals will not be incentivized to invest in physical or human capital or adopt more efficient technologies. It is important to note that economic institutions play a vital role in allocating resources to their most efficient uses, determining who receives profits, revenues, and residual rights of ownership. Meanwhile, there is a lack of opportunity to reap the benefits of commerce when markets are absent or neglected (as was in the case of the Soviet Union, for example). Societies that have economic systems to support and foster factor accumulation, innovation, and effective resource allocation will thrive.

This section has two aims. First, selectively review the evidence that economic institutions are fundamentally responsible for differences in prosperity between countries. Finally, an explanation of why economic institutions differs between countries—using historical examples and case studies.

3.5.1. Fundamental Causes of Income Differences

If the standard economic models of factor accumulation and endogenous technological change only provide proximate explanations of comparative growth, what types of explanations would constitute fundamental ones? According to Acemoglu et al’s (2005) study, they identify three theories: the first theory emphasises the importance of economic institutions in shaping economic incentives, while the second and third theories place an emphasis on geography and culture, respectively.

3.5.2. Economic Institutions

According to Acemoglu et al's. (2005, p. 12) statement: “At its core, the hypothesis that differences in economic institutions are the fundamental cause of different patterns of economic growth is based on the notion that it is the way that humans themselves decide to organize their societies that determines whether or not they prosper.” Therefore, when it comes to economic growth and how it's depended on the differences in economic institutions are the fundamental cause of different, it is widely accepted that people's decisions about how to organise their societies are the most important factor in determining whether or not society will prosper. Others encourage people to innovate, take risks, save for the future, find better ways of doing things, learn and educate themselves, solve collective action problems, and provide public goods in certain ways. Others are not (Acemoglu et al. 2005).

Many nineteenth-century scholars, including Adam Smith and John Stuart Mill (see the discussion in Jones 1981), argue that the prosperity of a society depends on the quality of its economic institutions. These good economic institutions can be thought of as a collection of interconnected elements. In order to encourage investment, innovation, and participation in the economy, property rights must be upheld for all members of society. In order for those with good investment opportunities to take advantage of them, there needs to be some degree of equality of opportunity in society, including things like equality before the law (Acemoglu et al. 2001).

To illustrate this point, one could think of other types of economic institutions, such as markets. According to Adam Smith's theories of economic growth, historians have traditionally emphasised the spread of markets (Pirenne 1937); however, more recent theories of comparative development also place a strong emphasis on differences in various economic institutions. Market imperfections, according to the theories of Rosenstein-Rodan (1943), Murphy et al. (1989a,b), and Acemoglu (1995, 1997), can lead to the existence of multiple Pareto-ranked equilibria, which can lead to poverty traps. Consequently, a country may find itself trapped in a Pareto inferior equilibrium associated with poverty. However, escaping from such a trap requires coordinated efforts that are impossible to achieve through the market. When capital markets are imperfect, the distribution of wealth matters for who can invest, according to the theory developed by Banerjee and Newman (1993) and Galor and Zeira (1993). Societies with unequal income distributions can become impoverished.

These theories provide intriguing models of how incentives are influenced by expectations of other people's behaviour or the distribution of wealth in the context of a set of market imperfections that exists. On the other hand, they take the market structure as a foregone conclusion. Acemoglu et al. (2005) believe that the structure of markets is endogenous, and that property rights play a role in determining this structure. Individuals will have secure property rights, and there will be equality of opportunity, which will create incentives for creating and improving markets (even though achieving perfect markets would be typically impossible). For this reason, Acemoglu et al. (2005) anticipate that variations between countries' property rights and political institutions, rather than inherent characteristics, will be responsible for differences in economic performance across countries.

3.5.2.1. Geography

While institutional theories emphasise the role of man-made factors shaping incentives, "nature", that is, the physical and geographical environment, can also play a role. This approach emphasises differences in geography, climate, and ecology that determine both the preferences and opportunity set of individual economic agents in different societies. So we call it the "geography hypothesis". This hypothesis has three major versions, each emphasising a different mechanism for how geography affects prosperity (Acemoglu et al. 2005).

First and foremost, climate may be a significant factor in determining work effort, incentives, and even productivity. In the classic book The Spirit of the Laws, written by the famous French philosopher Montesquieu ([1748], 1989), who wrote: “The heat of the climate can be so excessive that the body there will be absolutely without strength. So, prostration will pass even to the spirit; no curiosity, no noble enterprise, no generous sentiment; inclinations will all be passive there; laziness there will be happiness,” and “People are ... more vigorous in cold climates. The inhabitants of warm countries are, like old men, timorous; the people in cold countries are, like young men, brave”. Marshall (1890), a leading figure in modern economics and who emphasised the importance of climate arguing: “vigor depends partly on race qualities: but these, so far as they can be explained at all, seem to be chiefly due to climate” (Marshall 1890, p. 195).

Second, geography may influence technology to society, particularly in agriculture. According to Myrdal and Barber, Nobel laureate in economics, “serious study of the problems of underdevelopment ... should take into account the climate and its impacts on soil, vegetation, animals, humans and physical assets–in short, on living conditions in economic development” (Myrdal and Barber 1968, p. 2121). Diamond (1997) expressed his support for this viewpoint, “... proximate factors behind Europe’s conquest of the Americas were the differences in all aspects of technology. These differences stemmed ultimately from Eurasia’s much longer history of densely populated ... [societies dependent on food production],” which was in turn determined by geographical differences between Europe and the Americas (Diamond 1997, pp. 358). “By the start of the era of modern economic growth, if not much earlier, temperate-zone technologies were more productive than tropical-zone technologies ...”, according to economist Sachs (2001, p. 2).

The third variant of the geography hypothesis, which has become increasingly popular in recent years, links poverty in many parts of the world to their "disease burden," emphasising that "the burden of infectious disease is similar in the tropics as it is in the temperate zones" (Sachs 2000, p. 32). Several researchers, including Bloom and Sachs (1998), assert that the prevalence of malaria, a disease that kills millions of children every year in sub-Saharan Africa, has a negative impact on the annual growth rate of sub-Saharan African economies by as much as 1.3 percent per year (this is a large effect, implying that had malaria been eradicated in 1950, income per capita in sub-Saharan Africa would be double of what it is today).

3.5.2.2. Culture

Another fundamental explanation for economic growth is the idea that different societies (or maybe even different races or ethnic groups) have different cultures because of differences in shared experiences or different religions. This is the final fundamental explanation for economic growth. Cultural differences are considered to be important determinants of the values, preferences, and beliefs held by individuals and societies, with the argument being that these differences have a significant impact on economic performance (Acemoglu et al. 2005).

The influence of culture on equilibrium outcomes for a particular set of institutions can be hypothesised to exist on some level. Because there are many possible equilibrium conditions associated with any given collection of institutions, and because cultures differ, various societies will coordinate on different equilibrium conditions (Acemoglu et al. 2005). Greif (1993) argues that different cultures generate distinct sets of assumptions about how people behave, and this might modify the range of equilibria for an institution's unique specification (for example, some beliefs will allow punishment strategies to be used whereas others will not).

The most well-known connection between culture and economic development is that proposed by Weber (1930), who argued that the origins of industrialisation in Western Europe could be traced back to the Protestant Reformation and, in particular, the rise of Calvinism, as well as the rise of the Roman Catholic Church. According to him, the collection of worldviews that were essential to Protestantism had a critical role in the emergence of capitalism. Protestantism placed a strong emphasis on the concept of predestination, which held that some people were 'chosen' while other people were not. “We know that a part of humanity is saved, the rest damned. To assume that human merit or guilt play a part in determining this destiny would be to think of God’s free decrees, which have been settled from eternity, as subject to change by human influence, an impossible contradiction” (Weber 1930, p. 60).

Landes (1998) argues that the origins of Western economic dominance are attributable to a set of beliefs about the world and how human endeavour might modify it, which is tied to religious differences. However, religious beliefs are endogenous to both economic outcomes and other fundamental causes of income differences (as stated by Tawney, 1926, and Hill, 1961, in their critiques of Weber's thesis).

The role of religion isn't the only way that culture can influence growth. There have been arguments in the literature attempting to explain comparative development that certain cultural endowments are usually linked to specific nation-states. Because of its Iberian heritage, Latin America may be poor, whereas North America is prosperous because of its Anglo-Saxon heritage (V'eliz 1994). A large body of anthropological literature suggests that societies can become "dysfunctional" or "maladapted" in the sense that they adopt a system of beliefs or operating methods that do not promote the success or prosperity of the society (see Edgerton 1992). People in Southern Italy had adopted a culture of "amoral familiarism" in which they only trusted those within their own families and refused to cooperate or trust anyone else, according to Banfield (1958), the most famous version of such an argument. Putnam (1993) resurrected this argument by describing these societies as lacking "social capital." However, despite Putnam and others, such as Knack and Keefer (1997), and Durlauf and Fafchamps (2003), documenting positive correlations between measures of social capital and various economic outcomes, there is no evidence of a causal effect since measures of social capital are potentially endogenous.

3.6. WHY DO INSTITUTIONS DIFFER?

There is no doubt that economic institutions play an important role in determining a country's relative prosperity. In terms of the various fundamental theories, the emphasis on institutions by North and Thomas outperforms other candidate explanations that emphasise geography or culture. That differences in economic institutions can account for most differences in per-capita income between countries raises more questions than answers. Think about it this way: Why do countries have different economic institutions? If poor countries are poor because they have poor economic institutions, why don't they fix them? In short, we need a theory of economic institutions to explain the evidence presented in the last two sections. The theory will help explain the equilibrium set of economic institutions in a country and why economic institutions differ between countries.

Overall, there are four main approaches to why institutions differ across countries. In the following section, we will go over each of these in detail and discuss whether or not we believe they provide a satisfactory framework for thinking about differences in economic institutions (see Acemoglu 2003a and Robinson 1998, for related surveys of some of these approaches).

3.6.1. The Efficient Institutions View–The Political Coase Theorem

Societies will choose the most socially efficient economic institutions. The distribution of this surplus among various groups or agents is unrelated to economic institutions. Hence, this emphasises that efficiency is associated with surplus, wealth, or output maximisation.

The Coase Theorem underpins this viewpoint. Economists can bargain to internalise potential externalities, according to Coase (1960). Pollution from a nearby factory can be paid for by a farmer. Similarly, if current economic institutions benefit one group while harming another, these two groups can work together to change the rules. They can then bargain over the distribution of this additional surplus.

The efficient economic institution's view has been proposed in many forms. Observing an institution and trying to understand what circumstances lead to it being efficient is a standard methodological approach of economists. Demsetz (1967) argues that common property became private when land became scarce and valuable enough to privatise. Williamson's (1985) research, like Coase's (1937) earlier work and Grossman and Hart's (1986) more formal analysis, argues that firm or market governance ensures efficiency (given the underlying informational and contractual constraints). Williamson argued that firms arose as an efficient response to market-wide contractual issues, particularly when individuals make relationship-specific investments. North and Thomas (1973) show that feudal economic institutions, such as serfdom, were an efficient contract between serfs and lords. In exchange for the serfs' labour, the lords provided protection. This was an efficient way to organise this exchange without a modern fiscal system (Townsend 1993).

Many important economic institutions for development are collective choices, not individual bargains, and Williamson and North and Thomas do not specify how parties will reach an agreement to achieve efficient economic institutions. Creating efficient economic institutions may therefore involve free-riding issues. Nonetheless, Becker (1960) and Wittman (1989) argue that competition among pressure groups and political parties leads to efficient policies and collective choices. They argue that an inefficient economic system cannot be stable because a political entrepreneur will be enticed to propose a better economic system, thereby increasing his electoral appeal. The structure of political institutions or power is irrelevant to efficient institutions. This may matter for total surplus distribution but not for efficiency. So, the 'efficient' set of political institutions is therefore indeterminate.

In his paper Acemoglu (2003a), he refers to the Political Coase Theorem as the notion that Coasian logic holds true in both political and economic life. Although individuals and groups' intuition will strive to achieve the most efficient economic outcomes is appealing, the Political Coase Theorem has theoretical and empirical limits, as demonstrated in the following examples. As Acemoglu (2003a) argued and discussed further below, the first is that there is an inherent commitment problem in politics, which makes the Political Coase Theorem inapplicable in many situations.

Second, the Political Coase Theorem doesn't get us very far in terms of understanding the impact of economic (or, indeed, political) institutions on economic outcomes — according to this view, economic institutions are chosen efficiently, and all societies have the best possible economic institutions given their needs and underlying structures (Acemoglu et al. 2005); as a result, according to the Political Coase Theorem, economic institutions cannot be the fundamental cause of income gaps (Acemoglu et al. 2005).

To summarise, we require a conceptual framework for figuring out why some societies continue to develop economic institutions that are not beneficial to their citizens in the long run. Economic institutions must be viewed as distinct from the underlying needs of societies in order to understand these patterns. According to Acemoglu et al. (2005), the Political Coase Theorem is insufficient, so we need a framework other than the Political Coase Theorem.

3.6.2. The Ideology View

Acemoglu (2003a) calls this the Modified Political Coase Theorem because of the similarity between this and the previous view. According to this theory, people and their leaders may disagree about what is best for society, so that they may choose different economic institutions with very different consequences. This theory holds that the right economic institutions are so uncertain that even well-intentioned political actors disagree on what is best for their own people. Societies that thrive are those in which the leaders or electorate are proven to be correct. This is important because, just as with the efficient institutions view, strong forces are preventing the implementation of policies that are known in general to be harmful to society.

There are several related theoretical models. According to Piketty (1995), different people believe different things about how much effort is rewarded in society. Taxation produces few distortions if effort is not rewarded, and such agents prefer a high tax rate. Low taxes are preferred if one believes the effort is rewarded. Piketty showed that even if all agents had the same goal, dispersion of beliefs could lead to dispersion of tax rates. Incorrect beliefs may also be self-fulfilling and persist over time because information tends to support them. Romer

(2003) shows that society can choose a socially inefficient outcome if voters' beliefs differ. These models show that different societies can rationally choose different economic institutions based on their social efficiency beliefs.

Policy and institutions are likely to be shaped by differences in people's beliefs. Several examples of this can be found in the early stages of independence in former British colonies (Acemoglu et al. 2005). For example, Julius Nyerere's policies in Tanzania cannot be explained without reference to his and other leading politicians' belief that a socialist society is desirable. In India, it appears that Jawaharlal Nehru's Fabian socialist beliefs played a significant role in determining the initial course of Indian economic policy (Acemoglu et al. 2005).

Based on these considerations, Acemoglu et al. (2005) argue that we are more likely to hold a view that emphasizes the rational and consequences-aware actions of prominent economic and political actors rather than merely disagreements over beliefs. Although we do not rule out the importance of ideological differences, we do not think they can be used as the basis for a theory of institutional differences.

3.6.3. The Incidental Institutions View

Economic reasoning underpins the efficient institutions perspective: various economic institutions' societal costs and benefits are compared to determine which economic institutions are most efficient. Efficiency arises because individuals ultimately calculate according to social costs and benefits. Instead, many political scientists, sociologists, and economists think of economic and political institutions as accidental outcomes of other social interactions or historical events. Institutions are established by crucial historical occurrences that have long-term implications, and it's helping to determine institutional structures (Acemoglu et al. 2005).

In this section, we will look at two such hypotheses. The first is the theory of political institutions developed by Moore (1966) in his Social Origins of Dictatorship and Democracy, and the second is the recent emphasis in the economics literature on legal origins, such as in the work of La Porta et al. (1998, 1999); Djankov et al. (2002, 2003); Glaeser and Shleifer (2002) on the legal origins of dictatorship and democracy.

Moore (1966) tried to explain the differences in British, German, and Russian political evolution. He looked into why Britain became a democracy, whereas Germany fell to fascism, and Russia had a communist revolution. Moore (1966) emphasised the level of agricultural commercialisation, the strength of the ‘bourgeoisie,' and the character of class coalitions. In his view, a robust, politically commercial middle class and the commercialisation of agriculture meant no feudal labour relations in the countryside. Fascism began because the middle classes were weak and joined the landowners' coalition. Finally, a communist revolution occurred when there was no middle class, no commercialisation of agriculture, and no rural labour control. According to Moore, political institutions emerge based on class coalitions and agricultural organisation. However, the agricultural organisation is not chosen with political institutions in mind; therefore, it is unintentional. Civilizations may wind up with institutions that do not maximise revenue or growth is a clear result of Moore's (1966) analysis.

La Porta et al. (1998) and Djankov et al. (2003) have argued that the legal system's origin is a fundamental source of variation in many critical economic institutions. For example, “Civil laws give investors weaker legal rights than common laws do, independent of the level of per-capita income. Common-law countries give both shareholders and creditors–relatively speaking–the strongest, French-civil-law countries the weakest protection. ” (La Porta et al. 1998, p. 1116).

These differences impact resource allocation. For example, when shareholders' rights are poorly protected, share ownership tends to be increasingly concentrated. Djankov et al. (2003) compiled a cross-national dataset on evicting tenants for non-payment of rent and collecting rejected checks. They used these data to create a country-specific index of procedural formalism, which they found to be associated with higher expected judicial proceedings, less consistency, less honesty, less justice in judicial judgements, and more corruption. Law seems to influence crucial institutional outcomes.

According to Acemoglu et al. (2005), who agreed that the value of historical chance and persistence, the power of choice over institutions seems too essential to ignore. They conclude that even if institutions tend to remain, actors can choose to modify them if they so desire. Historically, countries like Japan after the Meiji restoration, Russia after the Crimean War, and Turkey under Mustafa Kemal in the 1920s have changed their legal systems dramatically. Another example is central economic planning. While many countries followed this economic model, some abandoned it, like North Korea and Cuba (Acemoglu et al. 2005). The study also concludes that even while institutions may have developed due to historical conditions in certain cases, individuals will eventually begin to question why society has developed the institutions that it has and seek other options. At this point, we are back in the domain of possibility and selection.

3.6.4. The Social Conflict View

Some believe that economic (and political) institutions are not necessarily chosen by the entire population but rather by those who control political power. These groups will choose the economic institutions that maximise their own rents, and the economic institutions that result may not coincide with those that maximise total surplus, wealth, or income (Acemoglu et al. 2005). If a monarch plans to use economic institutions to seize assets in the future, such institutions may not be in their best interest. This king would be reducing his own future rents by enforcing property rights; hence he may choose economic structures other than private property. Economic institutions in a stable equilibrium do not maximise the pie but rather the share of the pie obtained by the most influential organisations (Acemoglu et al. 2005).

When North (1981) wrote "A Neoclassical Theory of the State," he advocated for a self-interested model for state actors, the first systematic development of this point of view in the economics literature. According to him, people would choose the set of property rights that maximised personal return, but these would not necessarily be the set of rights that maximised societal welfare because of "transactions costs." According to North's reasoning, the state and citizens' interests are at odds because he doesn't explain the transaction costs that cause this. Here, they conclude that this discrepancy stems from a lack of commitment.

A large part of the Marxist and dependency theory literature is also based on the idea that elites, i.e. the politically powerful, may choose economic systems that increase their earnings, frequently at the expense of the rest of society. For example, Dobb (1948), Brenner (1976, 1982), and Hilton (1981) saw feudalism as a system of institutions structured to extract rents from peasants at the expense of social welfare, in contrast to North and Thomas's (1973) model of feudalism. According to dependent theory, the international trading system was designed to extract rents from developing countries to benefit developed countries. Dependency theorists such as Williams (1944), Wallerstein (1974-1982), and Frank (1978) made this argument.

According to the social conflict perspective, economic institutions that were previously efficient for a particular set of conditions are no longer efficient once the environment changes. Examples include the findings of Acemoglu, Aghion, and Zilibotti (2001), who demonstrate that while certain types of organisations may be beneficial for countries that are far from the technological frontier, it may be more socially efficient to change them later. However, this is unlikely to occur because it is not a privately rational decision. Furthermore, in very impoverished countries, a certain set of institutions are efficient, but they continue to apply even when they are no longer efficient.

Political institutions have a critical role in social strife, in striking contrast to the efficient institutions' perspective. Which economic institutions are created or blocked depends on who has the political ability to do so. In a social conflict theory of economic institutions, also political institutions play an important role in distributing power. The social conflict approach differs from the ideological view in that even when all agents have common awareness that this causes underdevelopment, decisions of economic institutions might be made because of social conflict (Acemoglu et al. 2005). What sets it apart from the incidental approach is its emphasis on deliberate, rather than unintentional, institutional choices as the source of underdevelopment. The difference between the efficient institutions perspective and the social conflict view is that it does not assume that institutions are always efficient (Acemoglu et al. 2005).

3.7. NATIONAL COMPETITIVE ADVANTAGE THEORY

An emerging strand of the literature suggests that the relationship between technology and economic growth is affected by a country's quality of governance institutions. The theory of national competitive advantage (or national competence) suggests that national governance plays a moderating role in relationships with economic growth. National competence is the ability of the national economy to grow and compete, and it is measured by a set of factors, including government policies, political institutions, social infrastructure, monetary policy, fiscal policy, and the microeconomic environment (Delgado et al. 2012). GDP, however, remains the key variable that indicates productivity in assessing a nation's competitiveness (Jin and Cho 2015).

National competence theory deals with political institutions (governance or institutional quality) as a moderator of the productivity of labour and capital. Thus, governance represents a major dimension of the country's macroeconomic competitiveness. For instance, there is a strand of macroeconomic literature that shows that the quality of institutions (quality of governance) affects economic growth (Acemoglu 2003; Acemoglu et al. 2001; Kaufmann et al. 2009; Nawaz 2015). In particular, economic growth is linked to the rule of law (Porta et al.

1998), control of corruption (Hall and Jones 1999; Mauro 1995), and democracy (Helliwell 1994). Acemoglu (2003) argues that institutions are a fundamental cause of economic growth, whereby nations with good and sound institutions promote human and capital investment to achieve economic prosperity.

Whereas it is clear that good governance matters for economic growth, the literature remains equivocal about the working mechanism. Acemoglu et al. (2005) state that:

> "Even though many scholars, including John Locke, Adam Smith, John Stuart Mill, Arthur Lewis, Douglass North, and Robert Thomas, and recently many papers in the literature on economic growth and development, have emphasized the importance of economic institutions, we are far from a useful framework for thinking about how economic institutions are determined and why they vary across countries" (Acemoglu et al. 2005, p. 385-472).

They argue that the majority of the literature has focused on the proximate cause of economic growth as a result of lacking an explicit framework of the institutions' role in cross country growth differentials. Many studies have examined the moderating role of institutions for other economic growth determinants, e.g., governance quality thresholds and the relationship between finance and growth (Law et al. 2013).

3.8. CONCLUDING REMARKS

In this chapter, a review of the main theories of economic growth has been provided. Moreover, the theories that investigate the relationship between technology and economic growth from different perspectives were discussed. The main similarity between models is that they all depend on the same variables (labour, capital, and technology) to determine economic growth. The main difference between the models is in the way they measure the effect of technology on economic growth. Solow's model considers technology as an exogenous change, but in the Romer model, technology is considered as an endogenous change. While both growth models confirmed the role of technology to boost economic growth, exogenous theories assume that the technology variable is created outside the economic system, in contrast to the endogenous theory that proposes the activities inside the economic system result in its creation.

This chapter further showed technological effects on economic growth are not complete without the presence of good quality governance. Therefore, this chapter also reviewed national competence theory, which suggests that governance quality plays a moderating role in promoting economic growth through key variables. Finally, this chapter demonstrated that the endogenous economic growth theories (Barro and Sala-i-Martin 1997; Romer 1986) are more appropriate for this study. Endogenous theories attribute economic growth to innovations and creativity. Moreover, these theories support the significance of the institutional framework for stimulating innovation. Chapter 4 will present the empirical literature on this issue and connect it to theoretical models.

CHAPTER 4: REVIEW OF LITERATURE

4.1. INTRODUCTION

Numerous empirical studies have been conducted to identify the effect of ICT on economic growth, but these studies have not produced conclusive results. Thus, there remains some ambiguity surrounding the effect of ICT on economic growth and the moderating role of governance quality in developing countries, especially MENA countries. Acemoglu (2003) argues that governance is a fundamental driver of economic growth, whereby countries that have good and sound governance witness economic prosperity.

Another study by Acemoglu et al. (2005) argues that many scholars, from Adam Smith and John Locke up to recent scholars, have proved the significant role of governance on economic growth. Furthermore, the study argues that there is a crucial need to establish a clear framework on the effect of governance on economic growth and why it varies across countries. Empirical studies have focused on the proximate cause of economic growth as a result of lacking an explicit framework of the governance role in cross country growth differentials. What complicates the issue is the fact that economic theories do not offer a certain prediction for the impact of governance quality indicators on ICT and economic growth. Therefore, this chapter will review the significant contributions to the ICT–economic growth literature, including recent contributions demonstrating that this relationship produces mixed results. Moreover, a synopsis will be provided of the recent literature that discusses how governance quality can play an important role in improving economic growth.

This chapter aims to provide a synthesis of the empirical literature on the ICT–economic growth nexus, the effects of governance quality on economic growth, and the moderating impact of quality of governance on economic growth. The shortcomings of previous empirical studies will be identified to show the existing research gap that would benefit from some investigation.

This chapter proceeds as follows: Section 4.2 reviews the literature related to the effect of ICT on economic growth; Section 4.3 presents the studies that have investigated the role of quality of governance on economic growth; Section 4.4 demonstrates the empirical literature on the moderating impact of governance quality on economic growth; Section 4.5 identifies the shortcomings of previous empirical studies; Section 4.6 discusses the study hypotheses; and Section 4.7 provides some concluding remarks.

4.2. ICT AND ECONOMIC GROWTH

As a result of accelerating technological change in the past few years, numerous studies have investigated the influence of ICT on economic growth. Furthermore, governments are convinced of the role of technology in driving their economies (Kim et al. 2009). Madden and Savage (1998) investigated the relationship between telecommunications investment and economic growth in 27 Central and Eastern European (CEE) countries from 1990 to 1995. The authors find a unidirectional causal relationship between telecommunications investment and economic growth. Conversely, by testing panel data from 29 countries, Seo et al. (2009) found that ICT investment was influenced by GDP increase in the 1990s. Roller and Waverman (2001) examined telecommunications infrastructure and economic growth in all OECD countries from 1970 to 1990 and discovered a positive connection between economic growth and telecommunications infrastructure.

Three subsections that fall under this heading will be discussed as follows: (i) ICT Usage–Economic Growth nexus; (ii) ICT Investment–Economic Growth nexus; and (iii) ICT and Economic Growth nexus (MENA region).

4.2.1. ICT Usage–Economic Growth Nexus

The effect of ICT usage on economic growth has been widely examined by economists in recent years. ICT usage is an important key to boosting productivity, and it therefore leads to economic growth. A study conducted by Thompson Jr and Garbacz (2007) notes that the world's rate of progress and productive efficiency—especially in low-income countries—rises when the adoption rates of telecommunication services are high. They discovered this through testing panel data from 93 countries for the period 1995–2003. Similarly, Vu (2011) investigates the impact of ICT on economic growth for 102 countries from 1996 to 2005 and finds the following: countries witnessed high levels of economic growth due to ICT; there was a statistically significant correlation between ICT and economic growth; and PCs, mobile-cellular telecommunications and internet usage influence economic growth.

Many studies have shown that ICT usage significantly affects economic growth (Dedrick et al. 2013; Kneller and Young 2001). They show that the countries which appropriately employed ICT in productivity processes experienced high economic growth. Lee et al. (2005) explain the effects of information and communications technology on economic growth in developed/newly industrialised countries and developing countries. Their results reveal a significant outcome in developed/newly industrialised countries, but not in developing countries. This is in line with the results of Edquist (2005), who concludes that there is no clear impact of ICT on the economic growth of developing countries due to the delay in introducing information and communications technology in these kinds of countries. Internet use in these countries only began in the late 1990s and was not always fully available or able to cover large areas. However, these findings contrast with those of Antonelli (1991, 1993), who found that ICT exerted a positive impact on economic growth in developing countries, to the extent that these countries benefited more than developed countries.

Oulton (2012) looks at the data of 15 European and 4 non-European countries, using the EU KLEMS database. The results show a significant impact of ICT on economic growth in the United States and Sweden. In addition, an effect was noticeable in many European countries, but not in the short run. Nevertheless, ICT investment has a positive long-run effect on economic growth in these 19 countries. Similarly, Salahuddin and Gow (2016) employ an ARDL model to find the impact of internet usage, trade openness, and financial development on economic growth in the long run for South Africa from 1991–2012. A Dynamic Ordinary Least Squares (DOLS) estimation method was also employed to check the robustness of the long-run relationship between the variables. The results reveal a positive and significant long-run relationship between internet usage and economic growth. Moreover, they find a significant positive relationship among trade openness, financial development and economic growth. The Granger causality test reveals that both financial development and internet usage Granger-caused economic growth in South Africa.

Vu (2013) examines the contributions of ICT to Singapore's economic growth for the years 1990–2008. He identifies three main results regarding this contribution. The first result shows there is a strong relationship between an increase in ICT usage and the growth of labour productivity. The second result highlights the effect of ICT investment on Singapore's GDP; ICT investment increased Singapore's GDP by around 1 percentage point for the period 1990–2008. The author explains that Singapore's success in economic growth is the result of its adoption of pro-ICT policies.

Likewise, Evangelista et al. (2014) investigate the economic effects of digital technologies on many dependent economic variables (employment rate, labour productivity, and GDP per capita) for 27 European countries from 2004 to 2008. They use a collection of complex ICT indicators to find the best description for ICT and how it empowers individuals socially and economically. Many transmission mechanisms are identified, such as access to ICT, as well as main indicators associated with ICT, including usage, infrastructure, and empowerment. Results show that digitalisation is one of the cornerstones of economic growth and contributes to the creation of new jobs for disadvantaged people.

Conversely, some studies have indicated that the effectiveness of ICT usage on economic growth may be uncertain for developing and developed countries (Irawan 2014). It is not always shown to be the case that developed countries gain more benefit from ICT development than less developed countries. Moreover, the extent of the impact of ICT on a nation's economy depends on the strength of the ICT sector and the intensity of ICT use (Irawan 2014). Yousefi (2011) investigates the impact of ICT on economic growth based on the data of 62 developed and developing countries during the period 2000–2006. The results show that the effect of ICT on economic growth depends on the income of the countries; ICT has a significant effect on economic growth in the upper-middle and high-income countries, rather than the lower-middle-income countries where ICT does not contribute to economic growth. These results contended that the level of ICT investment is not what causes slow economic growth in lower-middle-income developing countries, as previously thought.

Cheng et al. (2021) examined the relationship between financial development, ICT diffusion, and economic growth by taking into account the interaction between ICT and finance, using panel data for 72 countries over the period 2000 to 2015. The purpose of the study was to capture the impact of financial development on economic growth, using a broad index of financial development by utilising principal component analysis. After applying dynamic GMM estimation, the results show that financial development harms economic growth in high-income countries. Further, results show that ICT diffusion can enhance economic growth in high-income countries, but the impact is equivocal in middle-income and low-income countries. For example, mobile telecommunications growth will boost economic growth in middle- and low-income countries, while growth in internet or secure internet servers will not. The interaction term among financial development and ICT has a positive effect on all income level countries, and this interaction may reduce the negative impacts of financial development, although the impacts are just significant for high-income countries.

In order to understand the role of ICT on economic variables such as economic growth and the output of a worker, Kumar and Vu (2014) explore the relationship between ICT, remittances and output per worker in Vietnam by using the ARDL approach and Granger causality tests for the period 1980 to 2012. Their results show that capital productivity is the dominant driver of economic growth in the long run. Moreover, the results reveal that ICT supports output per worker, both in the short run and long run. This indicates that ICT has a pervasive role in boosting economic growth. Their findings demonstrate that ICT influence on per worker output is 0.002 percent in the short term and 0.006 percent in the long term. The elasticity coefficient in the long term for remittances is positive but insignificant and has mixed consequences in the short term. Elsewhere, Wamboye et al. (2016) show that ICT has a significant and positive effect on labour productivity growth in their analysis of sub-Saharan Africa for the years 1975–2010. These authors further find that foreign direct investment (FDI) helps to improve labour productivity growth and ICT rapid growth.

Kumar et al. (2018) assess the impact of ICT and tourism on per-worker output in Israel from 1960 to 2016 by utilising the ARDL approach. Their results show that mobile subscriptions and visitor arrivals positively impact the percentage of workers' output. Nevertheless, the ICT variable is only significant in the long term, and the elasticity coefficient is 0.03. The long-term elasticity coefficient for tourism is 0.05. These results find that technological progress and growth in the tourism industry help accelerate overall economic growth. In another study, Ishida (2015) analyses the impact of ICT on the percentage of electrical energy consumption and economic growth in Japan from 1980 to 2010, using the ARDL approach. The results indicate a statistically significant outcome in the long term for ICT and a stable relationship with energy demand. However, ICT investment in the long term is statistically insignificant. It is concluded that ICT investment leads to less energy consumption, but it does not increase economic growth.

4.2.2. ICT Investment–Economic Growth Nexus

Many studies have examined the effect of ICT investment on economic growth as ICT investments are commonly seen as a key driver of economic growth. This relationship has been widely investigated at the country level and firm level, showing the productivity influence of ICT to be significant and positive economically. Cardona et al. (2013), Colecchia and Schreyer (2002) and Van Reenen et al. (2010) have all documented the significant effect of ICT investment on economic growth. In another study, Cronin et al. (1991) show a causal correlation between ICT investment and economic growth. Moreover, their results reveal that economic growth stimulates demand for ICT infrastructure investment and vice versa and that ICT investment enhances economic growth. However, these findings were contradicted by Beil et al. (2005), who conclude that investment in telecommunications does not generate economic activity in the United States. Studies by Yoo and Kwak (2004) in South Korea and Veeramacheneni et al. (2008) in India find bidirectional causality between ICT investment and economic growth. In another study, Dvornik and Sabolić (2007) find a unidirectional causality from ICT investment to economic growth in Eastern Europe. In China, Shiu and Lam (2008) found a unidirectional causality but in a different direction, where economic growth led to better telecommunications investment.

The relationship between broadband and the economic growth of ICT has also been widely discussed by scholars in recent years, because broadband as a part of ICT investment is one of the main conditions for boosting economic growth. For instance, Koutroumpis (2009) uses a simultaneous equations model to disentangle the connection between broadband infrastructure and GDP in 22 OECD countries from 2002 to 2007. He detects a positive connection between broadband infrastructure and economic growth. Elsewhere, by using the panel dynamic OLS (PDOLS) estimator, Venturini (2009) investigates the impact of ICT capital on the economic growth of 15 countries in the European Union and the United States in the long run. He finds that ICT capital is a significant factor for GDP growth over time, in the US and the EU-15 countries over the period 1980–2004.

In another study, Kolko (2012) focuses on the relationship between broadband expansion and economic growth. Moreover, he studies how this relationship affects wage and employment levels, using data from the North American Industrial Classification System (NAICS) from 1999 to 2006. The study finds that there is a positive relationship between broadband expansion and economic growth. The study also finds that broadband might have heterogeneous effects on employment (depending on a given industry's reliance on information technology). The study further reveals that there is no support for his hypothesis that areas with excellent broadband expansion have higher income or better employment rates.

Hong (2017) employs the Granger causality method to evaluate the relationship between research and development (R&D) investment and economic growth in South Korea's ICT industry from 1988 to 2013. Results show that there is bidirectional causality between ICT R&D investment and economic growth. This suggests that ICT R&D investment is driven by economic growth and vice versa. The study also concludes that ICT investment by the private sector is strongly correlated with economic growth. This indicates that public and private sector ICT R&D investment is a very powerful feature of economic growth. Castaldo et al. (2018)

analyse the effects of fixed broadband on economic growth in 23 OECD countries from 1996 to 2010. Through the application of panel data analysis and the GMM with the two-stage approach, the study observes a positive relationship between economic growth and broadband prevalence. The results also find a relationship between economic dynamics and broadband prevalence in the short and long term. Another study using a similar approach by Crandall et al. (2007) investigates the relationship between economic growth and broadband infrastructure. They examine what happened in the United States from 1998 to 2002, concluding that the accessibility and availability of broadband explains relevant differences in growth and employment between communities.

Similarly, Lehr et al. (2006), using a cross-sectional panel data set of communities across the United States, estimate the effect of broadband availability on several indicators of economic activity, including employment, wages and industry mix. The study supports the positive effect of broadband availability on economic growth in many ways. Their results reveal that between 1998 and 2002, employment, the number of businesses overall, and businesses in IT-intensive sectors have experienced more rapid growth. This view is supported by Czernich et al. (2011), who estimate the impact of broadband infrastructure on economic growth in the OECD countries for the period 1996–2007. Their study is based on an Ordinary Least Squares (OLS) estimation, along with fixed effects and random effects. The results show that broadband has a significant impact on economic growth, in that 10 percent broadband penetration led to an increase in the annual per capita growth by 0.9–1.5 percentage points. Ng et al. (2013) confirm these findings for ten countries in the Association of Southeast Asian Nations (ASEAN) for 1998–2011. They find a positive relationship between broadband penetration and economic growth. Their study is based on an Ordinary Least Squares (OLS) estimation, with fixed and random effects. They use the Generalized Method of Moments (GMM) to solve the endogeneity, concluding that broadband penetration is a significant key factor in economic growth in this region. Their result is robust even after controlling for ICT goods importation. In contrast, the study by Jayakar and Park (2013) detect no relationship between broadband expansion and employment levels in a similar study in the United States.

Whitacre et al. (2014) investigate the role of broadband in the economic growth of rural regions over ten years using broadband accessibility and adoption between 2001 and 2010. Results show that elevated quantities of broadband adoption in rural areas increased people’s income during the period of study, but also compromised non-labour development. Likewise, low levels of broadband adoption in rural areas contribute to declines in the range and type of firms and employment rates in the country. Pradhan et al. (2018) find that ICT infrastructure and economic growth are cointegrated, but they did not have any long-term effect in G20 countries for the years 2001–2012. The study employed panel cointegration to find the long-run effect between ICT infrastructure and economic growth. Moreover, the study uses the vector error correction models (VECM) to confirm that an improved ICT infrastructure is important for increasing economic growth and rising per capita GDP.

The results of various studies have shown that ICT investment has a significant impact on economic growth (Edquist 2005; Falk and Biagi 2015; Hanclova et al. 2015). They find that countries investing heavily in ICT in the long run experienced higher growth rates than ICT-importing countries. Kraemer and Dedrick (1994) investigate 12 Asia-Pacific countries to assess the relationship between ICT investment and productivity growth. The study finds a significant relationship between them. Similarly, Dewan and Kraemer (1998) investigate the contributions of ICT to economic output and productivity for 17 developed countries from 1985 to 1992. Their results reveal a significant and positive impact of ICT investment on economic growth in developed countries. This is confirmed in the results reported by Dewan and Kraemer (2000) when they tested 36 countries from 1985 to 1993.

This view is further supported by Dedrick et al. (2013), who estimate the investment of information technology and productivity for 45 developed and developing countries from 1994 to 2000. Their study finds that ICT investment positively impacts productivity and achieves important productivity for higher-income developing countries because they raise their ICT capital stocks. Furthermore, the study reveals that lower-income developing countries have a chance to increase productivity gains from ICT investments by increasing their ICT capital stocks. The study also finds that two country-specific factors moderate the relationship of ICT investment to productivity in developed countries: foreign investment and cellular penetration.

Datta and Agarwal (2004) empirically assess the effects of telecommunication infrastructure on economic growth in 22 OECD countries from 1980 to 1992. By using the panel data model and the fixed effects estimation technique, they determine differences in aggregate production functions for each country. They find some results to be significant and that telecommunication infrastructure is positively correlated with growth in GDP per capita. In another study, Bakhshi and Larsen (2005) investigate the influence of the fast development of ICT on economic growth in the United Kingdom. Results suggest that labour productivity growth improved in the long run by approximately 20–30 percent as a result of implementing

ICT. They also demonstrate that the continued increase in ICT could lead to an increase in the share of investment expenditure of GDP, but this share will only be achieved if the aggregate consumption rate is reduced. They also find that any rise in the return on investment in information and communications technology would in turn elevate the consumption and expenditure rates.

Most studies show a positive impact of ICT investment on economic growth. For example, Oliner and Sichel (2000) analysis of Singapore, Oulton (2002) of 15 European and 4 non-European countries, Daveri (2002) of some EU economies, Jorgenson and Motohashi (2005) of Japan, and Kuppusamy et al. (2009) study of Malaysia, show a positive impact of ICT investment on economic growth. Moreover, Jorgenson and Vu (2007) looked at the annual data for 110 countries, while Venturini (2009) and Seo et al. (2009) investigated 15 European Union countries and the USA in the 1990s. The results of these studies detect a positive impact arising from ICT investment on GDP growth. Similarly, Salahuddin and Gow (2016) detect a positive impact on economic growth in the short- and long-term in South Africa.

A study by Martínez et al. (2010) examines the effect of ICT on the United States economic growth for the period 1980–2004, using a dynamic general equilibrium approach. They employ a production function with three variables of non-ICT assets and another three for ICT assets as capital inputs in the production function. Their results suggest that US productivity growth depends on non-ICT assets (hardware equipment), which accounted for around one-quarter of the total growth during the study period, whereas all ICT assets represented approximately 35 percent of labour productivity.

4.2.3. ICT and Economic Growth Nexus (MENA region)

A few studies have investigated the impact of ICT on economic growth in the MENA region. For example, Sassi and Goaied (2013) investigate the impact of financial development and ICT on economic growth in the region. They examined whether having better ICT infrastructure led to financial development and an increase in economic growth in 17 MENA countries from 1996 to 2010. They did this by applying a dynamic panel model and employing the Generalized Method of Moments (GMM). The results suggest that information technology proxies significantly influence MENA countries' economic growth. Also, the interaction between financial development and ICT penetrations is significantly positive in the growth regression. That means the MENA region can benefit from financial development only with a strong ICT infrastructure in place.

Hodrab et al. (2016) use the Ordinary Least Squares (OLS) method, a random and fixed effects model, to establish the influence of ICT on economic growth during the period 1995–2013 in 18 Arab countries. The results show that there is a positive and significant effect of ICT on economic growth in all these countries. In another study, Niebel (2018) examines the impact of ICT on economic growth in emerging, developed and developing countries. This study included six MENA countries (Egypt, Jordan, Morocco, Tunisia, Iran, and Turkey). The main aim of this study was to investigate whether the earnings from investments in ICT differ between these three types of countries. He used a large sample of 59 countries from 1995 to 2010. The results reveal a positive relationship between ICT capital and GDP growth for all 59 countries. Moreover, the results show that emerging and developing countries did not obtain greater earnings from investments in ICT than developed economies.

A recent study in the MENA region conducted by Mim and Jeguirim (2021) measures the effect of ICT on economic growth for a set of 14 MENA countries. They also use the GMM estimator to control for endogeny. Internet use promotes growth significantly, according to estimation results. Most transmissions are either investment or human capital. This relationship between ICT and growth is not linear and is more intense in countries investing heavily in ICT infrastructure.

The main difference between the current study and the study by Mim and Jeguirim (2021) is that the latter only investigates the direct impact of ICT variables on economic growth on MENA countries, without any consideration of the moderating role of quality of governance on this effect. The current study investigates the direct effect of ICT investment and usage on economic growth. Further, it examines the consequences of the moderating role of quality of governance on the association between ICT investment, usage and economic growth in MENA countries. This is of particular relevance, given that this region suffers from poor governance.

4.3. QUALITY OF GOVERNANCE AND ECONOMIC GROWTH

Numerous studies have examined the impact on the economic growth of the quality of governance, including factors such as corruption, the rule of law, and other governance indicators (Andrianaivo and Kpodar 2011; Vu 2011). Countries with good enforcement of law and a low rate of corruption are expected to have rapid economic growth. A pioneer study that estimated the impact of corruption on economic growth was conducted by Mauro (1995) for 70 countries for the period 1980–1983. He found a negative and significant relationship between corruption and economic growth. Based on the results of Mauro, policies to fight corruption can be considered beneficial to growth:

> "A country that improves its standing on the corruption indicator, say, 6 to 8, (0 being the most corrupt, 10 the least) will experience a 4-percentage point increase in its investment rate and a 0.5 percentage point increase in its annual GDP growth rate" (Mauro 1998, pp 11-14).

Empirical research has concentrated on the impact of poor governance (such as political instability and corruption) on economic growth. There are different ways in which corruption can impact economic growth. It reduces economic growth by changing the pattern of government investment and through directing investment to the interests of corrupt politicians (Mauro 1998). La Porta et al. (1999), Aidt et al. (2008), and Pellegrini and Gerlagh (2004), show that there is a significant negative effect of corruption on economic growth. Furthermore, a study by Campos and Nugent (1999) finds that good governance enhances economic growth. Studies by Kaufmann et al. (1999a, 1999b) argue that good governance is very important for economic growth. In contrast, some other studies have found an insignificant impact of the quality of governance on levels of economic growth. For example, Sachs et al. (2004) report that the importance put on governance reforms in African countries is misguided in terms of its impact on economic growth.

A few studies have examined the impact of government effectiveness on economic growth. Using the Generalized Method of Moments (GMM), Alam et al. (2017) investigate the effect of government effectiveness on economic growth in 81 countries for 2000–2011. The study finds a positive and significant impact of government effectiveness on economic growth. In contrast, a study by Kurtz and Schrank (2007) shows that government effectiveness does not impact economic growth:

> "None of the panels provides support for the hypothesis that governance is a useful predictor of future economic growth. On the other hand, we also estimate a series of alternative basic models, which in no case reduce a positive or significant association between government effectiveness and subsequent growth" (Kurtz and Schrank 2007 , p. 548).

Many studies support the need for economic and political freedom as a condition for a country to achieve economic growth (Miletzki and Broten 2017; Owens 1987; Sen 1999). For example, Aisen and Veiga (2013) explore the effect of political instability on economic growth in 169 countries by applying dynamic panel data (GMM) from 1960–2004. Their study finds evidence that a high level of political instability leads to low economic growth. Furthermore, the results reveal that political instability has a negative effect on the growth of productivity and physical and human capital. Their study also finds that low democracy slightly negatively impacts economic growth.

Some other researchers have shown that democracy has an influential role in economic growth. For example, Tavares and Wacziarg (2001) investigate the effects of democracy on economic growth by using panel data (3SLS) estimates for the years 1970 to 1989 for 65 industrial and developing countries. Their findings demonstrate that a high degree of democracy significantly affects economic growth, particularly through improving human capital and reducing income inequality. Thus, the overall impact of democracy on economic growth is slightly positive. This view is supported by Barro (1996a), who looked at the data of 100 countries for the years 1960 to 1990. The results reveal that maintaining the rule of law, free markets, small government consumption, and high human capital increase economic growth. Once these variables and the initial level of real per capita GDP are held constant, the overall impact of democracy on economic growth is weakly negative. This result suggests that there is a nonlinear relationship in which more democracy increases economic growth at low levels of political freedom but decreases economic growth when a moderate level of political freedom is in place.

4.4. MODERATING IMPACT OF QUALITY OF GOVERNANCE ON ECONOMIC GROWTH

As mentioned earlier, growth theories predict many key drivers, such as labour, capital (investments), and technological progress. ICT plays an important role in technological progress as a dynamic scale of economies by simplifying and improving various economic activities' efficiency and productivity (International Telecommunication Union 2010). Moreover, research by the World Economic Forum[51] demonstrates that a rise in digitisation by 10 percent in a country would turn into a 0.75 percent increase in GDP per capita. However, the nexus between ICT and economic growth is not straightforward. Wang (1999) stresses that

[51] World Economic Forum. The Global Information Technology Report 2013, Digitization for Economic Growth and Job Creation. 2013. Available online: http://www3.weforum.org/docs/WEF_GITR_Report_2013.pdf

the mutually reinforcing relationship between technological innovation and economic growth creates a ‘virtuous circle.’

A limited number of empirical studies have examined the moderating role of governance indicators on the ICT and economic growth nexus. Jin and Cho (2015) examine the effects of corruption of the ICT contribution to economic growth, using cross-sectional and time-series data (1999–2012) in addition to one case study, using Korean national survey data. They find that ICT variables have a direct impact on economic growth. Furthermore, the interaction variable of ICT and corruption has a positive and significant impact on economic growth. In addition, they find that in the case study, policy factors (including corruption) played a significant role in ICT development.

Studies by Sridhar and Sridhar (2007) and Waverman et al. (2005) show the important role of regulatory policies in increasing ICT penetration effectiveness on economic growth in poor and developing countries. The results reveal that ICT penetration reduces the digital divide and empowers citizens to increase productive activities through good regulatory policy, which boosts economic growth.

4.5. QUALITY OF GOVERNANCE INDICATORS

As discussed earlier, the national competitive advantage theory posits that governance indicators help to boost economic growth. This theory indicates that a decline in governance quality will lead to decline in economic growth. Many studies have investigated the moderating effect of governance quality on economic growth. For example, in a study conducted by Gholipour and Farzanegan (2018), institutions' role in environmental protection expenditures in MENA countries was studied, and institutional indicators were shown to reduce air pollution significantly. These results align with Islam and McGillivray (2020), who investigate the moderating effect of governance quality on the relationship between wealth inequality and economic growth for 45 countries between 2000–2012. Results show that the effect of wealth inequality on growth is mitigated by the better quality of governance.

The aforementioned studies all used quality governance indicators to examine the final effect of governance on economic growth. Studies by Humphreys and Banerji (2003) and Martínez-Zarzoso and Márquez-Ramos (2019), show that to enhance governance quality in the MENA region, policymakers should consider implementing a plan that considers all governance indicators. Such a plan should consider accountability and inclusiveness, such as the right to participate in choosing a government, the right to government accountability, the right of expression, the right of equality before the law, and many other citizens' rights (Nabli 2007). Furthermore, the recent empirical literature suggests that the quality of governance promotes the growth effects of ICT investment and usage in developed countries (Cardona et al. 2013; Van Reenen et al. 2010) but remains equivocal in developing countries.

In general, governance is defined as:

> "the traditions and institutions by which authority in a country is exercised … [including] three main dimensions: (a) the process by which governments are selected, monitored and replaced; (b) the capacity of the government to effectively formulate and implement sound policies; and (c) the respect of citizens and the state for the institutions that govern economic and social interactions among them" (Kaufmann, Kraay and Mastruzzi 2011, p. 222).

I follow Kaufmann et al. (2011) to define the quality of governance. Each dimension is divided into two indicators (a and b) as follows[52] :

(1) The process by which governments are selected, monitored and replaced (Transparency):

a.) Voice and accountability (VA): perceptions of the extent to which a country's citizens can participate in choosing their government, as well as freedom of expression, freedom of association, and a free media.

b.) Political stability and absence of violence (PV): perceptions of the likelihood of political instability and/or politically motivated violence.

(2) The capacity of the government to effectively formulate and implement sound policies (Efficiency):

a.) Government effectiveness (GE): perceptions of the quality of public services, the quality of the civil/public service and the degree of its independence from political pressures, quality of policy formulation and implementation, and credibility of the government's commitment to such policies.

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[52] The definitions have been derived from the Worldwide Governance Indicators (WGI) of the World Bank. See http://info.worldbank.org/governance/wgi/index.aspx#home.

b.) Regulatory quality (RQ): perceptions of the government's ability to formulate and implement sound policies and regulations that permit and promote private sector development.

(3) The respect of citizens and the state for the institutions that govern economic and social interactions among them (Responsiveness):

a.) Rule of law (RL): perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

b.) Control of corruption (CC): perceptions of the extent to which public power is exercised for private gain or advantage, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests.

The WGI aggregate indicators assemble the perspectives of a large number of organisations, citizens, and experts around the world. The data comes from 32 different sources, such as research institutes, non-governmental organisations, think tanks, and private sector firms. The WGI is the only index that has measured the quality of governance in these countries for more than 15 years (Kaufmann et al. 2009). Estimation with a mean of zero and a standard deviation of one is normally distributed throughout the years of measurement. In short, nearly all scores are located between -2.5 and 2.5, with higher scores representing better outcomes. More details can be found in Kaufmann and Kraay (2007). The WGI scores have reflected changes in government policies over time. For example, governments such as those in Bahrain and Oman have seen their governance quality diminish. In contrast, Qatar and the United Arab Emirates have seen their governance quality rise in the previous fifteen years. Governance quality indicators as measured by the WGI scores are confirmed even further since donor nations and international organisations depend on these indicators when assessing the governing quality of recipient nations (Thomas 2010).

One or two governance indicators cannot adequately measure the real effect of governance in the MENA region. All indicators should be weighed to find which has the greatest effect on economic growth. Therefore, the current study investigates the influence of all governance indicators on economic growth. These indicators assess the moderating role of the average of six governance indicators (GOV) and the efficiency of governance such as (GE and RQ). Furthermore, the transparency such as (PV and VA). Finally, the responsiveness such as (CC and RL) on the impact of ICT usage on economic growth in MENA countries.

4.6. THE SHORTCOMINGS OF PREVIOUS STUDIES

To date, there is limited and ambiguous empirical evidence on the contribution of ICT investment and usage to economic growth for developing countries. Notwithstanding this, the World Bank (2012)[53] suggested optimistically that "information and communication technology (ICT) has great promise to reduce poverty, increase productivity, boost economic growth, and improve accountability and governance."

There may be reasons behind the different impact of ICT on economic growth between developing and developed countries. To clarify, developing countries might have a shortage of human capital or research and development expenditure, meaning that developing countries earn less than developed countries from ICT investment and usage. However, according to Steinmueller (2001), ICT provides the tools to lead developing countries to leap to another level of productivity. That is, ICT might reduce transaction expenses and speed up ways of collecting information and creating knowledge.

Notwithstanding the previous discussion on the literature, to the best of my knowledge, there have been few studies that explained how the quality of governance affects the relationship between ICT investment and usage on economic growth. A summary of previous empirical studies on the nexus between ICT and economic growth is presented in Table 4.1, followed by a summary of the results of ICT in prior studies, in terms of direction and components of ICT, in Table 4.2. While the direct relationship between ICT and economic growth has been studied extensively, there are few studies that investigate the role of governance in the effect of ICT on economic growth. The existing studies measured a maximum of one or two quality governance indicators or the average of six governance indicators and their impact on ICT and economic growth. Importantly, this study considers the impact of all governance indicators on the nexus between ICT investment and usage and economic growth in MENA countries. This is of particular relevance given that the MENA region suffers from poor governance. As far as I am aware, the current study is the first attempt to empirically examine the moderating role of the quality of governance in the effect of ICT investment and usage on economic growth in MENA countries. It asks whether the quality of

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[53] See http://documents.worldbank.org/curated/en/105121468149370524/Information-and-Communication-Technology-ICT-for-greater-development-impact-World-Bank-Group-strategy-for-ICT

the governance matters for the relationship between ICT investment and usage and economic growth in the MENA region.

It is worth remembering that many studies have investigated the relationship between ICT and economic growth in developed countries (Castaldo et al. 2018; Niebel 2018; Pradhan et al. 2018; among others), but there is a lack of studies on this topic for the MENA region. Hence, there is a research gap that needs to be filled by focusing on and investigating this region. This is important, because, globally many countries are taking advantage of ICT adoption for their economic growth. Consequently, this study articulates another important gap in the literature, which is to ask whether ICT investment and usage affect economic growth in MENA countries. Moreover, it investigates what is the moderating role of governance quality in the relationship between ICT investment and usage on economic growth in MENA countries.

Table 4.1: ICT and Economic Growth – Literature Review Summary.

Authors	Sample	Period	Variables	Methodology	Results
Madden and Savage (1998)	27 Central and Eastern European countries	1990 to 1995	Telecommunications infrastructure investment (as a percentage of GDP)	OLS approach	Positive impact of investment on economic growth.
Dewan and Kraemer (1998)	36 countries (developed and developing)	1965 to 1994	IT Investment	OLS approach	Positive impact in developed countries and insignificant in developing countries.
Thompson Jr and Garbacz (2007)[54]	93 countries	1995 to 2003	Internet users per 1000 people; Mobile phone subscribers per 1000 people; Mainlines per 1000 people	2SLS approach	Positive and significant impact, especially in low-income countries.
Martínez et al. (2010)	United States	1980 to 2004	Non-ICT assets and ICT assets	Dynamic general equilibrium approach	Positive impact of non-ICT assets.
Oulton (2012)	15 European and 4 non-European countries	1970 to 2007	Computers, software and communications equipment	Two sectors involving growth accounting	Positive long-run relationship between ICT investment and economic growth.
Kumar and Vu (2014)	Vietnam	1980 to 2012	Internet users	ARDL and Granger causality	Positive impact and unidirectional trend from ICT and capital per worker to remittances.

[54] Thompson Jr and Garbacz (2007) study contians 7 MENA countries; Egypt, Iran, Israel, Jordan, Morocco, Tunisa, and Turkey.

Table 4.1 (continued): ICT and Economic Growth – Literature Review Summary.

Authors	Sample	Period	Variables	Methodology	Results
Salahuddin and Gow (2016)	South Africa	1991 to 2012	Internet usage	ARDL and DOLS approaches	Positive impact of ICT usage on economic growth.
Hodrab et al. (2016)	18 MENA (Arab Countries)	1995 to 2013	Internet usage and ICT investment	OLS approach	Positive and significant effect of ICT on economic growth.
Castaldo et al. (2018)	23 OECD countries	1970 to 1990	Main lines per capita and investment in telecommunications infrastructure	GMM and 2SLS approach	Positive relationship between economic growth and broadband prevalence in the long and short term.
Pradhan et al. (2018)	G20 countries	2001 to 2012	ICT infrastructure	VECM approach	ICT infrastructure and economic growth are cointegrated.
Niebel (2018)[55]	59 developed and developing countries	1995 to 2010	ICT investment	POLS approach	Positive relationship between ICT investment and GDP growth for all 59 countries.
Cheng et al. (2021)	72 countries	GDP per capita growth	Mobile subscribers (per 100 people); individuals using the Internet (as a percentage of population); secure internet servers (per 1 million people)	GMM approach	ICT diffusion can improve economic growth in high-income countries, but the effect is ambiguous in the middle- & low-income countries. The interaction effects of ICT and finance can reduce the negative effects of financial development, but the effects are only significant for high-income countries.

Notes: OLS: Ordinary Least Square; 2SLS: Two-Stage Least Squares; DOLS: Dynamic Ordinary Least Squares; GMM: Generalized Method of Moments; VECM: Vector Error Correction Models; POLS: Pooled Ordinary Least Square.

[55] Niebel (2018) study included 6 MENA countries; Egypt, Jordan, Morocco, Tunisa, Iran and Turkey.

Table 4.2: Summary of the Impact of ICT on Economic Growth in Prior Studies.

Note that (+) significantly positive ;(-) significantly negative; (NS) insignificant.

ICT Indicators	Reported sign	Empirical Studies
Usage	(+)	Vu (2011, 2013), Evangelista et al. (2014), Kumar and Vu (2014), Salahuddin and Gow (2016)
	(-)	Thompson Jr and Garbacz (2007)
Accessibility	(+)	Czernich et al. (2011)
	NS	Evangelista et al. (2014)
ICT imports	(+)	Sassi and Goaied (2013)
Mobile phones	(+)	Thompson Jr and Garbacz (2007), Sassi and Goaied (2013)
	(-)	Vu (2011)
ICT Investment	(+)	Dewan and Kraemer (1998), Dewan and Kraemer (2000), Roller and Waverman (2001), Koutroumpis (2009), Venturini (2009), Seo et al. (2009), Niebel (2018)
	(NS)	Dewan and Kraemer (2000), Pohjola (2002)
Fixed Broadband	(+)	Castaldo et al. (2018)
Personal Computer	(+)	Vu (2011)
Telecom Lines per 100 inhabitants	(+)	Datta and Agarwal (2004)
Broadband infrastructure	(+)	Koutroumpis (2009), Kolko (2012)
Fixed telephones	(+)	Thompson Jr and Garbacz (2007)

4.7. THE HYPOTHESES

As noted earlier in this chapter, based on the gaps in the previous literature, the main research hypotheses of this thesis are about the impact of ICT investment and usage on economic growth in the MENA countries. Furthermore, it investigates whether there is a moderating impact of the quality of the governance on the association between ICT variables and economic growth in the MENA countries. A few studies have studied the role of governance indicators on ICT, such as Albiman and Sulong (2016), who examine the effect of ICT on economic growth in the sub-Saharan African region between 1990 and 2014. They find that governance quality is an important factor to ICT, and it acts as a channel through which ICT makes a huge contribution to economic growth. Another study by Jin and Cho (2015) finds a positive relationship between governance and ICT that ultimately contributes to economic growth in 128 countries. Lio et al. (2011) examine a panel of 70 countries for the years 1998–2005; these countries included five MENA countries (Israel, Tunisia, Jordan, Turkey, and Egypt). They employ a Granger causality test and dynamic panel data (DPD) models to fix the problem of endogeneity. Their results reveal a bi-directional causality between corruption and ICT variable, namely internet adoption. Their results also show that internet adoption significantly reduces corruption, but not enough to eliminate it.

In this study, I evaluate the impact of governance quality indicators on the association between ICT investment and usage and economic growth in MENA countries. Consequently, my main hypotheses are:

H1: ICT investment and usage positively affect economic growth in MENA countries.

H2: Higher quality of governance improves the effectiveness of ICT investment and usage and leads to economic growth in the MENA countries.

As discussed earlier, the current study use data from the Worldwide Governance Indicators (WGI) of the World Bank, which have been widely applied in the relevant empirical literature in the institution and economic growth (e.g. Gholipour and Farzanegan 2018; Islam and McGillivray 2020). The other study hypotheses elaborate on the moderating role of components of governance indicator in the impact of ICT investment and usage on economic growth in the MENA countries. Therefore, the sub-hypotheses of H2 are as follows:

H2.1: Higher level of Control of Corruption (CC) improves the effectiveness of ICT investment and usage and therefore leads to higher economic growth in the MENA countries

H2.2: Higher level of Government Effectiveness (GE) improves the effectiveness of ICT investment and usage and therefore leads to higher economic growth in the MENA countries.

H2.3: Higher level of Rule of Law (RL) improves the effectiveness of ICT investment and usage and therefore leads to higher economic growth in the MENA countries.

H2.4: Higher level of Regulatory Quality (RQ) improves the effectiveness of ICT investment and usage and therefore leads to higher economic growth in the MENA countries.

H2.5: Higher level of Political Stability and Absence of Violence (PV) improves the effectiveness of ICT investment and usage and therefore leads to higher economic growth in the MENA countries.

H2.6: Higher level of Voice and Accountability (VA) improves the effectiveness of ICT investment and usage and therefore leads to higher economic growth in the MENA countries.

4.8. CONCLUDING REMARKS

This chapter reviews the empirical literature on the ICT and economic growth nexus, the effects of governance quality on economic growth, and the moderating impact of governance quality on economic growth. More importantly, the shortcomings of previous empirical studies were identified to show the research gap that needs to be addressed.

Most previous empirical studies have investigated the role of governance in the effect of ICT on economic growth using one or two variables of governance quality. Consequently, there is a lack of studies that have investigated the effect of all governance quality variables on the ICT–economic growth nexus. In contrast, this study takes into account the effect of all governance quality variables on the association between ICT and economic growth in the MENA region. To the best of my knowledge, this study is the first to empirically examine the moderating role of the quality of governance in the effect of ICT investment and usage on economic growth in MENA countries by using all governance indicators and their averages. Moreover, while previous studies have examined the ICT and economic growth nexus in developed countries, there is no research in the context of MENA countries. This study empirically examines how ICT investment and usage affect economic growth in MENA countries.

In summary, this study investigates the effects of ICT investment and usage on economic growth in 16 MENA countries and examine how these effects vary with the quality of governance levels in these countries. It is known that ICT investment and usage, and the quality of governance can have a long-run impact on economic growth; that has been proven through previous studies, which have found that ICT has a positive impact on economic growth in developed countries (Kumar et al. 2018; Kumar and Vu 2014). To date, however, there is limited empirical evidence on the contribution of ICT investment and usage to economic growth for developing countries. This motivates the consideration of estimating the effect of ICT on economic growth and whether these effects in these countries depend on the level of quality of governance.

In the following chapter, I endeavour to explain the research methodology used in this study. The variables, the country sample, and the period of study are discussed in that chapter. I will then explain the methodology applied in this study and present the initial tests to be applied and verified before choosing the appropriate method.

CHAPTER 5: DATA AND RESEARCH METHODOLOGY

5.1. INTRODUCTION

This chapter discusses the methodology employed in this thesis, the selected variables, the country sample, the period of study, and the data sources. Section 5.1 presents the data description. Section 5.2 presents the variables that will be used in this study, Section 5.3 explains the methodology, and Section 5.4 presents the initial testing before choosing the model. Section 5.5 shows the model selection to test the main research hypothesis. Finally, Section 5.6 sheds light on the model specifications.

5.2. DATA DESCRIPTION

This study uses annual data over the period 1995–2018 for the 16 MENA countries. In 1995, the MENA countries witnessed the introduction of ICT. Therefore, the initial point for computing ICT variables in the MENA region is 1995.

The list of countries is based on the World Bank's (2019) definition and the sample covers all those MENA countries for which data on all variables is obtainable: Algeria, Bahrain, Egypt, Iran, Israel, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Tunisia, Turkey, and the United Arab Emirates. This study uses unbalanced panel data, mainly due to some missing observations on ICT variables. The data are collected from various sources, including the World Development Indicators (WDI) of the World Bank, Worldwide Governance Indicators (WGI) of the World Bank, Euromonitor International database, and the International Telecommunication Union (ITU). Table 5.1 shows the data sources and definitions of variables.

5.3. VARIABLES OF THE STUDY

5.3.1. Dependent Variable: Economic Growth

The dependent variable in this study is economic growth. This study uses real GDP growth as a measure of economic growth. The real GDP growth is the key variable that indicates productivity and evaluate the country's growth and progress (Jin and Cho 2015). The data for economic growth is sourced from the World Bank development indicators database (WDI).

5.3.2. Variables of Interest: ICT Variables

5.3.2.1. ICT Usage

For this variable, this study uses three proxies for measuring the effect of ICT usage on economic growth: the number of individuals using the internet as a percentage of population (*USAGE*), proportion of households with internet access at home as a percentage of population (*ACCESS*), and mobile cellular subscriptions per 100 people (*MOB*). These variables are widely used in the relevant empirical literature in ICT and economic growth, such as those by Cheng et al. (2021), Dedrick et al. (2013), Evangelista et al. (2014), Oulton (2012), and Yousefi (2011), among others. In addition, these variables are selected based on the availability of data. The data for these variables are sourced from the International Telecommunication Union (ITU) database as well as from the Euromonitor International database.

5.3.2.2. ICT Investment

This study employs capital investment in telecommunications as a percentage of GDP (INV) to measure the effect of ICT investment on economic growth. This variable is obtained from the Euromonitor International (2020) database. Capital investment in telecommunications includes the expenditure associated with telecommunications equipment infrastructure (such as computer software, hardware, mobile phone infrastructure, internet cables, expenditure on initial telecommunications installations, and additions to existing telecommunications installations). This variable is the most relevant one to analyse the effect of ICT investment on economic growth (subject to data availability).

ICT investment is expected to affect economic growth positively, by opening new channels between the countries, opening new markets and increasing the information and communication technology flow among them. Further, ICT investment helps to expand the boundaries of internal markets. Roller and Waverman (2001) reported that one-third of output growth in OECD countries from 1970 to 1990 was due to the rise in telecommunications investment. The data on ICT investment is obtained from the Euromonitor International (2020) database.

5.3.3. Moderator Variables: Governance Indicators

As explained in Chapter 4, there is no standard definition for governance, but most scholars believe governance encompasses several characteristics that link the public and private sectors (e.g. Hyden et al. 2004; Neumayer 2003). In this study, I follow the World Bank's recommendations and assess three measures: transparency, efficiency, and responsiveness (Grindle 2004). Transparency can be fostered by mechanisms that allow citizens to monitor the allocation of resources; inclusion, accountability, and transparency are all covered under this measure. Efficiency includes a well-organised constitutional framework and is present when projects and policies are implemented as quickly as possible with a well-organised regulatory framework in place, along with fair competition and legal securities (Kaufmann et al. 2006). Responsiveness is where citizens have a say in how their government allocates resources, such as goods and services, because this ensures that the government will act in the best interests of the people.

To operationalise these criteria, this study uses six indicators for institutions: Control of Corruption (CC), Government Effectiveness (GE), Rule of Law (RL), Regulatory Quality (RQ), Political Stability and Absence of Violence (PV), and Voice and Accountability (VA), as explained in Chapter 4. Furthermore, I create a new indicator, which measures the average of six indicators of the quality of governance (GOV). The data for these indicators come from 32 different sources, including research institutes, non-governmental organisations, and private sector firms. These indicators have scores ranging approximately from -2.5 to +2.5 (worst governance and best governance, respectively). The quality of governance indicators is based on data from the Euromonitor International (2020) database.[56]

This study will run the regression analysis with each of the indicators separately. Because we cannot conclusively decide which facet of governance is the most important for the MENA region, all indicators must be considered in order to determine which have an impact on economic growth in the MENA region.

5.3.4. Control Variables

The main control variables chosen in this study are the important determinants of economic growth that have been utilised in the related studies. Based on the endogenous growth model,

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[56] The indicators rely on the 32 sources created by a set of survey institutes. Please see http://info.worldbank.org/governance/wgi/index.aspx#home.

as discussed in Chapter 3, this study includes the major drivers of economic growth: capital (K) and Labour (L).

This study uses the labour force as a percentage of the population (LF) as a measure for labour (L). The expected sign of the effect of the labour force is positive, as this variable may raise the efficient employment of technology and accessibility to ICT tools (Romer 1990; Wamboye et al. 2016), and based on the endogenous theories, the expected sign of the effect of human capital on economic growth is positive. Furthermore, this uses gross fixed capital formation as a percentage of GDP (GFCF) as a measure of capital (K). Lastly, I consider trade openness as a percentage of GDP (TRADE). According to Freund and Weinhold (2002), trade openness has a positive effect on economic growth; specifically, it allows the exchange of technology between the countries, leading to enhanced domestic production, which in turn leads to improved economic growth. This variable is also one of the main robust predictors of economic growth (Sala-i-Martin 1997). This proxy has been confirmed by Asteriou and Spanos (2019), who find that trade openness is the leading determinant of economic growth for a sample of 26 European countries. The data for TRADE was obtained from the World Bank database. The LF and GFCF were obtained from the Euromonitor International database.

This study also considers the Arab Spring (DSPRING), which may have affected economic growth in the MENA region, especially during the period of this study—for instance, one may argue that civil wars reduce economic growth in neighbouring countries. Therefore, the Arab Spring is included in order to control the potential externality effect. I construct a dummy for the Arab Spring, which equals 1 in 2011 and onwards, and 0 for years before 2011. Table 5.1 provides a summary of variable definitions and data sources.

Table 5.1: Summary of Variable Definitions and Data Sources.

Variables	Description	Definition	Sources	Expected Sign
RGDPG	Real GDP Growth	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.	World Bank (2020)	
USAGE	Individuals Using the Internet (as a percentage of the population)	Internet users are individuals who have used the internet (from any location) in the last 3 months. The internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV, etc. (as a percentage of the population).	World Bank (2020)	+
ACCESS	Households with Internet Access at home (as a percentage of population)	This indicator estimates survey data corresponding to the proportion of households with the internet. Access is not assumed to be only via a computer—it may also be by mobile phone, game machines, digital TV, etc. (as a percentage of the population).	International Telecommunication Union (2020)	+
MOB	Mobile Cellular Subscriptions (per 100 people)	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provides access to the PSTN using cellular technology. The indicator includes (and is split into) the number of post-paid subscriptions and the number of active prepaid accounts (i.e., that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging, and telemetry services.	World Bank (2020)	+
INV	Capital Investment in Telecommunications (as a percentage of GDP)	Refers to expenditure associated with the ownership of telecommunications equipment infrastructure (including supporting land and buildings and intellectual and non-tangible property, such as computer software). These include expenditure on initial installations and additions to existing installations (as a percentage of GDP).	Euromonitor International (2020)	+

Table 5.1 (continued): Summary of Variable Definitions and Data Sources.

Variables	Description	Definition	Sources	Expected Sign
GOV	Quality of Governance	The average of six indicators of the quality of governance: voice and accountability (VA), political stability and absence of violence (PV), government effectiveness (GE), regulatory quality (RQ), rule of law (RL), and control of corruption (CC).	Author's calculation	+
CC	Control of Corruption indicator	Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests.	Euromonitor International (2020)	+
GE	Government Effectiveness indicator	Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	Euromonitor International (2020)	+
RL	Rule of Law indicator	Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	Euromonitor International (2020)	+
RQ	Regulatory Quality indicator	Regulatory quality captures perceptions of the government's ability to formulate and implement sound policies and regulations that permit and promote private sector development.	Euromonitor International (2020)	+
PV	Political stability and Absence of violence indicator	Political stability and Absence of violence measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism.	Euromonitor International (2020)	+
VA	Voice and Accountability indicator	Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.	Euromonitor International (2020)	+

Table 5.1 (continued): Summary of Variable Definitions and Data Sources.

Variables	Description	Definition	Sources	Expected Sign
LF	Labour Force Participation Rate (as a percentage of population)	All persons aged 15–64 who furnish the supply of labour for the production of economic goods and services (employed and unemployed, including those seeking work for the first time), during a specified time reference period as a percentage of the population aged 15–64. In Passport Cities data, labour force participation rate refers to the total labour force as a percentage of the population age 15–64.	Euromonitor International (2020)	+
GFCF	Gross Fixed Capital Formation (as a percentage of GDP)	Includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.	Euromonitor International (2020)	+
TRADE	Trade Openness (as a percentage of GDP)	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product (as a percentage of GDP).	World Bank (2020)	+

5.4. ESTIMATION PROCEDURE

In this section of the study, I briefly review the general framework of panel data to test the relationship between explanatory variables and economic growth. First, I discuss the initial tests that will be applied before employing the study model. After that, I elaborate on the panel ARDL model developed by Pesaran et al. (1999).

Panel data analysis has become widely used in economic literature in recent years. A panel data technique is used when the data contain time-series observations of several individuals. Panel data observations should incorporate a time-series dimension (t) and a cross-sectional dimension (i) (Hsiao 2007). According to Baltagi (2008), panel data is a pooling of observations on a cross-section for many time periods.

Hsiao (2014) and Baltagi (2008) point out that there are several advantages to applying panel data over time-series and cross-sectional data. The first advantage of panel data is the ability to control for country and time variables, while cross-sectional and time-series studies cannot (Baltagi 2008). Also, panel data methods can control heterogeneity, and the cross-sectional and time-series studies are not able to do so, leading to biased results. For example, panel data allows the researcher to find unobserved time-invariant and country-specific fixed effects, such as cultural, religious, and climate factors, etc., while cross-sectional and time-series studies cannot. Second, panel studies generate more informative data, have a greater degree of freedom, less collinearity among the variables, more variability, and more efficiency. This data structure permits researchers to produce more reliable parameter estimates. Third, panel data makes it possible to investigate the dynamics of adjustment, unlike cross-sectional distributions, which are relatively stable but may hide many changes. Hence, panel data are better suited to the speed of adjustments on economic policy changes. Fourth, panel data are better suited to demonstrate effects that cannot simply be discovered using time-series or cross-sectional data. Finally, panel data models make it possible for researchers to test and build better complicated behavioural models than time-series or cross-sectional data.

A panel data regression is a combination of a cross-section and a time-series, which has subscript i and t at the same time on its variables, i.e.

$$Y_{it} = \alpha_i + X_{it}\beta + u_{it} \qquad i = 1, \dots\dots, N; t = 1, \dots\dots, T \qquad (5.1)$$

Where i indicates countries and t indicates time. The i subscript, therefore, represents the cross-section dimension, whereas t is the time-series dimension. β is $K \times 1$ and X_{it} is the it the observation on K explanatory variables.

My empirical analysis includes three steps: (1) checking the order of integration of the data, (2) testing panel cointegration, and (3) estimating the short-run and long-run coefficients using the ARDL method. The steps are described as follows: Panel unit root test in Section 5.3.1, Panel co-integration test in Sections 5.3.2, and Lag-length selection test in Section 5.3.3, to find the appropriate number of lags for the variables in the ARDL model.

5.4.1. The Panel Unit Root Test

To avoid the problem of spurious regression[57], which gives noneconomic, unreal, and vague explanations (Wang and Hafner 2017), the panel unit root test is applied first to test the stationarity of the variables. This section discusses an assortment of panel unit root tests, taking into account the sample dimensions as well as the asymptotic properties of the following tests: the Breitung (2001), Hadri (2000) and Levin et al. (2002) test, the Im et al. (2003) test, and also the test by Choi (2001). This section will then present the main differences between the panel unit root tests, and choose the most appropriate test for the study sample, as shown in the following equation:

$$y_{it} = \rho_i y_{it-1} + \delta_i X_{it} + \varepsilon_{it} \tag{5.2}$$

where (i) refers to the country; (t) is the time series; X_{it} are the explanatory variables including individual deterministic effects[58] ; ρ_i refers to the (AR) coefficients; and ε_{it} refers to the error terms. If $\rho_i < 1$, y_{it} reflects a weak stationary trend, whereas $\rho_i = 1$, then y_{it} has a unit root. The Maddala and Wu (1999), Breitung (2001), and Choi (2001) Fisher-ADF statistic tests, as well as Levin et al. (2002), propose that the panel data has no unit root under the null hypothesis. Meanwhile, Hadri (2000) assumed that all the panels are stationary with the null hypothesis.

Levin et al. (2002) suggest a Levin, Lin and Chu (LLC) test. This test is an extension of the Augmented Dickey-Fuller (ADF) test.

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[57] For more details please see Kao (1999).

[58] Note: deterministic effects represent a fixed effect and the individual time trend.

$$\Delta y_{it} = \alpha_i y_{i,t-1} + \sum_{j=1}^{\rho i} \beta_{ij} \Delta y_{i,t-j} + \delta_i X_{it} + \varepsilon_{it} \tag{5.3}$$

Due to the fact that the lag length (ρ_i) is anonymous, Levin et al. (2002) indicate the following types of procedures for it: the first type is to execute separate ADF regressions for every individual, differentiating the lag order of the different terms, as (ρ_i) is generally decided on to correct for serial correlation; the second type is to measure the innovation standard deviation ratio in two terms—long and short term for every individual. The last type is to calculate the pooled t-statistics and the average of the lag length and observations for each individual. Through this test, the null hypothesis supposes for the common unit root ($\alpha_i = \rho_i - 1 = 0$), and the alternative hypothesis is ($\alpha_i < 0$). However, to test these hypotheses, they must be homogeneous across all individuals by restricting the AR coefficient. The pooled t-statistic is the best test as the common unit root for moderate-sized panels like this study (N=16 and T=24) because it includes the limiting of the normal distribution for the null hypothesis.

Im et al. (2003) improved the Levin, Lin and Chu (LLC) test by adding heterogeneity characteristics to autoregressive coefficients. This test measures the individual ADF regressions and then collects all these details to carry out a panel unit root. The LLC method permits for various criteria for their coefficients (α_i =cross-sectional). Using the ADF test for the individual unit root (T-bar statistic), the test estimates depend on the coefficient α if it is non-stationary under the null hypothesis ($\alpha_i = 0$ across all individuals (i), versus the alternative hypothesis ($\alpha_i < 0$) if at least one series is stationary). The previous tests—LLC and IPS—proposed by Levin et al. (2002) and Im et al. (2003) should be N < T, and the LLC test also requires a strongly balanced panel to apply this test.

Breitung (2001) used the Monte Carlo test to prove the sensitivity of the LLC and IPS tests to the deterministic components, such as inserting individual trends. He furthermore proposed testing a common unit root test.

Both Maddala and Wu (1999) and Choi (2001) applied the non-parametric tests (Fisher tests). The major advantage of Fisher is in collecting the p-value of the root unit tests for every cross-section, instead of the average test statistics. The Fisher evaluations are usually executed with respective Phillips-Perron or even Augmented Dickey-Fuller unit root tests; their asymptotic distribution follows a chi-square (P-test) as well. Choi (2001) also indicated various Fisher-type statistic that follows the normal distribution (Z-test). Both the IPS and Fisher-type evaluations unite information of individual unit root tests. However, simulation studies show that Fisher evaluations have improved the power of properties over the IPS evaluation. The disadvantages of the Fisher-type assessments relate to the need to derive p-values by simulating the Monte Carlo test.

Hadri (2000) suggested the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test, which depends on the Lagrange multiplier (LM) test. The calculation of the LM statistic is determined by the residuals of OLS regressions in both constant and trend, and these are known as deterministic components. This evaluation is completely different from the previous evaluations because this evaluation's null hypothesis supposes that all panels are stationary (H0 = there is no unit root), and the alternative hypothesis supposes that the panels are non-stationary (H1 = there is a unit root).

The main problem with all the previous tests is the presumption that all data is independent, and they also have cross-sectional independence per individual. However, from a practical point of view, this is impossible, because it follows that the moves of variables through time are independent or constant across the sample. This issue ought to be assessed on a case by case basis.[59] Pesaran (2021) and a Breusch-Pagan LM statistic (for T>N) to test the cross-sectional dependence should be performed.

Banerjee et al. (2005) indicate that the first-generation tests are sometimes performed poorly because of their size deformations, especially if there is cross-sectional dependence. This usually leads to non-stationarity and rejects the null hypothesis as common across individuals. This has resulted in the evolution of the panel unit root test from the first-generation tests to the second-generation tests (cross-sectional dependence). Pesaran (2007) proposed a simple system to eliminate the effects of cross-sectional dependence by strengthening the Augmented Dickey-Fuller regression with the average cross-sectional of lagged levels and first differences of series. After that, one can use the cross-sectional Augmented Dickey-Fuller statistics to improve the methods of the panel unit root tests, as with

[59] Levin, Lin & Chu (2002) suggest 'demeaning' the data in order to attenuate the biases caused by the presence of cross-sectional dependence, which involves subtracting cross-sectional averages (for each time period) from the series before the use of unit root tests. Nonetheless, this procedure cannot ensure the successful elimination of the bias.

previous tests (e.g., the IPS test, the Fisher test). Table 5.2 below summarises the types and traits of Panel Unit Root Tests.

Table 5.2: Types and Traits of Panel Unit Root Tests.

Test	Null Hypothesis	Alternative Hypothesis
LLC	Unit Root	No Unit Root
Breitung	Unit Root	No Unit Root
IPS	Unit Root	No Unit Root
Fisher	Unit Root	No Unit Root
Hadri	No Unit Root	Unit Root
Pesaran	Unit Root	No Unit Root

Source: Baltagi (2008).

This study starts with a panel unit root test to examine the stationarity of the data. Since the study datasets are unbalanced panel, I perform the IPS unit root test (developed by Im et al. 2003). Unlike other panel unit root tests, the IPS test does not require balanced datasets. Moreover, the IPS test relaxes the assumption that all panels share a common autoregressive parameter. Relaxation of this assumption is important for our panel because we have countries with different cultural and institutional contexts—e.g., Israel has a good quality of institutions, whereas Sudan has a poor quality of institutions, according to Hofstede (2011). The null hypothesis of the IPS test is that all panels contain a unit root.

5.4.2. The Panel Cointegration Test

This section discusses the panel cointegration test proposed by Pedroni (1999, 2004). This test takes into account the heterogeneity in the dynamics and variations of errors in panel data. Further, it allows for the interdependence (cross-section) of a different individual effect, as follows:

$$Y_{i,t} = \alpha_{it} + \delta_i t + \gamma_{1i} X_{i,t} + \gamma_{2i} X_{i,t} + \gamma_{3i} X_{i,t} \dots . + \gamma_{mi} X_{mi,t} + \varepsilon_{i,t} \qquad (5.4)$$

where, $Y_{i,t}, X_{i,t}$ are variables stationary of order one for members $i = 1, \dots \dots, N; t = 1, \dots \dots, T; m = 1, \dots \dots M$.

Where i refers to the country, t is the time series, and m is the number of independent variables. The α_{it} the parameter represents the fixed effects and the second parameter δ_i

represents deterministic trends that are country-specific. $\varepsilon_{i,t}$ indicates the estimated error term and the deviations from the long-run relationship. Where the H_0 = no-cointegration, $\rho_i = 1$. To test the null hypothesis and to find the unit root test see the below equation:

$$\varepsilon_{i,t} = \rho_i \varepsilon_{i,t-1} + w_{i,t} \quad (5.5)$$

Pedroni (1999, 2004) suggested two types of cointegration testing. The first test is based on the panel cointegration statistics (i.e., inside dimension approach), which has four statistics: i) panel v-statistic; ii) panel ρ-statistic; iii) panel PP-statistic; and iv) panel ADF-statistic. These statistics are a collection of autoregressive coefficients between different countries to estimate residuals by using unit root tests. Also, it takes into account common time factors and heterogeneity between the countries.

The panel unit root tests suggested above are used to test the degree of integration. If primary variables can be seen to be stationary at order one, then we must utilise panel cointegration tests to tackle the non-stationarity of this sequence.

Out of the seven tests previously mentioned, the panel v-statistic is a one-sided test where large positive values reject the null hypothesis of no cointegration, whereas large negative values for the remaining test statistics reject the null hypothesis of no cointegration. Therefore, this study uses the below group and panel statistics.

Panel v-statistic:

$$X_v \equiv \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{K}^{-2}{}_{11i} \, \hat{w}_{i,t-1} \right)^{-1} \quad (5.6)$$

Panel ρ-statistics:

$$X_\rho \equiv \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{K}^{-2}{}_{11i} \, \hat{w}_{i,t-1} \right)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{K}^{-2}{}_{11i} \left(\hat{w}_{i,t-1} \, \Delta \, \hat{w}_{i,t} - \hat{\lambda}_i \right) \quad (5.7)$$

Panel PP-statistic:

$$X_t \equiv \left(\sigma^2 \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{K}^{-2}{}_{11i} \, \hat{w}^2_{i,t-1} \right)^{-1/2} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{K}^{-2}{}_{11i} \left(\hat{w}_{i,t-1} \, \Delta \, \hat{w}_{i,t} - \hat{\lambda}_i \right) \right) \quad (5.8)$$

Panel ADF-statistic:

$$X_t^* \equiv \left(s^{*2} \sum_{i=1}^{N} \sum_{t=1}^{T} \widehat{K}^{-2}{}_{11i}\, \widehat{w}_{i,t-1}^{*2} \right)^{-1/2} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \widehat{K}^{-2}{}_{11i} \left(\widehat{w^*}_{i,t-1}\, \Delta\, \widehat{w^*}_{i,t} \right) \right) \tag{5.9}$$

In Pedroni (1999) tests, $\widehat{w}_{i,t}$ residuals are estimated from (5.7) and K_{11i}^2 estimates the long-run covariance matrix for it $\Delta\widehat{w}_{i,t}$.

The second type of panel test is the group tests (i.e., group mean panel cointegration statistics) based on the three statistic groups: group ρ-statistic, group PP-statistic, and group ADF-statistics. These types of statistics are based on averages of the individual autoregressive coefficients associated with the unit root tests of the residuals for each country in the panel.

Group ρ-statistics:

$$\tilde{X}_\rho \equiv \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \widehat{w}^2{}_{i,t-1} \right)^{-1} \sum_{t=1}^{T} \left(\widehat{w}_{i,t-1}\, \Delta\, \widehat{w}_{i,t} - \hat{\lambda}_{i,t} \right) \tag{5.10}$$

Group PP-statistics:

$$\tilde{X}_t \equiv \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \sigma^2 \widehat{w}^2{}_{i,t-1} \right)^{-1/2} \sum_{t=1}^{T} (\widehat{w}_{i,t-1}\, \Delta\, \widehat{w}_{i,t} - \hat{\lambda}_{i,t}) \tag{5.11}$$

Group ADF-statistics:

$$\tilde{X}_t^* \equiv \sum_{i=1}^{N} \left(\sum_{t=1}^{T} s^{*2} \widehat{w}^{*2}{}_{i,t-1} \right)^{-1/2} \sum_{t=1}^{T} \widehat{w^*}_{i,t-1}\, \Delta\, \widehat{w^*}_{i,t} - \hat{\lambda}_{i,t}) \tag{5.12}$$

where the null hypothesis of panel cointegration tests is the same for each statistic H_0 (no cointegration) : $\rho_i = 1$ for all i, but the alternative hypothesis for within-dimension-based and between-dimension-based is different. The within-dimension-based statistics panel cointegration has the alternative hypothesis $H_1 : \rho = \rho_i < 1$ for all values of i and it supposes a common value for $\rho_i = \rho$. The alternative hypothesis for between-dimension-based statistics panel cointegration is $H_1 : \rho_i < 1$ for all values of i, where a common value for $\rho_i = \rho$ was not required.

The previous Pedroni (1999) tests are asymptotically normally distributed, and the null hypothesis of all seven Pedroni (1999) tests are the same for each statistic no cointegration.

Panel cointegration analysis can show whether there is a long-run relationship between the variables.

Kao (1999) suggested that the Dickey-Fuller (DF) and ADF tests are identical to Padroni's. The main differences are in the fixed effects, such as the initial regression with individual intercepts, and further, there are no homogeneous trend coefficients. Both Kao (1999) and Pedroni (1999, 2004) believe that there is one cointegrating vector, even though it makes individuals heterogeneous.

Maddala and Wu (1999) indicated that the Fisher cointegration test is used in the multivariate frame applied by Johansen (1988). Based on this test, they documented collecting the probability limit value for the individual cointegration tests to get a panel test. The authors noted that the evaluation demands a high quantity of observations. Both these evaluations permit multiple cointegrating vectors in each cross-section.

Banerjee et al. (2004) asserted that these evaluations permit cross-sectional dependence, via the effects of short-run dynamics and do not consider long-term dependence induced from cross-sectional cointegration. As has been explained and demonstrated by numerous past studies, panel cointegration tests might be considerably over-sized. Also, most cointegration tests may be misleading, in that most data are static, while they might not require all data to be static.

In conclusion, this study uses the Kao (1999) and Pedroni (1999, 2004) tests to check the cointegration results among the study variables. Kao (1999) and Pedroni (1999, 2004) tests take into considerations the heterogeneity in the dynamics and variations of errors in panel data. Further, they employ both parametric and non-parametric kernel estimation of the long run variance.

5.4.3. Lag Length Selection Test

It is necessary to find the appropriate number of lags for the variables in the model. Many criteria will be used, including Akaike Info Criterion (AIC), Schwarz Info Criterion (SIC), Hannan–Quinn (HQ), Final Prediction Error criterion (FBE), and Likelihood ratio test (LR), to find the number of lags in the model (Ng and Perron 2001). The lag length selection is applied to determine the number of lags to be included in ARDL model. The ARDL method estimates $(c + 1)$ n number of regressions in order to obtain the optimal lag length for each variable, where c is the maximum number of lag to be used (Ng and Perron 2001).

5.4.4. Autoregressive Distributed-Lagged Model (ARDL)

My panel sample contains 16 countries from the MENA region, over a span of 24 years (more years than countries), and variables that may not be stationary at level. Therefore, the model is likely to be dynamic. In this case, the more suitable approach is the panel-ARDL approach, as suggested by Pesaran et al. (1999), as it permits short-term relationships across countries, thus allowing cross-country heterogeneity (Pesaran et al. 2001; Pesaran and Smith 1995). This methodology is dependent upon the newly constructed autoregressive distributed lag (ARDL) approach by Pesaran and Pesaran (2010), which does not demand pre-testing factors. Put in a different way, the ARDL approach to examining the connection between factors at different levels will be appropriate regardless of whether there is a mixture of I (0) and I (1).

The ARDL (p,q,q,…,q) approach is estimated as follows:

$$\Delta RGDPG_{it} = \sum_{j=1}^{p} \alpha_{ij}\, \Delta RGDPG_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}\, \Delta X_{i,t-j} + \varepsilon_{it} \qquad (5.13)$$

where $RGDPG_{it}$ represents the real gross domestic production growth as the dependent variable, X_i is the explanatory variable, which could be a combination of I(0) and I(1) of a unit root; $\alpha_{ij}$is the scalars[60] ; δ_{ij} are k $\times$ 1, representing the coefficient vectors; i represents the number of the sample (1 to N); t represents the time period of the study (1 to T); p and q represents the number of Lags; and ε_{it} represents the error term.

The estimates obtained by the ARDL procedure for the cointegration investigation are efficient and unbiased, and it has several desirable statistical features. First, it allows testing simultaneously for the long-run and short-run relationships between variables. Second, in contrast to the dynamic and static panel methods, this test procedure is valid irrespective of whether the variables are I(0) or I(1) or mutually co-integrated, which means there is no need for a unit root test. However, this test procedure will not be applicable if an I(2) series exists in the model. Third, in spite of the possible presence of endogeneity, the ARDL model provides unbiased coefficients of explanatory variables along with valid t-statistics. Furthermore, the ARDL model corrects the omitted lagged variable bias (Inder 1993). Ang (2009) and Jalil and Ma (2008) argue that the ARDL framework includes sufficient numbers of lags to capture the

[60] Scalars are the coefficient of the lagged dependent variable.

data generating process in general to find the specific modelling approach of Hendry (1995, 2001). Finally, this test is very efficient and consistent in small and finite sample sizes.

The ARDL approach (p,q,q,q,………q) and the error correction term (ECT) is expressed as:

$$\Delta RGDPG_{it} = \rho_i \left(RGDPG_{i,t-j} - \beta_i X_{it}\right) + \sum_{j=1}^{p-1} \alpha_{ij}^{*} \Delta RGDPG_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*} \Delta X_{i.t-j} + \varepsilon_{it} \quad (5.14)$$

Where:

- $\rho_i = (1 - \rho_i)$ represents the adjustment coefficient and this value expects that $\rho_i < 0$
- β_i = vectors to represent the long-run relationships
- ECT = $[RGDPG_{i,t-j} - \beta_i X_{it}]$, the error correction term
- α_{ij}^{*}, δ_{ij}^{*} are parameters representing the short-term dynamic coefficients

Equation 5.14 can be solved by using the Mean Group (MG), which estimates the parameters for each country in the sample. After that, it estimates the average parameters for all countries as one group, as proposed by Pesaran et al. (1999). Furthermore, the parameters show that another estimator is more efficient only if the long-run coefficients are homogenous across countries. The Pooled Mean Group (PMG) is a type of estimator that allows short-run parameters to differ between the countries, which drives the homogeneity of long-run parameters. Another important assumption for the consistency of the PMG model is that the relative size of T and N is crucial, which helps to solve the issue of heterogeneity and avoid the bias in the average estimators. Eberhardt and Teal (2011) showed that solving the issue of heterogeneity is essential to understanding the growth process. Thus, failing to fulfil these conditions would produce an inconsistent estimation in PMG. However, to apply this kind of estimator, variables should have a combination and cointegrated of I (1) and I (0) in their unit root test.

5.5. MODEL SPECIFICATION

This study aims to provide evidence on the effect of ICT investment and usage on economic growth and the consequences of the moderating role of quality of governance on this effect in the MENA countries context for the period 1995–2018. To do this, this study applies the endogenous theory used by Barro (1996b), Romer (1990), and Barro and Sala-i-Martin (1997).

Endogenous theories attribute economic growth to innovations and creativity, and they support the significance of the institutional framework for stimulating innovation. This model has also been applied in several previous empirical studies, such as those by Albiman and Sulong (2017), Albiman and Sulong (2016), Oliner and Sichel (2000), and Yousefi (2011). This study will begin with the endogenous growth theory as presented through the Cobb–Douglas production function, which takes the following form:

$$Y_{i,t} = Ae^{\partial_t}(\mathrm{L}_{i,t})^{\alpha}\,(\mathrm{K}_{\,i,t})^{\beta}(\mathrm{ICT}_{\,i,t})^{\gamma}e^{\mathrm{u}_{i,t}} \tag{5.15}$$

where Y represents output real GDP growth rate, and A represents the level of technology for each country. I assume that all countries have identical access to technology, while $K, L,$ and ICT represent capital, labour, and technology, respectively. ∂ represents the rate of technical change, while the parameters α, β and γ represent the elasticity of labour, capital, and information and communication technology. After taking natural logarithms for the explanatory variables, the problem of normality is reduced among the included variables in the model.

$$Y_{i,t} = \mathrm{C}_0 + \partial_t + \alpha\ln(L_{i,t}) + \beta\ln\big(K_{i,t}\big) + \gamma\ln\big(ICT_{i,t}\big) + u_{i,t} \tag{5.16}$$

Note that Y represents the real GDP growth rate, C is a constant, K refers to gross fixed capital formation, L represents the labour force, and ICT refers to ICT investment and usage. To measure the effect of ICT investment and usage, this study uses the common proxy of ICT as presented in Section 5.3—individuals using the internet (*USAGE*), internet access at home (*ACCESS*), mobile cellular phone subscriptions (*MOB*), and capital investment in telecommunications (*INV*); ln is the natural logarithm. ∂ represents the rate of technical change that supports the labour force and capital to boost the capability of production. Moreover, the control variables are added to discourage any possible issues that could arise from the omission of some important variables. These variables are included in the equation (5.17). As suggested by Barro (1991) and Romer (1986).

The conceptual framework is illustrated in Figure 5.1, which is a schematic representation showing the relationships among the dependent variable, explanatory variables, and the moderating variables that will be used in this study.

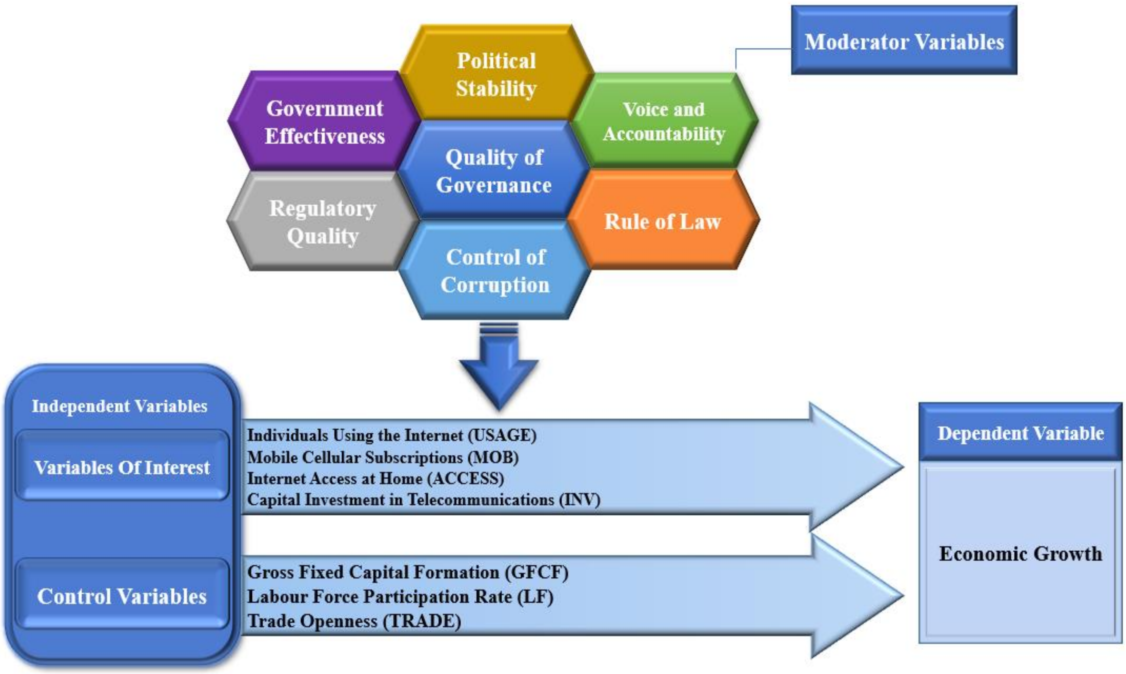

Figure 5.1: Conceptual framework

As mentioned early in this chapter, this study uses the panel-ARDL model developed by Pesaran et al. (1999), which is more appropriate to analyse the data to find the long-run and short-run effects and has been widely applied in the relevant empirical literature (e.g. Ishida 2015; Kumar et al. 2016; Oulton 2012).

Based on the above discussion, the ARDL approach (p,q,q,…,q) and the error correction term (ECT) is estimated as follows:

$$
\begin{aligned}
\Delta \mathrm{RGDPG}_{i,t} = {} & \rho_i \left(\mathrm{RGDPG}_{i,t-j} - \theta_{i,1} \ln\mathrm{ICT}_{i,t-1} - \theta_{i,2} \mathrm{GOV}_{i,t-1} - \theta_{i,3} \left(\ln\mathrm{ICT}_{i,t-1} \times \mathrm{GOV}_{i,t-1}\right)\right. \\
& \left. - \theta_{i,4} \ln\mathrm{LF}_{i,t-1} - \theta_{i,5} \ln\mathrm{GFCF}_{i,t-1} - \theta_{i,6} \ln\mathrm{TRADE}_{i,t-1} - \theta_{i,7}\, \mathrm{DSPRING}_{i,t-1}\right) \\
& + \sum_{j=1}^{p-1} \sigma^*_{i,j}\, \Delta\mathrm{GDPG}_{i,t-j} + \sum_{j=0}^{q-1} \gamma^*_{i,j}\, \Delta\ln\mathrm{ICT}_{i,t-j} \\
& + \sum_{j=0}^{q-1} \lambda^*_{i,j}\, \Delta\mathrm{GOV}_{i,t-j} + \sum_{j=0}^{q-1} \mu^*_{i,j}\, \Delta\left(\ln\mathrm{ICT}_{i,t-j} \times \mathrm{GOV}_{i,t-j}\right)_{i,t-j} + \sum_{j=0}^{q-1} \beta^*_{i,j}\, \Delta\ln\mathrm{LF}_{i,t-j} \\
& + \sum_{j=0}^{q-1} \alpha^*_{i,j}\, \Delta\ln\mathrm{GFCF}_{i,t-j} + \sum_{j=0}^{q-1} \varphi^*_{i,j}\, \Delta\ln\mathrm{TRADE}_{i,t-j} + \sum_{j=0}^{q-1} \psi^*_{i,j}\, \Delta\mathrm{DSPRING}_{i,t-j} + u_{i,t} \quad (5.17)
\end{aligned}
$$

Where $i = 1, \dots \dots .., 16$ and $t = 1995, \dots \dots \dots, 2018$. The variable $RGDPG_{i,t}$ represents the Real Gross Domestic Product Growth as the dependent variable, $ICT_{i,t}$ represents the set of variables of interest, $GOV_{i,t}$ is the set of quality of governance indicators, while $LF_{i,t}$, $GFCF_{i,t}$ and $TRDAE_{i,t}$ are the control variables. The impact of the Arab Spring is taken into account in the model by the dummy variable $DSPRING_{i,t}$. The $\theta_{i,1}$, $\theta_{i,2}$, $\theta_{i,3}$, $\theta_{i,4}$, $\theta_{i,5}$, $\theta_{i,6}$ and $\theta_{i,7}$ are the long-run coefficients; $\sigma^*_{i,j}$, $\gamma^*_{i,j}$, $\lambda^*_{i,j}$, $\mu^*_{i,j}$, $\beta^*_{i,j}$, $\alpha^*_{i,j}$, $\varphi^*_{i,j}$ and $\psi^*_{i,j}$ are the short-run coefficients. It should be noted that we add the governance indicators and ICT variables in the regression one by one (Busse and Hefeker 2007). I also add the interaction of ICT and quality of governance to the model one by one, given that these indicators and variables are significantly correlated. Furthermore, all-important control variables in the model (including all the variables in the regression analyses) are included in each regression equation. These include the labour force (*LF*), gross fixed capital formation (*GFCF*), and trade openness (*TRADE*). These equations differ due to the type of proxy used in the ICT option, while all other independent variables are maintained.

This estimation is divided into two groups. The first group aims to find the effect of ICT usage on economic growth. Hence, the first group contains the estimation models outlined below.

The first group (ICT usage):

The first group contains three models to estimate the effect of ICT usage on economic growth (Models 1, 2, and 3).

Model 1 shows the effect of individuals using the internet (*USAGE*) on economic growth:

$$\left.\begin{array}{l}
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \,\mathrm{lnUSAGE_{i,t}} + \theta_2 \,\mathrm{GOV_{i,t}} + \theta_3\left(\mathrm{lnUSAGE_{i,t}} \times \mathrm{GOV_{i,t}}\right) + \theta_4 \,\mathrm{lnLF_{i.t}} + \theta_5 \mathrm{lnGFCF_{i,t}} + \theta_6 \,\mathrm{lnTRADE_{i,t}} \\
\qquad + \mathrm{u_{i,t}} \qquad\qquad \textbf{\textit{Model}}\ \mathbf{1.1} \\[1ex]
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \mathrm{lnUSAGE_{i,t}} + \theta_2 \mathrm{CC_{i,t}} + \theta_3\left(\mathrm{lnUSAGE_{i,t}} \times \mathrm{CC_{i,t}}\right) + \theta_4 \,\mathrm{lnLF_{i.t}} + \theta_5 \mathrm{lnGFCF_{i,t}} + \theta_6 \,\mathrm{lnTRADE_{i,t}} \\
\qquad + \mathrm{u_{i,t}} \qquad\qquad \textbf{\textit{Model}}\ \mathbf{1.2} \\[1ex]
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \,\mathrm{lnUSAGE_{i,t}} + \theta_2 \mathrm{GE_{i,t}} + \theta_3\left(\mathrm{lnUSAGE_{i,t}} \times \mathrm{GE_{i,t}}\right) + +\theta_4 \,\mathrm{lnLF_{i.t}} + \theta_5 \mathrm{lnGFCF_{i,t}} + \theta_6 \,\mathrm{lnTRADE_{i,t}} \\
\qquad + \mathrm{u_{i,t}} \qquad\qquad \textbf{\textit{Model}}\ \mathbf{1.3} \\[1ex]
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \,\mathrm{lnUSAGE_{i,t}} + \theta_2 \mathrm{RQ_{i,t}} + \theta_3\left(\mathrm{lnUSAGE_{i,t}} \times \mathrm{RQ_{i,t}}\right) + \theta_4 \,\mathrm{lnLF_{i.t}} + \theta_5 \mathrm{lnGFCF_{i,t}} + \theta_6 \,\mathrm{lnTRADE_{i,t}} \\
\qquad + \mathrm{u_{i,t}} \qquad\qquad \textbf{\textit{Model}}\ \mathbf{1.4} \\[1ex]
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \,\mathrm{lnUSAGE_{i,t}} + \theta_2 \mathrm{RL_{i,t}} + \theta_3\left(\mathrm{lnUSAGE_{i,t}} \times \mathrm{RL_{i,t}}\right) + \theta_4 \,\mathrm{lnLF_{i.t}} + \theta_5 \mathrm{lnGFCF_{i,t}} + \theta_6 \,\mathrm{lnTRADE_{i,t}} \\
\qquad + \mathrm{u_{i,t}} \qquad\qquad \textbf{\textit{Model}}\ \mathbf{1.5} \\[1ex]
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \,\mathrm{lnUSAGE_{i,t}} + \theta_2 \mathrm{PV_{i,t}} + \theta_3\left(\mathrm{lnUSAGE_{i,t}} \times \mathrm{PV_{i,t}}\right) + \theta_4 \,\mathrm{lnLF_{i.t}} + \theta_5 \mathrm{lnGFCF_{i,t}} + \theta_6 \,\mathrm{lnTRADE_{i,t}} \\
\qquad + \mathrm{u_{i,t}} \qquad\qquad \textbf{\textit{Model}}\ \mathbf{1.6} \\[1ex]
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \,\mathrm{lnUSAGE_{i,t}} + \theta_2 \mathrm{VA_{i,t}} + \theta_3\left(\mathrm{lnUSAGE_{i,t}} \times \mathrm{VA_{i,t}}\right) + \theta_4 \,\mathrm{lnLF_{i.t}} + \theta_5 \mathrm{lnGFCF_{i,t}} + \theta_6 \,\mathrm{lnTRADE_{i,t}} \\
\qquad + \mathrm{u_{i,t}} \qquad\qquad \textbf{\textit{Model}}\ \mathbf{1.7}
\end{array}\right] \qquad (5.18)$$

Model 2 shows the effect of the proportion of households with internet access at home (ACCESS) on economic growth:

$$\left.\begin{aligned}
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{ACCESS}_{i,t} + \theta_2\mathrm{GOV}_{i,t} + \theta_3(\ln\mathrm{ACCESS}_{i,t} \times \mathrm{GOV}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 2.1}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{ACCESS}_{i,t} + \theta_2\mathrm{CC}_{i,t} + \theta_3(\ln\mathrm{ACCESS}_{i,t} \times \mathrm{CC}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 2.2}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{ACCESS}_{i,t} + \theta_2\mathrm{GE}_{i,t} + \theta_3(\ln\mathrm{ACCESS}_{i,t} \times \mathrm{GE}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 2.3}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{ACCESS}_{i,t} + \theta_2\mathrm{RQ}_{i,t} + \theta_3(\ln\mathrm{ACCESS}_{i,t} \times \mathrm{RQ}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 2.4}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{ACCESS}_{i,t} + \theta_2\mathrm{RL}_{i,t} + \theta_3(\ln\mathrm{ACCESS}_{i,t} \times \mathrm{RL}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 2.5}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{ACCESS}_{i,t} + \theta_2\mathrm{PV}_{i,t} + \theta_3(\ln\mathrm{ACCESS}_{i,t} \times \mathrm{PV}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 2.6}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{ACCESS}_{i,t} + \theta_2\mathrm{VA}_{i,t} + \theta_3(\ln\mathrm{ACCESS}_{i,t} \times \mathrm{VA}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 2.7}
\end{aligned}\right\} \quad (5.19)$$

Model 3 shows the effect of mobile cellular subscriptions (MOB) on economic growth:

$$\left.\begin{aligned}
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{MOB}_{i,t} + \theta_2\mathrm{GOV}_{i,t} + \theta_3(\ln\mathrm{MOB}_{i,t} \times \mathrm{GOV}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 3.1}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{MOB}_{i,t} + \theta_2\mathrm{CC}_{i,t} + \theta_3(\ln\mathrm{MOB}_{i,t} \times \mathrm{CC}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 3.2}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{MOB}_{i,t} + \theta_2\mathrm{GE}_{i,t} + \theta_3(\ln\mathrm{MOB}_{i,t} \times \mathrm{GE}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 3.3}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{MOB}_{i,t} + \theta_2\mathrm{RQ}_{i,t} + \theta_3(\ln\mathrm{MOB}_{i,t} \times \mathrm{RQ}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 3.4}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{MOB}_{i,t} + \theta_2\mathrm{RL}_{i,t} + \theta_3(\ln\mathrm{MOB}_{i,t} \times \mathrm{RL}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 3.5}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{MOB}_{i,t} + \theta_2\mathrm{PV}_{i,t} + \theta_3(\ln\mathrm{MOB}_{i,t} \times \mathrm{PV}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 3.6}\\
&\mathrm{RGDPG}_{i,t} = \theta_0 + \theta_1 \ln\mathrm{MOB}_{i,t} + \theta_2\mathrm{VA}_{i,t} + \theta_3(\ln\mathrm{MOB}_{i,t} \times \mathrm{VA}_{i,t}) + \theta_4 \ln\mathrm{LF}_{i.t} + \theta_5\ln\mathrm{GFCF}_{i,t} + \theta_6 \ln\mathrm{TRADE}_{i,t} + u_{i,t} && \boldsymbol{Model\ 3.7}
\end{aligned}\right\} \quad (5.20)$$

The second group (ICT investment):

The second group contains one model to estimate the effect of the ICT investment on economic growth (Model 4).

$$\left.\begin{array}{ll}
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \ln\mathrm{INV_{i,t}} + \theta_2\mathrm{GOV_{i,t}} + \theta_3(\ln\mathrm{INV_{i,t}} \times \mathrm{GOV_{i,t}}) + \theta_4 \ln\mathrm{GFCF_{i,t}} + \theta_5 \ln\mathrm{LF_{i.t}} + \theta_6 \ln\mathrm{TRADE_{i,t}} + \mathrm{u_{i,t}} & \textbf{\textit{Model}}\ \mathbf{4.1} \\
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \ln\mathrm{INV_{i,t}} + \theta_2\mathrm{CC_{i,t}} + \theta_3(\ln\mathrm{INV_{i,t}} \times \mathrm{CC_{i,t}}) + \theta_4 \ln\mathrm{GFCF_{i,t}} + \theta_5 \ln\mathrm{LF_{i.t}} + \theta_6 \ln\mathrm{TRADE_{i,t}} + \mathrm{u_{i,t}} & \textbf{\textit{Model}}\ \mathbf{4.2} \\
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \ln\mathrm{INV_{i,t}} + \theta_2\mathrm{GE_{i,t}} + \theta_3(\ln\mathrm{INV_{i,t}} \times \mathrm{GE_{i,t}}) + \theta_4 \ln\mathrm{GFCF_{i,t}} + \theta_5 \ln\mathrm{LF_{i.t}} + \theta_6 \ln\mathrm{TRADE_{i,t}} + \mathrm{u_{i,t}} & \textbf{\textit{Model}}\ \mathbf{4.3} \\
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \ln\mathrm{INV_{i,t}} + \theta_2\mathrm{RQ_{i,t}} + \theta_3(\ln\mathrm{INV_{i,t}} \times \mathrm{RQ_{i,t}}) + \theta_4 \ln\mathrm{GFCF_{i,t}} + \theta_5 \ln\mathrm{LF_{i.t}} + \theta_6 \ln\mathrm{TRADE_{i,t}} + \mathrm{u_{i,t}} & \textbf{\textit{Model}}\ \mathbf{4.4} \\
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \ln\mathrm{INV_{i,t}} + \theta_2\mathrm{RL_{i,t}} + \theta_3(\ln\mathrm{INV_{i,t}} \times \mathrm{RL_{i,t}}) + \theta_4 \ln\mathrm{GFCF_{i,t}} + \theta_5 \ln\mathrm{LF_{i.t}} + \theta_6 \ln\mathrm{TRADE_{i,t}} + \mathrm{u_{i,t}} & \textbf{\textit{Model}}\ \mathbf{4.5} \\
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \ln\mathrm{INV_{i,t}} + \theta_2\mathrm{PV_{i,t}} + \theta_3(\ln\mathrm{INV_{i,t}} \times \mathrm{PV_{i,t}}) + \theta_4 \ln\mathrm{GFCF_{i,t}} + \theta_5 \ln\mathrm{LF_{i.t}} + \theta_6 \ln\mathrm{TRADE_{i,t}} + \mathrm{u_{i,t}} & \textbf{\textit{Model}}\ \mathbf{4.6} \\
\mathrm{RGDPG_{i,t}} = \theta_0 + \theta_1 \ln\mathrm{INV_{i,t}} + \theta_2\mathrm{VA_{i,t}} + \theta_3(\ln\mathrm{INV_{i,t}} \times \mathrm{VA_{i,t}}) + \theta_4 \ln\mathrm{GFCF_{i,t}} + \theta_5 \ln\mathrm{LF_{i.t}} + \theta_6 \ln\mathrm{TRADE_{i,t}} + \mathrm{u_{i,t}} & \textbf{\textit{Model}}\ \mathbf{4.7}
\end{array}\right] \quad (5.21)$$

In addition, because of the interaction term in this study between the ICT variables and governance indicators, this study calculates the marginal effect of ICT variables on economic growth at a different level of governance indicators by examining the following partial derivative in previous equations (5.18, 5.19, 5.20 and 5.21):

$$\frac{\partial RGDPG}{\partial lnICT} = \theta_1 + \theta_3 \times GOV \qquad (5.22)$$

5.6. CONCLUDING REMARKS

This chapter has discussed the model used to test the main hypotheses of this study. The panel ARDL model was selected as it permits short-term relationships across countries, thus allowing cross-country heterogeneity. Further, the ARDL model examining the presence of the connection between factors at different levels will be appropriate regardless of whether there is a mixture of I (0) and I (1). Therefore, the more suitable model is the panel-ARDL model, as suggested by Pesaran, Shin and Smith (1999).

This chapter illustrated the empirical analysis in detail, which includes the tests applied before estimating the ARDL model, such as the Panel Unit Root test, Panel Co-integration, and Lag-Length selection test. The next chapter, Chapter 6, shows the analytical findings and discusses them.

CHAPTER 6: RESULTS AND DISCUSSION

6.1. INTRODUCTION

This chapter empirically examines the role of ICT investment and usage on economic growth in the MENA region. Furthermore, this chapter aims to investigate the moderating effect of quality of governance on the association between ICT investment and usage and economic growth. The previous chapters showed that ICT significantly and positively explains long-term economic growth across countries. This is in line with the findings of past research that reported a positive association between ICT investment and productivity gains in developed and developing countries (see e.g. Dimelis and Papaioannou 2010; Papaioannou and Dimelis 2007; Yousefi 2011).

This study applies an endogenous growth theory proposed by Barro (1996b), Romer (1990), and Barro and Sala-i-Martin (1997). This theory supports the significance of the institutional framework for stimulating innovation and ultimately boosting economic growth. Additionally, many economists assert that the development levels of individual economies rely on the innovation capacity of businesses and individuals (Grossman and Helpman 1991). This study will add to the existing literature by focusing on the MENA countries and examining the effect of ICT investment and usage on economic growth. Moreover, it investigates the moderating role of the quality of governance on the association between ICT investment and usage in economic growth.

This chapter is organised as follows: Section 6.2 outlines the descriptive statistics and correlation matrix of the variables; Section 6.3 presents the unit root test; Section 6.4 discusses the panel cointegration results; Section 6.5 provides the results of panel data regressions; Section 6.6 discusses the results of short-run impact and adjustment; and finally, Section 6.7 provides some concluding remarks for this chapter.

6.2. DESCRIPTIVE STATISTICS AND CORRELATION MATRIX

This section discusses the descriptive statistics and correlation matrix for all the study variables. As mentioned earlier, this study uses an unbalanced panel data covering 16 MENA countries over a span of 24 years (see Table 6.1). As reported in Table 6.2, the results of the descriptive statistics show that the number of observations is 375, as there are some missing observations on ICT variables. Further, the results of the descriptive statistics of the study variables show the mean values for proxy variables of ICT usage: internet users as a percentage of the population (*USAGE*), with a mean of 30.31%; internet access from home as a percentage of the population (*ACCESS*), with a mean of 30.29%; and mobile cellular phone subscriptions per 100 people (*MOB*), with a mean of 70.60%. The mean values for the proxy variables of ICT usage are fairly high. As expected, the highest growth rate of these variables is reached in the developing countries of the MENA region. In recent years, most MENA countries have experienced a dramatic surge in ICT usage, as measured by several indicators, such as mobile cellular phone subscriptions, internet users, and the number of internet users (International Telecommunication Union 2020). These results are in line with those of the prior literature and imply that ICT usage can help developing countries to improve their economic growth by boosting the rate of innovation processes. Such a boost leads to the development of new products and business models that can support and facilitate access to services such as education and health (Albiman and Sulong 2016; Andrianaivo and Kpodar 2011; Sassi and Goaied 2013; Venturini 2007). Many previous studies, such as those by Ahmed and Ridzuan (2013), Ng et al. (2013), and Vu (2011), show that ICT usage has a large impact on economic growth. Further, they conclude that countries with a high level of ICT usage enjoy a boost to their economic growth, and their economies prosper.

The maximum value among the proxy variables of ICT usage is 212.64% for *MOB*, as presented in Table 6.2. This value indicates that mobile phones have become an essential driver of economic growth in the MENA region. This observation consolidates the efforts of many MENA countries to accelerate mobile penetration. For example, in MENA countries such as Saudi Arabia, United Arab Emirates, Qatar, Kuwait, Oman, Israel, Egypt, Turkey, and Jordan, authorities are attempting to stimulate economic growth by increasing government services (e.g., e-government, banks, etc.) and facilitating e-commerce services. They are also facilitating people's access to mobile technology in order to accelerate the spread and use of mobile government services and e-commerce. Through higher mobile penetration, it will become easier for citizens of MENA to have access to different kinds of government services and for executing various financial transactions (e.g., storing and transferring money and paying bills). In other words, the highest mean value of the *MOB* indicates that the MENA countries' policymakers are taking into consideration the role of telecommunications in boosting their countries' economies.

The mean value of the capital investment in telecommunications as a percentage of GDP (*INV*) is 0.86 %. This value is not high in the MENA region. This implies that some of the

MENA countries have not invested enough in ICTs during the past two decades. Furthermore, developing economies such as the MENA economies do not gain economic growth from investing in ICT, compared with developed economies.

Regarding the level of governance indicators,[61] the mean value of the average of the six governance indicators (*GOV*) is -0.20. This study shows low quality governance in the MENA countries. The control of corruption (*CC*) mean value is -0.03; the government effectiveness (*GE*) mean value is 0.06; the rule of law (*RL*) mean value is 0.01; the regulatory quality (*RQ*) mean value is -0.03; the political stability (*PV*) mean value is -0.43; and the voice and accountability (*VA*) mean value is -0.78. These observations show that there is variation between the countries regarding the quality of governance. They indicate that the MENA region has poor governance quality except for some countries, namely, Israel, United Arab Emirates, and Qatar, as mentioned in Chapters 1 and 2.

Finally, the observations show that there is variation between the countries regarding the control variables. The labour force as a percentage of the population (*LF*) mean value is 55.73%; the gross fixed capital formation as a percentage of GDP (*GFCF*) mean value is 23.49%; and the trade openness as a percentage of GDP (*TRADE*) mean value is 80.45%. These observations demonstrate that these variables strongly affect economic growth in the MENA region.

Moving onto the correlation matrix of the study variables, as can be seen in Table 6.3, most of the variables used in this study are positively correlated with real GDP growth (RGDPG), except for the ICT variables such as usage (*lnUSAGE*), accessibility (*lnACCESS*), mobile cellular subscriptions (*lnMOB)*, trade openness (*lnTRADE*), and voice and accountability (*VA*), which are negatively correlated with the main dependent variable (*RGDPG*). In addition, Table 6.3 shows that all the variables of ICT usage, such as *USAGE*, *ACCESS*, and *MOB* are highly correlated with each other. For instance, the coefficient between *lnUSAGE* and *lnMOB* is around 0.95. Also, the correlation results show that the *lnGFCF* is weakly correlated with other variables.

Table 6.3 shows that *GOV* and the quality of governance indicators of *CC*, *RL*, *GE*, *RQ*, *PV*, and *VA* are highly correlated with each other. For instance, the coefficient between *GOV*

[61] These indicators have scores ranging from approximately -2.5 to +2.5 (worst governance and best governance).

and *RL* is 0.96. The strong inter-correlation among those explanatory variables may cause a multicollinearity problem, typically occurring when some correlations are large (Wooldridge, 2009). This study avoids the problem of strong inter-correlation between the explanatory variables, as it includes the governance indicators in the regression one by one (Busse and Hefeker 2007). In addition, because this study takes into account the correlation between the ICT variables, it adds these variables individually into the regression model.

Table 6.1: Sample Selection.

	Number of observations
16 MENA countries: annual observations sample from 1995 to 2018.	384
Observations of countries that are not covered by ICT variables.	9
Total sample	375

Table 6.2: Descriptive Statistics.

	RGDPG	USAGE	ACCESS	MOB	INV	LF	GFCF	TRADE	GOV	CC	RL	GE	RQ	PV	VA
Mean	4.418	30.201	30.158	70.501	0.009	55.753	23.505	80.519	-0.197	-0.026	0.011	0.066	-0.024	-0.427	-0.781
Median	4.083	20.000	19.300	70.183	0.006	51.700	23.047	80.021	-0.117	-0.100	0.100	0.000	0.000	-0.500	-0.800
Maximum	30.012	100.000	100.000	212.639	0.141	89.000	46.020	191.872	0.800	1.600	1.500	1.500	1.300	1.200	0.800
Minimum	-7.076	0.001	0.000	0.012	0.000	37.200	1.111	17.859	-1.650	-1.500	-1.700	-1.500	-1.700	-2.500	-1.900
Std. Dev.	3.927	29.257	30.659	56.576	0.015	12.236	6.760	34.219	0.577	0.654	0.632	0.621	0.716	0.913	0.597
Observations	375	375	375	375	375	375	375	375	375	375	375	375	375	375	375

Note: RGDPG is real GDP growth; USAGE is the individuals using the internet as a percentage of the population; ACCESS is the proportion of households with internet access at home as a percentage of the population; MOB is the mobile cellular subscriptions per 100 people; INV is the capital investment in telecommunications as a percentage of GDP; LF is the labour force participation rate as a percentage of the population; GFCF is the gross fixed capital formation as a percentage of GDP; TRADE is the trade openness as a percentage of GDP; GOV is the average of the six governance indicators: CC is control of corruption, RL is rule of law, GE is government effectiveness, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability.

Table 6.3: Correlations Matrix.

	RGDPG	lnUSAGE	lnACCESS	lnMOB	lnINV	lnLF	lnGFCF	lnTRADE	GOV	CC	GE	RL	RQ	PV	VA
RGDPG	1.00														
lnUSAGE	-0.06	1.00													
lnACCESS	-0.06	0.88	1.00												
lnMOB	-0.07	0.95	0.85	1.00											
lnINV	0.04	0.11	0.05	0.13	1.00										
lnLF	0.04	0.23	0.37	0.26	0.07	1.00									
lnGFCF	0.05	0.20	0.09	0.17	-0.02	-0.17	1.00								
lnTRADE	-0.01	0.38	0.40	0.38	0.05	0.37	0.04	1.00							
GOV	0.07	0.23	0.28	0.27	-0.12	0.72	-0.05	0.64	1.00						
CC	0.08	0.27	0.34	0.31	-0.07	0.75	-0.03	0.58	0.93	1.00					
GE	0.04	0.28	0.32	0.31	-0.12	0.69	0.00	0.61	0.93	0.88	1.00				
RL	0.04	0.28	0.35	0.33	-0.09	0.70	-0.06	0.59	0.96	0.89	0.87	1.00			
RQ	0.05	0.28	0.30	0.30	-0.09	0.64	-0.07	0.63	0.91	0.81	0.87	0.89	1.00		
PV	0.10	0.03	0.12	0.07	-0.10	0.57	-0.03	0.55	0.72	0.64	0.58	0.65	0.50	1.00	
VA	-0.02	0.07	-0.01	0.09	-0.17	0.20	-0.05	0.16	0.56	0.44	0.51	0.51	0.53	0.02	1.00

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; GOV is the average of the six governance indicators: CC is the control of corruption, GE is government effectiveness, RL is the rule of law, RQ is the regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability.

6.3. PANEL UNIT-ROOT TEST

Prior to examining the cointegration test, this study examines the order of stationarity for the variables using the panel unit root test (see Table 6.4). By doing so, the study can be guided as to whether the ARDL model must be applied or not. As mentioned earlier, in Chapter 5, and due to the fact that this study uses unbalanced panel data, the study uses the IPS method to examine the stationarity of the data.

Table 6.4 presents the test statistics for the variables. The results show that the variables have a mixed order of stationarity. Table 6.4 shows that the variables are stationary at the level (except *lnLF*, *GOV*, *CC*, *GE*, and *PV*). However, all variables have a stationary in the first difference as the IPS test rejects the null of a unit root. Due to these mixed orders of stationarity, panel ARDL is more appropriate for analysing the data in this study.

Table 6.4: Panel Unit Root Test.

	IPS W-statistic*		Unit Root Summary
	Level	**1st difference**	
RGDPG	-7.694***	-20.642***	-
lnUSAGE	-11.365***	-9.790***	-
lnACCESS	-7.394***	-2.867***	-
lnMOB	-15.523***	-5.515***	-
lnINV	-3.192***	-13.084***	-
lnLF	-1.105	-9.269***	I(1)
lnGFCF	-4.825***	-12.634***	-
lnTRADE	-2.985***	-10.715***	-
GOV	-1.146	-12.300***	I(1)
CC	-0.796	-11.991***	I(1)
RL	-2.617***	-12.088***	-
GE	-0.146	-14.207***	I(1)
RQ	-2.850***	-11.942***	-
PV	-0.906	-11.789***	I(1)
VA	-2.352***	-13.468***	-

Null Hypothesis: Unit Root.

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; lnACCESS is the natural logarithm of a proportion of households with internet access at home as a percentage of the population; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; GOV is the average of the six governance indicators: CC is the control of corruption, RL is the rule of law, GE is government effectiveness, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability. *Automatic lag length selection based on AIC. The test values are significant at ***$p < 0.01$.

6.4. PANEL COINTEGRATION TEST

From the above section, it can be noted that the five variables of the study (namely, *lnLF*, *GOV*, *CC*, *GE*, and *PV*) are stationary at their first difference, which certainly meets the requirements of the cointegration test. Hence, the next stage is testing whether there is a long-run equilibrium relationship between these variables. While there are a number of tests available, as mentioned and explained in Chapter 5, this study uses the Pedroni (1999) and Kao (1999) tests.

The Pedroni (1999) test supports two statistics, both based on a group-mean approach. The Group PP is non-parametric and analogous to the Phillips–Perron t-statistic, while Group ADF is parametric and analogous to the ADF t-statistic. These two statistics are referred to as 'between dimension' statistics that average the estimated autoregressive coefficients for each country. Under the alternative hypothesis of cointegration, the autoregressive coefficient is allowed to vary across countries. This allows us to model an additional source of potential heterogeneity across the panel (countries). Following appropriate standardisation, both statistics tend to have the standard normal distribution as $N, T \rightarrow \infty$ diverging to negative infinity under the alternative hypothesis. Consequently, the left tail of the normal distribution is used to reject the null hypothesis of non-cointegration.

This section presents the summary of panel cointegration results among the variables. As discussed earlier, this study used three proxies for ICT usage: internet users (*USAGE*), internet access (*ACCESS*), and mobile cellular subscriptions (*MOB*). In addition, this study used the capital investment in telecommunications for ICT investment. It can be seen from Tables 6.5, 6.6, 6.7, and 6.8 that the two statistics of the Pedroni (1999) test are significant at the 1 percent level. Hence, the null hypothesis of non-cointegration is rejected. These results strongly support the existence of long-run equilibrium relations among economic growth and the explanatory variables. The Kao (1999) test showed that the null hypothesis of no cointegration relationship was rejected. That is to say, the existence of cointegration in the sample panel is confirmed.

Table 6.5: Summary of Panel Cointegration Results (Model 1).

Dep. Var.	**Outcome***	**Model Num**
F_{RGDPG} *(RGDPG |lnUSAGE, GOV, lnUSAGE × GOV, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 1.1
F_{RGDPG} *(RGDPG |lnUSAGE, CC, lnUSAGE × CC, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 1.2
F_{RGDPG} *(RGDPG |lnUSAGE, RL, lnUSAGE × RL, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 1.3
F_{RGDPG} *(RGDPG |lnUSAGE, GE, lnUSAGE × GE, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 1.4
F_{RGDPG} *(RGDPG |lnUSAGE, RQ, lnUSAGE × RQ, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 1.5
F_{RGDPG} *(RGDPG |lnUSAGE, PV, lnUSAGE × PV, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 1.6
F_{RGDPG} *(RGDPG |lnUSAGE, VA, lnUSAGE × VA, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 1.7

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; GOV is the average of the six governance indicators: CC is the control of corruption, RL is the rule of law, GE is government effectiveness, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP. In order to conserve space, this study drops the tables from the main text and reports them in Appendix A (Table A1 to Table A7).

Table 6.6: Summary of Panel Cointegration Results (Model 2).

Dep. Var.	**Outcome***	**Model Num**
F_{RGDPG} *(RGDPG |lnACCESS, GOV, lnACCESS × GOV, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 2.1
F_{RGDPG} *(RGDPG |lnACCESS, CC, lnACCESS × CC, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 2.2
F_{RGDPG} *(RGDPG |lnACCESS, RL, lnACCESS × RL, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 2.3
F_{RGDPG} *(RGDPG |lnACCESS, GE, lnACCESS × GE, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 2.4
F_{RGDPG} *(RGDPG |lnACCESS, RQ, lnACCESS × RQ, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 2.5
F_{RGDPG} *(RGDPG |lnACCESS, PV, lnACCESS × PV, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 2.6
F_{RGDPG} *(RGDPG |lnACCESS, VA, lnACCESS × VA, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 2.7

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

Note: RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; GOV is the average of the six governance indicators: CC is the control of corruption, RL is the rule of law, GE is government effectiveness, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP. In order to conserve space, this study drops the tables from the main text and reports them in Appendix A (Table A8 to Table A14).

Table 6.7: Summary of Panel Cointegration Results (Model 3).

Dep. Var.	**Outcome***	**Model Num**
F_{RGDPG}*(RGDPG |lnMOB, GOV, lnMOB × GOV, lnLF, GFCF, lnTRADE)*	Cointegrated	Model 3.1
F_{RGDPG}*(RGDPG |lnMOB, CC, lnMOB × CC, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 3.2
F_{RGDPG}*(RGDPG |lnMOB, RL, lnMOB × RL, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 3.3
F_{RGDPG}*(RGDPG |lnMOB, GE, lnMOB × GE, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 3.4
F_{RGDPG}*(RGDPG |lnMOB, RQ, lnMOB × RQ, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 3.5
F_{RGDPG}*(RGDPG |lnMOB, PV, lnMOB × PV, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 3.6
F_{RGDPG}*(RGDPG |lnMOB, VA, lnMOB × VA, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 3.7

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

Note: RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; GOV is the average of the six governance indicators: CC is the control of corruption, RL is the rule of law, GE is government effectiveness, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP. In order to conserve space, this study drops the tables from the main text and reports them in Appendix A (Table A15 to Table A21).

Table 6.8: Summary of Panel Cointegration Results (Model 4).

Dep. Var.	**Outcome***	**Model Num**
F_{RGDPG} *(RGDPG |lnINV, GOV, lnINV* $\times$ *GOV, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 4.1
F_{RGDPG} *(RGDPG |lnINV, CC, lnINV* $\times$ *CC, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 4.2
F_{RGDPG} *(RGDPG |lnINV, RL, lnINV* $\times$ *RL, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 4.3
F_{RGDPG} *(RGDPG |lnINV, GE, lnINV* $\times$ *GE, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 4.4
F_{RGDPG} *(RGDPG |lnINV, RQ, lnINV* $\times$ *RQ, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 4.5
F_{RGDPG} *(RGDPG |lnINV, PV, lnINV* $\times$ *PV, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 4.6
F_{RGDPG} *(RGDPG |lnINV, VA, lnINV* $\times$ *VA, lnLF, lnGFCF, lnTRADE)*	Cointegrated	Model 4.7

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

Note: RGDPG is real GDP growth, lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; GOV is the average of the six governance indicators: CC is the control of corruption, RL is the rule of law, GE is government effectiveness, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP. In order to conserve space, this study drops the tables from the main text and reports them in Appendix A (Table A22 to Table A28).

To conclude, the above tables illustrate the cointegrating outcomes for the ICT investment and usage variables. Overall, all cointegration tests[62] show the long-run relationship among the variables. Therefore, in this case, the current study can employ the ARDL approach to investigate the long-run effect of the ICT investment and usage variables on economic growth. In this study, the long-run equilibrium relationship is estimated by using panel ARDL (Pesaran and Shin 1995), where this study estimates four variants[63] of a long-run equation in which real GDP growth rate is 'explained' by internet users, internet access, mobile cellular use, and capital investment in telecommunications. The results of these tests are presented in the next section of Tables 6.9, 6.10, 6.11, and 6.12, respectively.

6.5. ARDL ESTIMATION RESULTS (LONG-RUN EFFECT)

The ARDL estimation results of ICT on economic growth are presented in five subsections. In subsection 6.5.1, the findings showing the impact of ICT usage on economic growth are discussed. Subsection 6.5.2 deals with the findings demonstrating the impact of ICT investment on economic growth. The direct impact of governance quality indicators on economic growth will be debated in subsection 6.5.3. Subsection 6.5.4 will discuss the moderating effect of quality of governance on the association between ICT investment and usage and economic growth. Finally, subsection 6.5.5 presents the findings for the effect of the control variables on economic growth.

6.5.1. ICT Usage and Economic Growth

In order to test the robustness of the current study results, this study utilizes three proxies for ICT usage: individuals using the internet as a percentage of the population (*USAGE*), internet access at home as a percentage of the population (*ACCESS*), and number of mobile cellular subscriptions per 100 people (*MOB*). The results show that the coefficients of these models using alternative measures for ICT usage (see columns 1-7 Tables 6.9, 6.10, and 6.11) are positive and statistically significant in almost all estimated models. The estimates of equations (*USAGE*, *ACCESS*, and *MOB*) using the ARDL method on the data set are shown in Tables

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[62] This study omits the tables from the main text to save the space and it reports them in Appendix A (Table A1 to Table A21).

[63] The four variants estimation is divided into four different models. Each model consists of seven different sub-equations for each sub-governance indicator in order to estimate the effect of each indicator separately. Furthermore, this study takes into account the average of all sub-governance indicators as independent estimation equations, as explained in Chapter 4.

6.9, 6.10, and 6.11. Column 1 of Tables 6.9, 6.10, and 6.11 shows that the average of governance indicators *GOV* is added to the regression. In the second model (2), the first governance indicator *CC* is added to the model instead of *GOV*. RL is added to the regression in the third model (3) instead of *CC*. In the fourth model (4), the study dropped *RL* and added *GE* to the regression. In the fifth model (5), the study replaced *GE* with the *RQ* indicator in the regression analyses. In the sixth model (6), the study dropped *RQ* and added *PV* into the regression. Finally, in the seventh model (7), the study replaced *PV* with the *VA* indicator. In addition, all control variables are included in each regression equation (*GFCF*, *LF*, and *TRADE*). These equations differ according to the type of proxy used in the ICT option, as mentioned and explained in Chapter 5. The same procedure is used for ICT investment in Table 6.12.

The results of column 1 of Table 6.9 reveal that *USAGE* is significant and positively associated with *RGDPG* in MENA countries. This table shows the estimates of the first proxy variable of (ICT usage). In the first model (1), *GOV* is added to the *USAGE* regression. The result shows that the coefficient of *USAGE* is 0.196 and statistically significant at the 5 percent level. The results of model (2) are reported in column 2 of Table 6.9. In the second model (2), *CC* is added to the regression. The coefficient for *USAGE*, 0.569, is positive and statistically significant at the 1 percent level.

In model (3), *RL* is added in the *USAGE* regression. The coefficient of *USAGE* is 0.126, and it is positive and statistically significant at the 1 percent level. The model (4) result is reported in column 4 of Table 6.9. In model (4), *GE* is added to the regression. The coefficient of *USAGE* is 0.185 positive, but insignificant associated with *RGDPG*.

In model (5), *RQ* is added to the *USAGE* regression. The result reveals that the coefficient of USAGE is 0.283, positive and statistically significant at the 1 percent level. The results of model (6) are reported in column 6 of Table 6.9. In model (6), *PV* is added to the regression, and the coefficient of *USAGE* becomes 0.172, which is positive and statistically significant at the 5 percent level. Finally, model (7) shows that when *VA* is added to the *USAGE* regression, the *USAGE* coefficient is 0.059, positive but insignificantly associated with *RGDPG*.

According to the above findings regarding internet users (*USAGE*), the number of internet users has a positive and statistically significant impact on economic growth in the MENA region. During the past two decades, the MENA countries have increased ICT diffusion and the numbers of internet users (International Telecommunication Union 2020) because of the importance of increasing ICT usage to boost economic growth (Arezki et al. 2018). These results are in accordance with those of Choi and Yi (2009), who investigated the impact of internet use on economic growth. Their study findings demonstrate that the internet plays a positive and significant role in economic growth. According to the findings of Salahuddin and Gow (2016), there is a long-term positive and statistically significant relationship between internet usage and GDP growth in South Africa.

On the other hand, some empirical results indicate that the internet affects labour productivity, then boosts economic growth. One of the conclusions drawn by Najarzadeh et al. (2014), who examined the effect of the internet on labour productivity for 108 countries between 1995 and 2010, the internet has a positive and significant impact on labour productivity. Moreover, they support the idea that governments need to focus on increasing internet usage to boost economic growth.

ACCESS regression models are reported in Table 6.10, which provides the estimates using the second proxy variable, ICT usage, for the regression equations. Model (1) demonstrates that *GOV* is added to *ACCESS* regression. The result of column 1 in Table 6.10 shows that the coefficient of *ACCESS* 0.272 is positive and statistically significant at the 5 percent level. Furthermore, model (2) results show *CC* added to the *ACCESS* regression model. Column 2 indicates that the coefficient of *ACCESS*, 0.091, is positive and statistically significant at the 10 percent level.

In the third model (3), *RL* is added to the *ACCESS* regression. The result shows that the coefficient for *ACCESS*, -0.151, is insignificantly associated with *RGDPG*. The results of model (4) are presented in column 4 of Table 6.10. In the fourth model (4), *GE* is added to the regression. The coefficient of *ACCESS*, 0.195, is positive and statistically significant at the 5 percent level.

RQ is added to the *ACCESS* regression in model (5), column 5. The results show that the coefficient of *ACCESS* 0.454 is positive and statistically significant at the 1 percent level. In model (6), it can be seen that *PV* is added to the regression. Column 6, which is explained in Table 6.10, shows that the *ACCESS* coefficient is 0.603, a statistically significant value at the 1 percent level. On the other hand, *VA* is added to the regression in model (7), a clear explanation that *ACCESS* is positive and other than that insignificantly associated with *RGDPG*.

In summary, the second proxy variable of ICT usage (ACCESS) results shows a positive and statistically significant effect on economic growth in the MENA region. Having access to the internet is essential for economic growth for several reasons: internet access has the ability to increase the stock of human capital because it helps people to obtain information and knowledge more easily (Sepehrdoust 2018); internet access, for example, enables businesses to interact more quickly and effectively, lowering production costs and increasing their productivity (Meijers 2014). Additionally, internet access gives people access to new markets, reduces capital costs due to improved financial market efficiency, and minimises regional disparities in incomes and productivity (Pradhan et al. 2018). Finally, governments are able to streamline their public services using internet access, resulting in a more business-friendly environment. These optimised services include e-governance and electronic customs processing (De Wulf and Sokol 2004).

Table 6.11 presents the regression model of *MOB*, which is the third proxy that has been used in this study for ICT usage. In model (1), *GOV* is added to *MOB* regression, and results in the coefficient of *MOB* being 0.098 and in it being positive and statistically significant at the 10 percent level. Column 2 shows the result of model (2), in which the *CC* is added to the regression. The result of model (2) indicates that the coefficient of *MOB* is 0.035, and it is positive and statistically significant at the 5 percent level.

RL is added to the *MOB* regression in model (3), and the results show that the *MOB* coefficient 0.135, is positive and its value is insignificantly associated with *RGDPG*. In the following model, (4), *GE* is added to the regression and the *MOB* coefficient 0.195, is positive and statistically significant at the 5 percent level.

Model (5) depicts a positive and statistically significant value of *RQ*, 0.313 at the 1 percent level when added to the *MOB* regression. Furthermore, model (6) clarifies that the effect of *PV* when added to the *MOB* regression, results in a positive and statistically significant coefficient, 0.059 at the 10 percent level. Ultimately, model (7) shows a negative coefficient of *MOB* where *VA* is added, which is insignificantly associated with *RGDPG*.

Mobile cellular subscription (*MOB*) is positively and significantly associated with economic growth, in line with some other empirical studies, according to which the increase in the number of mobile phone subscribers would lead to boosting economic growth by facilitating various financial transactions and government services. These results are consistent with those of Ghita-Mitrescu and Duhnea (2016), while Lin and Lin (2007) demonstrate the significance of ICT usage in some major sectors of the economy (e.g., the banking sector), which highlights the role of ICT in improving banking performance. Customers can access banking services, and the banks receive feedback about customer satisfaction with their performance. These results are consistent with those of studies conducted by Lee et al. (2012) and Haftu (2019), who investigate the effect of telecommunication infrastructure on economic growth in sub-Saharan Africa. The studies show that mobile phone expansion leads to an increase in the GDP growth rate in sub-Saharan Africa. They find one of the main results of increasing the per capita income in sub-Saharan Africa was the increase in the number of mobile phone subscribers.

Further, the results show that a 10 percent increase in mobile phone penetration improves the GDP per capita by an estimated 1.2 percent. These results are confirmed by Sassi and Goaied (2013), who reveal a positive and statistically significant effect of mobile phones on economic growth between 1960 and 2009 in the MENA region. In other words, these results indicate that it is recommended that policymakers take into consideration the role of telecommunications in boosting a country's economy (Pradhan et al. 2016).

The current study's findings are broadly in line with the theoretical and empirical evidence in the literature. The current study indicates that ICT usage is a significant driver of economic growth in the MENA region. For example, the results are consistent with the main economic growth theories that postulate that technology is the main driver of economic growth, as shown in the Solow (1956) and Romer (1986, 1990) models. They agree that increases in productivity from ICT will directly and indirectly lead to increased revenue for capital investment and thus result in raising GDP. Recently, ICT usage in many economic institutions and international corporations has increased—especially internet and mobile phone usage—to facilitate the processes of production and communication between sectors, ultimately improving the economic performance of countries (International Telecommunication Union 2017). A study conducted by Thompson Jr and Garbacz (2007) note that the world's rate of progress and productive efficiency—especially in low-income countries—rose when the adoption rates of telecommunication services were high. They discovered this through testing panel data from 93 countries for the period 1995–2003. Similarly, Vu (2011) investigated the impact of ICT on economic growth for 102 countries from 1996 to 2005 and found that those countries that witnessed high levels of economic growth due to ICT observed a statistically significant correlation between ICT and economic growth. The author also found that PCs, mobile phone, and internet usage influence economic growth.

To conclude, the present study's estimates indicate a positive and significant effect of ICT usage on *RGDPG*, even when the three indicators are used as proxies for ICT usage separately. However, the magnitude of the impact of ICT usage is different, depending on the type of proxy considered in the analysis. This study finds that an increase in ICT usage would contribute to real GDP growth in MENA countries. Several studies have confirmed the high contribution of ICT, such as the internet and mobile phones, to the economic growth of numerous countries around the world (Gruber and Koutroumpis 2010; Inklaar et al. 2005; Koutroumpis 2009).

6.5.2. ICT Investment and Economic Growth

This section presents the results of the effect of ICT investment (*INV*) on economic growth in the MENA countries. The results show that *INV* positively affects the economic growth of MENA countries in some models estimated (see columns 1–7 of Table 6.12). In model (1), GOV is added to *INV* regression, and result in the coefficient of *INV* is positive, and it is insignificantly associated with *RGDPG*. Column 2 shows the result of model (2), in which the *CC* is added to the regression. The result of model (2) indicates that the coefficient of *INV* is 0.153, and it is positive and statistically significant at the 10 percent level.

In model (3), *RL* is added to the *INV* regression. The result appears that the coefficient of INV is positive, and it is insignificantly associated with *RGDPG*. In model (4), *GE* is added to the regression. Column 4 shows that the coefficient of *INV* is negative, and it is insignificantly associated with *RGDPG*.

Model (5), *RQ* is added to the *INV* regression. The result reveals that the coefficient of INV is negative, and it is insignificantly associated with *RGDPG*. On the other hand, model (6) results are reported in column 6 of Table 6.12. In model (6), *PV* is added to the regression, and the coefficient of *USAGE* becomes 0.649, which is positive and statistically significant at the 5 percent level. Finally, model (7) shows that when *VA* is added to the *INV* regression, the *INV* coefficient is 0.117, positive and statistically significant at the 10 percent level.

The previous results imply that *INV* has an insignificant impact on economic growth in the MENA region in most estimated models. This implies that the MENA region has not invested enough in ICTs during the last two decades. Further, like most developing economies, the MENA economies do not benefit economically from investing in ICT, as do the developed countries. This conforms with the results of Dedrick et al. (2013) and Niebel (2018), who find that developing and emerging countries do not gain more economic growth from ICT investment than developed countries. In addition, the insignificant results of INV implies that these countries are not gaining the so-called 'leapfrogging impact' proposed by Steinmueller (2001). Steinmueller (2001) argues that developing countries can achieve higher economic growth rates through an increase in the effectiveness of ICT investment. The leapfrogging strategy involves enabling developing economies to skip some steps related to accelerating and boosting their economic growth.

6.5.3. Governance Quality and Economic Growth

The direct impact of governance quality indicators on economic growth in most models for *USAGE*, *ACCESS*, and *MOB* is positive and significant (see columns 1–7 of Tables 6.9, 6.10, and 6.11), except in the *INV* models, where they have an insignificant effect on economic growth (see columns 1–7 of Table 6.12). The coefficient of *GOV* is 0.417 and is statistically significant at the 5 percent level (see column 1 in Table 6.9). The coefficient of *GOV* is -0.100 and -0.892, respectively, and is insignificantly associated with *RGDPG* (see column 1 in Tables 6.10 and 611). Regarding other governance indicators, such as *CC*, some positively impact economic growth in some estimations, but an insignificant impact on economic growth in other cases (see column 2 of Tables 6.9, 6.10, and 6.11). The coefficients of *CC* are 3.731 and 5.263, in Tables 6.10 and 6.11, respectively, and they are also statistically significant at 1 percent. On the other hand, the coefficient of *CC* is 0.196 in Table 6.9 but insignificantly associated with *RGDPG*.

The results of the direct effect of governance quality show that the effects of *RL* on economic growth in MENA countries are positive and statistically significant in most estimated models (see column 4 of Tables 6.9, 6.10, 6.11). For example, the coefficients of *RL* in Tables 6.9 and 6.10 are 1.449 and 1.416, respectively. They are statistically significant at the 1 and 5 percent levels, respectively. On the other hand, the coefficient of *RL* is 1.079, negatively but insignificantly associated with *RGDPG*, as presented in Table 6.11. Further, the results show that *RL* has a positive and significant effect on economic growth in the MENA region in most estimated models (see column 4 of Tables 6.9, 6.10, 6.11). The coefficients of *GE* in Table 6.9 and Table 6.10 are 2.395 and 2.039, respectively, and statistically significant at the 1 percent level. In contrast, Table 6.11 presents a negative coefficient of 0.268 for *GE*, which is insignificantly associated with *RGDPG*.

The democracy (or VA) findings are positive and statistically significant (see column 7 of Tables 6.9, 6.10, and 6.11). The coefficients of *VA* are 1.694 and 4.417 in Tables 6.9 and Table 6.10, respectively. Furthermore, they are statistically significant at the 1 percent level.

However, the coefficient of *VA* is 0.621, negatively and statistically insignificantly associated with *RGDPG* (see column 7 of Table 6.11). It can be seen that democracy has an insignificant effect on economic growth in the MENA region (see Tables 6.11 and 6.12).

In light of the results of the measures of quality of governance indicators, the results have shown contradictory impact on economic growth. Some of these indicators are positive, and some are negative. Further, some are significant, but the majority have an insignificant impact on economic growth in MENA countries (see columns 1-7 of Tables 6.9, 6.10, 6.11, and 6.12). The coefficients of *GE* and *RL* are positive and show consistent significant association with *RGDPG* in almost all models (see columns 3 and 4 of Tables 6.9, 6.10, and 6.11). This shows that only *GE* and *RL* indicators can boost the economic growth in the MENA region, whereas the other indicators may not do so for *RGDPG*. Hence, the inconsistent empirical results of governance quality indicators confirm that the governance indicators do not explain economic growth in isolation. These findings are consistent with Glaeser et al. (2004) and Méon and Sekkat (2008), who state that the role of quality of governance in economic growth is insignificant or negative in developing countries due to the fact that economic growth depends on the policies pursued; it is a factor of stability, and is not related to the quality of governance. Growth diagnostics on Brazil and the Dominican Republic conduct by Hausmann et al. (2008) present varied results. They show that reforming all governance quality indicators in Brazil will not increase growth or that it is not a binding constraint. They also find that the Dominican Republic's low governance quality indicators increase the economic growth. Thus, they conclude a targeted approach to one or two indicators may not be effective, but broad reforms are required to enhance economic growth (i.e., all governance quality indicators). These results are confirmed by Bellos and Subasat (2012), who find that even countries with poor governance, such as those in the MENA region, are able to increase their economic growth.

Some studies have found that governance indicators (e.g., government effectiveness and rule of law) alone affect economic growth (e.g. Alam et al. 2017; Hausmann et al. 2008; Huynh and Jacho-Chávez 2009). They argue that *RL* and *GE* can improve economic growth by boosting the quality of public services and increasing the quality of the civil service, which results in improvements to the quality of government services. Barro (1996b) argues that increasing the rule of law by one point leads to a 0.5% increase in the economic growth rate.

The findings of the present study, as far as *RL* and *GE* are concerned, provide support for the suggestions of the World Bank report.[64] In 2019, the World bank suggests that the MENA countries should reform their judicial systems as well as their legal structures by promoting the rule of law and transparency, to enhance economic growth. Moreover, the World Bank report shows that the improvement of economic growth depends on government effectiveness in implementing policies that can help to attract new investors to the region. This is because investors are generally searching for ways to ensure their investments and business practices are secure and predictable.

[64] Please see https://www.mei.edu/publications/justice-and-rule-law-world-bank-need-reinventing-itself

Table 6.9 (Model 1): ARDL Estimation of Internet Usage (USAGE) and Economic Growth.

	Dependent variable: RGDPG						
	GOV (1)	CC (2)	RL (3)	GE (4)	RQ (5)	PV (6)	VA (7)
Long-run coefficients:							
$lnUSAGE_{i,t}$	0.196** (2.341)	0.569*** (6.589)	0.022 (0.317)	0.185*** (2.630)	0.283*** (4.050)	0.172** (2.337)	0.059 (0.627)
$GOV_{i,t}$	0.417** (0.546)	0.196 (0.334)	1.449*** (4.693)	2.395*** (3.829)	0.879 (1.355)	-0.330 (-1.077)	1.694*** (3.404)
$lnUSAGE_{i,t} * GOV_{i,t}$	0.218*** (2.974)	0.277** (2.048)	0.126 (1.543)	0.289* (1.734)	0.153** (1.949)	0.128** (2.307)	0.239* (1.795)
$lnLF_{i,t}$	5.410*** (3.020)	14.937*** (7.960)	1.015*** (2.921)	0.649 (1.177)	6.354*** (4.365)	5.057*** (2.618)	0.223 (0.419)
$lnGFCF_{i,t}$	0.453 (0.813)	7.003*** (23.043)	0.824* (1.761)	0.397 (0.576)	-0.178 (-0.323)	0.316 (0.465)	1.869*** (3.171)
$lnTRDAE_{i,t}$	-0.572 (-0.847)	2.879*** (8.069)	0.554* (1.711)	0.039 (0.080)	-0.877 (-1.295)	-0.685 (-0.936)	0.747* (1.735)
$DSPRING_{i,t}$	-1.844*** (-10.739)	-0.182 (-1.376)	-1.045*** (-6.499)	-1.538*** (-6.499)	-1.821*** (-11.529)	-1.908*** (-9.814)	-1.082*** (-3.950)
Short-run coefficients:							
Error correction term	-0.9294*** (-6.7584)	-0.8471*** (-4.5680)	-0.8257*** (-4.6502)	-0.7590*** (-8.0932)	-1.005*** (-6.5208)	-0.9274*** (-6.9855)	-0.7512*** (-8.8754)
Observations	349	347	335	363	349	349	363
Number of lags (ARDL)	(2, 1, 1, 1, 1, 1, 1)	(1, 2, 2, 2, 2, 2, 2)	(3, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; GOV is the average of the six governance indicators: CC is the control of corruption, GE is government effectiveness, RL is the rule of law, RQ is the regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The test values are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. t-statistics are reported in parentheses.

Table 6.10 (Model 2): ARDL Estimation of Internet Access at Home (ACCESS) and Economic Growth.

	Dependent variable: RGDPG						
	GOV (1)	CC (2)	RL (3)	GE (4)	RQ (5)	PV (6)	VA (7)
Long-run coefficients:							
$lnACCESS_{i,t}$	0.272** (2.461)	0.091* (1.873)	-0.151 (-1.606)	0.031** (1.077)	0.237*** (4.257)	0.454*** (4.437)	0.603 (5.219)
$GOV_{i,t}$	-0.100 (-0.238)	3.731*** (7.117)	1.416** (2.398)	2.039*** (2.993)	2.646 (3.791)	-0.318 (-0.642)	4.417*** (5.671)
$lnACCESS_{i,t} * GOV_{i,t}$	0.405*** (4.229)	0.564*** (4.114)	0.358** (2.1208)	0.839*** (4.554)	0.427*** (5.017)	-0.134 (-1.297)	1.489*** (6.300)
$lnLF_{i,t}$	6.102*** (6.988)	0.379 (0.961)	-0.721 (-0.987)	0.291 (1.164)	3.383** (2.304)	-4.429 (-1.531)	-2.007 (-1.345)
$lnGFCF_{i,t}$	0.943** (2.441)	-0.682 (-1.125)	0.552 (0.736)	1.527*** (3.482)	1.162** (2.042)	0.624 (0.680)	3.626*** (6.822)
$lnTRDAE_{i,t}$	-0.074 (-0.160)	1.073** (2.173)	1.168** (2.034)	1.813*** (4.313)	0.198 (0.320)	2.784*** (2.853)	1.317** (2.207)
$DSPRING_{i,t}$	-1.505*** (-11.476)	-1.346*** (-9.146)	-0.630** (-2.057)	-1.377*** (-20.434)	-1.335*** (-9.663)	-0.940*** (-4.022)	-0.989*** (-5.677)
Short-run coefficients:							
Error correction term	-1.1769*** (-5.3598)	-0.9207*** (-6.5901)	-0.7663*** (-5.5157)	-0.7948*** (-7.2642)	-1.0767*** (-6.6564)	-0.8332*** (-11.7916)	-0.9271*** (-5.7569)
Observations	320	347	360	320	347	360	347
Number of lags (ARDL)	(4, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)	(4, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1)

Note: RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; GOV is the average of the six governance indicators: CC is the control of corruption, GE is government effectiveness, RL is the rule of law, RQ is the regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag selection criterion in this model is Akaike's information criterion (AIC). The test values are significant at * $p < 0.1$, **$p < 0.05$, ***$p < 0.01$. *t*-statistics are reported in parentheses.

Table 6.11 (Model 3): ARDL Estimation of Mobile Cellular Subscriptions (MOB) and Economic Growth.

	Dependent variable: RGDPG						
	GOV (1)	CC (2)	RL (3)	GE (4)	RQ (5)	PV (6)	VA (7)
Long-run coefficients:							
$lnMOB_{i,t}$	0.098* (0.998)	0.035* (0.341)	0.135 (1.771)	0.195** (1.905)	0.313*** (3.953)	0.059* (0.599)	-0.101 (-1.056)
$GOV_{i,t}$	-0.892 (-1.158)	5.263*** (5.103)	-1.079 (-0.952)	-0.268 (-0.267)	-0.442 (-0.681)	1.067 (1.922)	-0.621 (-1.110)
$lnMOB_{i,t} * GOV_{i,t}$	0.253*** (2.694)	1.265*** (4.579)	0.470* (1.909)	-0.031 (-0.214)	0.336*** (4.146)	0.231* (1.879)	0.001 (0.006)
$lnLF_{i,t}$	-1.945 (-0.876)	-2.107 (-0.775)	1.371*** (4.464)	-1.977 (-0.671)	-2.334 (-1.526)	-0.870 (-1.610)	0.585 (1.129)
$lnGFCF_{i,t}$	2.250*** (3.015)	-0.117 (-0.117)	2.442*** (5.993)	-1.610 (-1.548)	1.701*** (2.898)	1.754*** (3.666)	0.920* (1.660)
$lnTRDAE_{i,t}$	-0.973 (-1.316)	1.268 (1.119)	0.587*** (2.878)	-0.171 (-0.166)	1.790*** (2.883)	0.653* (1.703)	-0.065 (-0.163)
$DSPRING_{i,t}$	-1.569*** (-9.056)	-1.743*** (-6.752)	-1.558*** (-7.638)	-1.977*** (-8.926)	-1.618*** (-12.073)	-1.764*** (-10.123)	-1.824*** (-7.648)
Short-run coefficients:							
Error correction term	-0.9694*** (-6.7261)	-0.7710*** (-8.8293)	-0.8589*** (-4.8393)	-0.8402*** (-9.8326)	-1.0286*** (-6.3808)	-0.8328*** (-5.9168)	-0.7839*** (-10.0003)
Observations	351	366	350	366	351	351	366
Number of lags (ARDL)	(2, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)	(2, 2, 2, 2, 2, 2, 2)	(1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)

Note: RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; GOV is the average of the six governance indicators: CC is the control of corruption, GE is government effectiveness, RL is the rule of law, RQ is the regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag selection criterion in this model is Akaike's information criterion (AIC). The test values are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *t*-statistics are reported in parentheses.

Table 6.12 (Model 4): ARDL Estimation of Capital Investment in Telecommunications (INV) and Economic Growth.

	Dependent variable: RGDPG						
	GOV	CC	RL	GE	RQ	PV	VA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Long-run coefficients:							
$lnINV_{i,t}$	0.305	0.153*	0.036	-0.178	-0.069	0.649**	0.117*
	(1.161)	(0.519)	(0.165)	(-0.827)	(-0.341)	(2.401)	(0.3023)
$GOV_{i,t}$	-0.644	-0.328	0.116	2.617	-0.507	-0.354	0.549
	(-1.438)	(-0.496)	(0.275)	(2.510)	(-1.610)	(-1.325)	(1.441)
$lnINV_{i,t} * GOV_{i,t}$	0.040	0.503*	-0.201	0.587	0.289	0.399*	0.661**
	(0.137)	(1.720)	(-0.668)	(3.471)	(1.740)	(1.847)	(2.338)
$lnLF_{i,t}$	0.577	-4.034	-0.758	5.401	0.802	-0.109	7.215**
	(1.213)	(-1.282)	(-1.290)	(2.023)	(2.084)	(-0.240)	(2.128)
$lnGFCF_{i,t}$	0.084	2.230**	1.191**	8.040	0.147	0.714	0.986
	(0.158)	(2.325)	(2.014)	(10.594)	(0.400)	(1.539)	(0.984)
$lnTRDAE_{i,t}$	0.510	3.923***	0.883**	1.607	0.245	0.675**	6.054***
	(1.275)	(3.547)	(2.427)	(1.799)	(0.699)	(2.096)	(5.338)
$DSPRING_{i,t}$	-1.513***	0.104	-1.714***	1.351	-1.017	-1.632***	-0.867**
	(-5.884)	(0.256)	(-7.001)	(3.049)	(-4.343)	(-6.998)	(-1.982)
Short-run coefficients:							
Error correction term	-0.7320***	-0.884***	-0.7721***	-0.8210***	-0.8430***	-0.7670***	-0.8636***
	(-9.6709)	(-11.7134)	(-9.0637)	(-5.9613)	(-7.1917)	(-9.9459)	(-10.1323)
Observations	366	366	366	350	350	366	366
Number of lags (ARDL)	(1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)	(1, 2, 2, 2, 2, 2, 2)	(1, 2, 2, 2, 2, 2, 2)	(1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1)

Note: RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; GOV is the average of the six governance indicators: CC is the control of corruption, GE is government effectiveness, RL is the rule of law, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag selection criterion in this model is Akaike's information criterion (AIC). The test values are significant at * $p < 0.1$, **$p < 0.05$, ***$p < 0.01$. *t*-statistics are reported in parentheses.

6.5.4. Moderating Effect of Governance Quality

In this study, we hypothesize that the direct impact of improved ICT investment and usage on economic growth depends on the quality of governance. This is owing to an improved governance association with high economic growth and investment, which are drivers of the improved effectiveness of ICT usage as well. However, the final impact of ICT investment and usage on economic growth in my analysis relies on the governance indicators. Without considering their levels, we cannot form a definite judgment about the impact of governance on this association.

This section consists of two subsections: subsection 6.5.4.1 discusses the results of the moderating role of governance quality on the association between ICT usage and economic growth. Subsection 6.5.4.2 deals with the results of the moderating role of governance quality on the association between ICT investment and economic growth.

6.5.4.1. Moderating effect of governance quality on the link between ICT usage and economic growth

This section discusses the moderating role of the quality of governance on the impact of three proxy variables of ICT usage (*USAGE*, *ACCESS*, and *MOB*) on economic growth in MENA countries. The results show that the interaction term between the *GOV* and *USAGE*, *ACCESS*, and *MOB* positively impact economic growth, as their coefficients are 0.218, 0.405, 0.253, respectively. Furthermore, they are statistically significant at the 1 percent level (see column 1 of Tables 6.9, 6.10, and 6.11). These results indicate that the quality of governance is indeed influential in the association between ICT usage and economic growth in MENA countries. Moreover, this implies that countries with good quality governance can increase the effectiveness and performance of ICT usage and ultimately boost economic growth. These results are in line with studies by Kadhim (2013) and Dixit (2009), who investigated the importance of promoting institutions to motivate economic sectors including ICT, the results of which are reflected in economic growth.

Likewise, quality governance increases the chances of successful absorption of foreign technologies. Countries that have a good quality of governance have the ability to receive more investment flows that carry significant technological content (Ali et al. 2010; Méon and Sekkat

2008). These flows increase domestic exposure to foreign technologies, leading to promoting and improving labour productivity (Meyer and Sinani 2009; Saggi 2004). That is, good quality governance is more attractive to foreign investors due to the fact that these countries have fewer constraints for foreign direct investment (Crespo and Fontoura 2007). To conclude, this result indicates that governance is an important factor in economic activities and transactions, and these transactions cannot function well in its absence. Moreover, governance quality plays a leading role in the exploitation of information and communication technology used to promote economic growth.

It is commonly agreed that countries with lower levels of corruption enjoy faster economic growth, better infrastructure, and more foreign and local investment. On the other hand, pervasive corruption in the country is frequently accompanied by a lack of economic efficiency (UNDP, 2008). The current study's results, as far as interaction terms between *CC* and *USAGE*, and *ACCESS* and *MOB* are concerned, show a positive impact of these interaction terms on economic growth. The coefficients for the interaction terms are 0.277, 0.564, 1.265, respectively. Further, they are statistically significant at the 1 percent level (see column 2 of Tables 6.9, 6.10, and 6.11). These results are in line with Yoon and Chae (2009, p. 34), who demonstrate that "corruption actually lowers the effectiveness of national e-strategy and its implementation." Kim et al. (2009) and Lio et al. (2011) propose that governments must establish effective anticorruption measures to increase the effectiveness of ICT access and usage. In other words, the existence of corruption in a country will hinder the growth of ICT and will affect the level of technological sophistication it has attained. Likewise, some studies have found that corruption can hinder ICT development (e.g., Oruame 2008; Quibria et al. 2003). To sum up, a country with good control of corruption will experience ICT development. In other words, a country with efficient control of corruption will positively impact information infrastructure growth, which leads to an increase in the probability of technology exposure and usage.

Looking at the interaction term between *RL* and *ACCESS* and *MOB* variables, its coefficients (0.358 and 0.470) are positive and statistically significant (see column 4 of Tables 6.10 and 6.11) at the 5 and 10 percent levels, respectively. On the other hand, the interaction term between *RL* and *USAGE* is positive and insignificantly associated with *RGDPG*. Overall, the results demonstrate that *RL* can increase the effectiveness of ICT usage and therefore lead to higher economic growth. *RL* extends to cybercrime law, which identifies standards of acceptable behaviour for ICT users. Cybercrime law establishes socio-legal sanctions against conduct such as spreading rumours and hacking websites and aims to protect ICT users and their personal information (United Nations Office on Drugs and Crime 2013)[65]. Cybercrime may result in the loss of confidential business information, which decreases a company's competitiveness. It may also cause reputational harm for companies, which is reflected in the public trust in the company's online operations.[66] Many companies in the MENA region have relied on cybercrime laws and regulations to protect their data and information from being hacked. Such measures have also helped to reduce employee distraction and to increase the efficiency of work and labour productivity, which in some MENA countries, such as Jordan, Israel, UAE, and Qatar have adopted laws related to browsing on internet pages not related to work in order to curb the negative impact on employee productivity during official work hours (Mawgoud et al. 2019).

Regarding the interaction term between *GE* and *USAGE* and *ACCESS*, they positively impact economic growth, as their coefficients are 0.289 and 0.839, respectively. Furthermore, they are statistically significant at the 10 and 1 percent levels (see column 4 of Tables 6.9 and 6.10). Conversely, the interaction term between *GE* and *MOB* is negative and insignificant associated with *RGDPG* (see column 4 of Table 6.11). This implies that the interaction terms for *GE* and *USAGE* and *ACCESS* are positively associated with economic growth in the MENA region. These results are in line with the objectives of governments, which are to provide and develop public services, and the formulation and implementation of policy that can help citizens and businesses to gain access to public services, including ICT services (Srivastava and Teo 2007). In other words, by drawing from the resource complementarity perspective, it is logical to assume that a higher level of government effectiveness leads to a good ICT infrastructure, which in turn in will lead to increases in the effectiveness of ICT usage and

[65] Please see United Nations Office on, D & Crime 2013, 'Global study on homicide 2013: trends, contexts, data', UNODC.

[66] McAfee and Center for Strategic and International Studies (CSIS) (2013), The Economic Impact of Cybercrime and Cyber Espionage, www.mcafee.com/us/resources/reports/rp-economic-impact-cybercrime.pdf.

access, and therefore lead to higher levels of economic growth (Teo and Koh 2010). Therefore, the government should successfully achieve these objectives to enhance economic growth (Kaufmann et al. 1999b). The study results are consistent with Weill (1993), who argues that governance effectiveness strongly affects how information infrastructure is employed to raise productivity. These results were also confirmed by Meso et al. (2009) in their study of developing countries: they show that governance effectiveness can affect the kind of ICT systems and technologies that are developed.

Among the interaction terms between ICT usage variables and the quality of governance indicators, *RQ* has a positive association between *USAGE*, *ACCESS*, and *MOB* variables and economic growth (see column 5 of Tables 6.9, 6.10, and 6.11). The coefficients for the interaction terms are 0.153, 0.427, and 0.336, respectively. They are positive and statistically significant at the 5 and 1 percent levels, respectively. *RQ* refers to the government's ability to permit and promote private sector development and to the role of government in resource allocation and organizing market mechanisms. It therefore leads to increasing competitiveness and attracting new investment. This will lead to an expansion of the market share of enterprises and the scale of industry and thus boost economic growth (Meyer and Sinani 2009; Silberberger and Königer 2016; Wei 2000). Furthermore, the role of regulatory quality stimulates local entrepreneurship and encourages domestic innovation systems (Audretsch and Thurik 2001; Krammer 2009). As a result, countries with a higher level of regulatory quality will gain more returns from foreign and domestic sources of innovation, as reflected in higher productivity levels. This is particularly so when compared with lower quality governance countries due to lower regulatory quality.

According to the Global Competitiveness Indicator,[67] MENA countries such as the UAE, Qatar, and Saudi Arabia have a good regulatory quality, as evidenced by high competitiveness in all their economic sectors, including ICT sectors. In terms of ease of doing business, the UAE leads in the region and holds 11th position in the World Bank ranking as of 2019. Hence,

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[67] Please see http://www3.weforum.org/docs/Arab-World-Competitiveness-Report-2018/AWCR%202018.0724_1342.pdf

when business operators are given wider freedom to conduct their activities, they save time and costs, which is reflected in economic growth.

This result indicates that the MENA region can increase the effectiveness of ICT usage by lifting some restrictions on entry to ICT markets and increasing competition and marketing. This can be done by allowing a larger share of the MENA population to enjoy and benefit from internet access. The current study findings align with Wallsten (2005), who shows that developing countries' regulatory policies have considerable effects on ICT usage and accessibility. In particular, Wallsten (2005) proposes that a country's regulatory approach to ICT can have a sizeable impact on its ubiquity throughout the country, as reflected in increased ICT usage. He also finds that increasing the regulatory quality, in terms of promoting market competition, could increase internet access in developing countries and raise the potential benefits of businesses and individuals due to this access. In other words, promoting ICT competition can lead to an increase in internet use in developing countries.

The interaction terms between *PV* and *USAGE* and *MOB* are positive, 0.128 and 0.231, respectively, and statistically significant at the 5 and 10 percent levels (see column 6 of Tables 6.9 and 6.11). On the other hand, the coefficient of the interaction term between *PV* and *ACCESS* (see column 6 of Table 6.10) is insignificantly associated with *RGDPG*. This result is in line with Sadowsky (1993), who demonstrates that political stability is an important factor for increasing foreign direct investment in data network infrastructure. Furthermore, the results present the fact that a greater degree of political instability leads to an increase in the risk of investing in the country, especially in its ICT infrastructure. This result was confirmed by Meso et al. (2006), who reveal that the countries that suffer from political instability and witness a high level of conflict usually suffer from imbalances in the infrastructure, which leads to a reduction in the effectiveness of ICT usage and access, as a result of the weakness in the ICT infrastructure. In other words, a high level of political stability increases the effectiveness of ICT infrastructure, which allows better ICT diffusion, and so ICT exposure in the society increases. Finally, this leads to raising the effectiveness of ICT usage for economic growth.

Regarding the interaction term between democracy (*VA*) and the proxy variables of ICT usage, the results show that *USAGE* and *ACCESS* are positive and statistically significant at 10 and 1 percent levels, respectively. The coefficients for these interactions are 0.239 and 1.489, respectively (see column 7 of Tables 6.9 and 6.10). In contrast, the coefficient of the interaction term between *VA* and *MOB* is positive (see column 7 of Table 6.11) but insignificantly associated with *RGDPG*. This result implies that *VA* is an important tool for improving the effectiveness of ICT usage on economic growth in the MENA region. This result is consistent with Balkin (2004), who argues that ICT usage and access are conditioned by free expression and democracy and vice versa. In other words, increased freedom of expression and openness, public debate, and free media, all lead to the enhancement of ICT usage and access. (Goetz and Jenkins 2001, 2002). When citizens enjoy free expression and democracy, there is an increase in ICT access and usage, and people are more inclined to participate in the political process (Weare 2002). The results of the present study support these claims. ICT and social media can also be used to organize pressure groups, express grief, and protest against different political and economic issues, which in turn improves government effectiveness and helps to increase economic growth. To conclude, the above studies argue that the countries that have a high level of freedom of expression (VA) have the ability to increase the effectiveness of ICT usage, which leads to economic growth.

In conclusion, the findings of this study show that all governance indicators are very important factors in the association between ICT usage and economic growth in the MENA region. Following these findings, it is concluded that ICT usage in the MENA region will not lead to any significant improvements in economic growth unless effective governance indicators are implemented.

6.5.4.2. Moderating effect of governance quality on the link between ICT investment and economic growth

This section investigates the interaction term between the *INV* and quality of governance indicators and economic growth in the MENA region. The results of this model demonstrate that there are a few estimations for interaction terms, such as *CC* and *PV* (see columns 2 and 6 of Table 6.12), that have a positive effect on economic growth. The coefficients of these interactions are 0.503 and 0.399, respectively. Furthermore, both are statistically significant at the 10 percent level. These results are aligned with those of Al-Rawashdeh et al. (2013), Crespo and Fontoura (2007), Sabir et al. (2019), and Tang and Abosedra (2014). These authors have shown that countries that have good quality governance indicators (particularly control of corruption and political stability) have the ability to receive investment flows that carry significant technological content. These flows increase domestic exposure to foreign technologies, leading to the promotion of, and improvement in, labour productivity in the region, which in turn leads to enhanced economic growth (Saggi 2004).

The study also finds that the interaction term between democracy (or *VA*) and *INV*, 0.661 (see column 7 of Table 6.12), is positively associated with *RGDPG* and statistically significant at the 5 percent level. This result is consistent with previous theoretical findings, such as those by Barro (1996a) and Helliwell (1994), who proved the existence of positive interaction between the institutional environment (*VA*) and the productivity of investment. This means that investment performance relies on a good institutional environment and implies that countries with high levels of civil freedoms tend to be the most prosperous. This result is in line with the findings of Scully (2014), who shows that increased civil freedoms and economic prosperity go hand in hand.

This study thus finds that civil liberties and political rights (*VA*) promote the effectiveness of investment. This result is comparable to those of several studies that have investigated the role of institutions in the economic performance of countries. Kormendi and Meguire (1985) found that civil and political freedoms had a significant impact on economic growth and investment in 47 countries from 1950 to 1977, and that countries with high levels of civil rights tended to be the most prosperous. Furthermore, this result is consistent with that of Isham et al. (1997), who compared the results of 100 projects supported by the World Bank between 1974 and 1993 in a selection of developing nations. They found that a one-point boost in the index of civil liberties and political rights results in significant improvements to a project's return.

Conversely, the insignificant interaction among *INV* and the remainder of the governance indicators (see columns 1,3, 4, and 5 of Table 6.12) indicates that governance indicators do not increase the effectiveness of ICT investment on economic growth if only some of them are present. To enhance the effectiveness of ICT investment and increase economic growth, an environment is needed where all governance quality indicators are high (Bellos and Subasat 2012; Glaeser et al. 2004). This result is in line with those of King et al. (1994), who show that governance quality has a significant influence on ICT investment settings—for instance, governments can introduce helpful market policies, such as price control and free movement of capital, which create a good investment environment in all economic sectors, including ICT. Furthermore, the findings illustrate that if the countries improve their quality of governance, this, in turn, can improve the effectiveness of ICT investment on economic growth. This result is consistent with those of North (1990) and Sabir et al. (2019), who found that good quality of governance affects economic activities by decreasing manufacturing and production costs. Furthermore, good quality of governance can minimise the cost of doing business and raise profitability.

In contrast, investors hesitate to invest in risky environments, such as those in countries with poor quality of governance. This links good quality of governance to better international and local investment. This result is consistent with those of Hausmann et al. (2008) and Rodrik (2012), who recommended that policymakers should not apply the same policies across countries, but rather should conduct an independent analysis of growth for each country to determine country-specific bottlenecks and barriers to growth. Generally, investors hesitate to invest in the risky environment of countries that have a poor quality of governance. In summary, investors prefer locations that offer the best economic and institutional facilities (Dunning 2006).

To conclude, the findings provide support for the World Bank's (2018) policy recommendations for the MENA region, and show that improvement of the effectiveness of ICT investment on economic growth depends on governance quality in implementing policies that can help to attract new investors to the region. In other words, investors look for countries with good economic and institutional facilities and select countries that are not perceived as violent or have a probability of political instability. In general, investors are interested in countries that have excellent levels of control of corruption and they avoid those in which public power is abused for private gain. Moreover, they are attracted to countries that respect civil liberties and political rights (i.e., that have a higher level of democracy). In other words, the final outcome of ICT investment on economic growth in MENA countries depends on the quality of governance indicators, such as *VA*, *CC*, and *PV*. At the higher levels of these indicators, more ICT investment leads to higher economic growth in the MENA countries. This leads to the conclusion that, to obtain the expected economic benefits from ICT investment, an environment is needed where all governance indicators are favourable.

6.5.5. Control Variables and Economic Growth

This section discusses the results of the effects of the control variables on economic growth in the MENA region. The coefficient of *LF* is statistically significant and has the expected positive sign in the results of most models (see columns 1-7 of Tables 6.9, 6.10, 6.11, and 6.12). This implies that a higher *LF* participation rate leads to an increase in *RGDPG*. These findings are consistent with the economic growth theories and most empirical studies. Theories and empirical studies show that the labour force positively affects economic growth (Benos and Zotou 2014; Gyimah-Brempong et al. 2006; Hanushek and Woessmann 2010; Mankiw et al. 1992; Romer 1990; Solow 1956; Temple 1999). Furthermore, according to studies by Barro (1996b) and Barro and Sala-i-Martin (1997), the labour force is one of the main determinants of economic growth. According to Romer (1990), an increase in the percentage of labour force productivity leads to a rise in per capita GDP growth. The growth rate of the labour force has a reciprocal effect on productivity and knowledge growth.

GFCF is the second control variable used in this study. It has a positive association with *RGDPG* in some estimations (see columns 1-7 of Tables 6.9, 6.10, 6.11, and 6.12). This result is consistent with theoretical and empirical predictions in the literature; see, for example, Romer (1986) and Solow (1956), who argue that physical capital is expected to boost local employment and labour productivity in the economy, and the higher the investment rate, the higher the output level. The empirical predictions are the same as the theoretical predictions, as capital accumulation leads to economic growth, which is considered one of the basic building blocks of economic growth. In other words, capital accumulation impacts economic growth through the increased value of an initial investment as a return on investment in the economy. This implies that high *GFCF* leads to increased economic growth in the MENA region in the long run. This finding is consistent with the literature (e.g. Iwaisako and Futagami 2013; Kaldor 1961; Li and Liu 2005).

Another control variable used in this study is *TRADE*, which has a positive association with the economic growth of MENA countries in most estimations (see columns 1-7 of Tables 6.9, 6.10, 6.11, and 6.12). This finding is in line with several theoretical predictions and the empirical evidence in the literature. For instance, Freund and Weinhold (2002), Sachs et al. (1995), Frankel and Romer (1999), and Irwin and Terviö (2002) find that trade openness has a positive effect on economic growth. Specifically, it allows the exchange of technology between countries, leading to enhanced domestic production, which in turn boosts economic growth.

Furthermore, TRADE promotes income by stimulating capital accumulation and human capital and raising the output for particular levels of capital (Frankel and Romer 1999). This result is consistent with the previous literature and confirms the positive effect of trade openness on economic growth (e.g. Chang et al. 2009; Dollar and Kraay 2004; Freund and Bolaky 2008). Research by Das and Paul (2011), Marelli and Signorelli (2011), Nowbutsing (2014), and Zarra-Nezhad et al. (2014) shows that the positive impact of trade on economic growth is due to the implementation of policies that encourage trade openness, followed by the exchange of technology and quality of governance. The positive effect of trade openness on economic growth is achieved in two ways. First, domestic firms become better acquainted with the technical characteristics of imported goods, which opens up possibilities for imitation of foreign technologies, leading to enhanced productivity and performance (Keller and Shiue, 2008). Second, international trade caters to a greater variety of intermediary inputs with different technological levels for domestic production process, which in turn increases technological content and the value-added aspect of products (Kimura and Lee 2006). To sum up, the results regarding the control variables are in accordance with the theoretical and empirical evidence in the literature that shows that these variables significantly affect economic growth (e.g. Barro 1996b; Barro and Sala-i-Martin 1997; Das and Paul 2011; Marelli and Signorelli 2011; Romer 1986; Solow 1956; Zarra-Nezhad et al. 2014).

Finally, *DSPRING* is negatively associated with *RGDPG* in almost all estimations (see columns 1-7 of Tables 6.9, 6.10, 6.11, and 6.12). Since the start of the Arab Spring at the end of December 2010, many MENA countries have encountered considerable governance challenges. These challenges include the unlimited political and economic power of the governing elites and their clans, the dearth of accountability and transparency of state agents, and inequality and lack of social justice in general (Arayssi et al. 2019; Heidenhof 2014). The Arab Spring impacted the economic growth of the MENA region, which lessened the confidence of investors in the area. That is, the declining trust of the people and investors in the region's institutions produced lower economic growth (Kasmaoui et al. 2018). A study by

Murdoch and Sandler (2002) argues that civil wars and unrest negatively can even affect the economic growth of neighbouring countries.

6.6. SHORT-RUN IMPACT AND ADJUSTMENT

The coefficients of the error correction term (ECT) for all four specifications are presented in Tables 6.9, 6.10, 6.11, and 6.12. ECT estimates the speed of adjustment to equilibrium in a cointegrating relationship. Therefore, ECT depends on whether the variables are cointegrated. As mentioned earlier in this chapter, all the study variables are cointegrated, based on the Pedroni (1999) and Kao (1999) tests.

The sign of the ECT coefficient should be negative and the range should be between 0 and -2 (Loayza and Ranciere 2006). If the ECT value is bigger than -1, it means that the speed of adjustment is monotonically converging. On the other hand, if the value of the ECT coefficient is between -1 and -2, it produces a dampened fluctuation among the variables, which means that the speed of adjustment will be in a dampening manner. In other words, the ECT process fluctuates around the long-term value. This means that the negative sign of ECT indicates the degree of correction and the presence of a long-run causal relationship (see Narayan and Smyth 2006).

The coefficient of ECT values in Tables 6.9, 6.10, 6.11, and 6.12 are negative and statistically significant at the 1% level. The values of the ECT coefficients strongly suggest that the disequilibrium caused by the previous year's shocks dissipates, and the economy converges back to the long-run equilibrium in the current year (see Long and Samreth 2008). In other words, the speed of adjustment and negative sign imply a convergence from short run to long run.

The ECT coefficients of the proxy variables of ICT usage (*USAGE*, *ACCESS*, and *MOB*) are negative and statistically significant at the 1% level. Most of the ECT coefficients in the *USAGE*, *ACCESS*, and *MOB* models are greater than -1. This indicates that any previous period shock in the model is to be adjusted in the long-run equilibrium (see columns 1-7 of Tables 6.9, 6.10, and 6.11). Conversely, some ECT coefficients were less than -1, which means that the ECT produces dampened fluctuations of ICT usage on economic growth about the equilibrium path. In other words, in this case, it does not take a long time to adjust the shock between the proxy variables of ICT usage and *RGDPG* (see columns 1-7 of Tables 6.9, 6.10, and 6.11).

Regarding the ECT, the coefficients of ICT investment (*INV*) are negative and statistically significant at the 1% level (see columns 1-7 of Table 6.12). All the ECT coefficients in the *INV* models are between 0 and -1, which means that any previous period shock in the model is to be adjusted in the long-run equilibrium. In other words, this implies monotonically converging to the equilibrium path directly in the long run. Finally, the short-run impact tables are presented in detail in Appendix C.[68] The tables show that there are no effects of ICT investment and usage on economic growth in MENA countries in the short run.

6.7. CONCLUDING REMARKS

This study investigates the effect of ICT investment and usage and economic growth in the MENA region using the panel ARDL model. The ARDL model is most effective in the case that the regressors are purely I (0), purely I (1), or mixed, and also in the case of finding the long-run and short-run effects.

The empirical results present in this chapter suggest that ICT usage variables have a positive and significant effect on economic growth. Observing the effect of ICT investment on economic growth, furthermore, reveals that some of the models present a positive effect. The study results are consistent with both theoretical and empirical research into the real impacts of ICT on economic growth. Most previous studies show that ICT promotes economic growth through technological change because it increases production per hour worked (e.g. Colecchia and Schreyer 2002; Dedrick et al. 2013; Evangelista et al. 2014; Romer 1990; Salahuddin and Gow 2016; Solow 1956).

In addition, the results of this study suggest that an increase in governance efficiency leads to increases in the reliability of economies, which ensures the implementation of sound policies

[68] This study omits the results of short run effect from the main text and makes them available in Appendix C (C1 to C28).

that are able to keep the capital market and investment climate stable. All these lead to increases in the efficiency of resource distribution, which in turn leads to an increase in economic growth. The results also show that some of the governance indicators, such as the rule of law, control of corruption, voice and accountability, and government effectiveness, have a direct and significant effect on economic growth in MENA countries. The results further show that all the control variables positively affect economic growth in the MENA region, except the dummy for Arab Spring, which reveals a negative effect on economic growth.

The next chapter discusses and calculates the marginal effect of the interaction term between the ICT variables and the quality of governance indicators under different levels of governance quality. The marginal effect is calculated by examining the partial derivative of the variable of interest coefficient (ICT) and the interaction term between the ICT investment and usage variables, and the quality of governance indicators, as mentioned in Chapter 5. This calculation determines the effect of the interaction quality of governance indicators and ICT variables on economic growth.

CHAPTER 7: MARGINAL EFFECT

7.1. INTRODUCTION

As discussed earlier, the quality of governance indicators plays an important moderating role in the effect of ICT investment and usage on economic growth in MENA countries. Therefore, this chapter investigates the marginal effect of the interaction term between ICT investment and usage and the quality of governance indicators on economic growth in MENA countries and how these effects vary with the level of quality governance. Since moderating variables have a known effect on economic sectors, this study conducts the marginal effect estimation method, following some recent studies that have examined the impact of governance indicators. For instance, Gholipour and Farzanegan (2018) investigated the role that institutions play in government expenditure on environmental protection in the MENA countries. They found that institutional indicators significantly contribute to the final environmental effects of government expenditures on environmental protection in the MENA countries. Furthermore, Buehn and Farzanegan (2013) examined the effect of education on the shadow economy and how the quality of governance impacts the relationship between education and the shadow economy. They found that the sample countries with high levels of quality of governance have an increased quality of education and reduced shadow economy activities.

This study follows previous studies, such as the one by Gholipour and Farzanegan (2018), to examine the quality of governance in MENA countries and to calculate the marginal effect of ICT investment and usage on economic growth at different levels of governance. The current study chooses two levels of governance (governance at level 1 and governance at level 2). The levels of governance estimations of models (1–4) produce some interesting results. The interaction term between ICT usage and quality of governance is statistically significant in almost all models. In contrast, the interaction term between ICT investment and quality of governance is insignificant in most models. This indicates that the marginal effect of ICT investment and usage on economic growth relies on the level of governance. In other words, to improve the effectiveness of ICT investment and usage on economic growth in MENA region, an environment is needed in which all governance quality indicators are high.

The governance level values of 1 and 2 were selected based on the governance indicators scale. In other words, these values should be within scores of the scale of governance indicators -2.5 and +2.5. These numbers are only an example, which shows that increasing the governance level from 1 to 2 will yield better results of the effectiveness of ICT investment and usage.

This chapter proceeds as follows: Section 7.2 discusses the results of the marginal effect of ICT usage on economic growth. Section 7.3 presents the results of the marginal effect of ICT investment on economic growth. A conclusion to this chapter is provided in Section 7.4.

7.2. MARGINAL EFFECT OF ICT USAGE

This section discusses the marginal effect of the proxy variables of ICT usage on economic growth at different levels of the quality of governance indicators. As this study mentioned earlier, the current study applies three proxies for ICT usage: internet users (*USAGE*), internet access (*ACCESS*), and mobile cellular phone subscriptions (*MOB*).

It can be seen from Table 7.1 that models (1.4, 2.6, 3.3, and 3.7) for *USAGE*, *ACCESS*, and *MOB* have an insignificant effect on economic growth. On the other hand, models (1.1, 2.1, and 3.1) show the marginal effect of the interaction between *GOV* and all the proxy variables of ICT usage have a significant effect on economic growth. At the governance level of 1, a one percentage increase in *USAGE*, *ACCESS,* and *MOB* leads to an increase in the *RGDPG* by 0.414, 0.677, and 0.351 percentage points, respectively. At the governance level of 2 for the same models, a one percentage increase in *USAGE*, *ACCESS*, and *MOB* leads to a rise in the *RGDPG* of 0.632, 1.082, and 0.604 percentage points, respectively. The increase in the level for the average of the six governance indicators (*GOV*) is undoubtedly a determining factor when it comes to the link between ICT usage and economic growth in the MENA countries. To sum up, this indicates that countries with good governance in all indicators are capable of making ICT usage more effective and productive, resulting in overall economic growth. These results are consistent with those of other studies, which found that a good institution is important for boosting economic growth in all sectors, including the ICT sector (Dixit 2009; Kadhim 2013).

Next, models (1.2, 2.2, and 2.3) show the marginal effect of the interaction between *CC* and the proxy variables of ICT usage. At the governance level of 1, a one percentage increase in *USAGE*, *ACCESS*, and *MOB* leads to a rise in the *RGDPG* by 0.846, 0.655, and 1.300 percentage points, respectively. At the governance level of 2 for the same models, a one percentage increase in *USAGE*, *ACCESS*, and *MOB*, in turn, increases the *RGDPG* by 1.123, 1.219, and 2.565 percentage points, respectively. This result agrees with some empirical studies that show corruption is a hindrance to economic growth. Countries with less corruption see stronger economic growth, better infrastructure, and good internet usage (Kim et al. 2009; Lio et al. 2011). In other words, when a country's level of control over corruption is high, it will have better ICT development. Additionally, a country with effective corruption control will result in better technology adoption, which, in turn, leads to gains in information infrastructure expansion and usage (Oruame 2008).

Following on, models (1.3 and 2.3) illustrate the marginal effect of the interaction between *GE* and *USAGE* and *ACCESS*. At the governance level of 1, a one percentage increase in USAGE and *ACCESS* improves *RGDPG* by 0.474 and 0.870 percentage points, respectively. At the governance level of 2 for model (1.3), a one percentage increase in *USAGE* increases *RGDPG* by 0.763 and 1.709 percentage points, respectively. Government effectiveness means the ability of the government to apply sound policies that provide a good level of public services, including those for ICT usage and infrastructure, for its citizens and businesses (Kaufmann and Fellow 2011). Government effectiveness leads to a rise in ICT use and access, which results in higher levels of economic growth. In other words, the more government effectiveness, the better the public service and ICT usage, which in turn boost economic growth. These results are in line with those of other studies that have confirmed the role of government effectiveness in enhancing government services and all economic sectors (Meso et al. 2009; Srivastava and Teo 2007).

Models (2.4 and 3.4) present the marginal effect of the interaction between *RL* and *ACCESS* and *MOB*. At the governance level of 1, a one percentage increase in *ACCESS* and MOB leads to a rise in *RGDPG* of 0.207, 0.605 percentage points, respectively. At the governance level of 2 for the same model, a one percentage increase in *ACCESS* increases *RGDPG* by 0.565, 1.075 percentage points, respectively. The findings indicate that *RL* can enhance the effectiveness of ICT usage and hence lead to higher economic growth. Rule of law means the ability to enforce contracts and property rights, and this is important, as markets need to work efficiently and effectively (Kaufmann et al. 2011). Overall, investors seek ways to guarantee the funds they invest in, so a higher level of rule of law yields more investment, which then leads to more ICT diffusion. This leads to increases in social exposure to ICT and ultimately leads to an increase in the effectiveness of ICT usage. This result is largely in line with a study by Shih et al. (2005), who argue that the rule of law is a significant factor when engaging in e-commerce, which indirectly leads to an increase in the number of internet users and access.

Next, models (1.5, 2.5, and 3.5) show the marginal effect of the interaction between *RQ* and the proxy variables of ICT usage. At the governance level of 1, a one percentage increase in *USAGE*, *ACCESS*, and *MOB* leads to a rise in *RGDPG* by 0.436, 0.664, and 0.649 percentage points, respectively. At the governance level of 2 for the same models, a one percentage increase in *USAGE*, *ACCESS*, and *MOB* increases *RGDPG* by 0.589, 1.091, and 0.985 percentage points, respectively. This implies that a higher *RQ* leads to increases in the effectiveness of ICT usage, and thereby leads to improved economic growth in the MENA region. This means that regulatory quality increases local entrepreneurship and fosters domestic innovation systems (Silberberger and Königer 2016). The greater the level of regulatory quality, the greater the return on both foreign and domestic sources of innovation (Meyer and Sinani 2009). In other words, regulatory approaches have a significant impact on ICT usage. Increasing regulatory quality and promoting market competition will help developing countries by increasing internet access and offering greater potential benefits to the country as a whole. These results are consistent with those in a study by Wallsten (2005), who shows that increasing ICT competition helps to increase internet use in developing countries.

Moving on, models (1.6 and 3.6) demonstrate the marginal effect of the interaction between *PV* and *USAGE* and *MOB*. At the governance level of 1, a one percentage increase in *USAGE* and *MOB* raises *RGDPG* by 0.300 and 0.172 percentage points, respectively. At the governance level of 2 for the same models, a one percentage increase in *USAGE* and *MOB* increases *RGDPG* by 0.428 and 0.403 percentage points, respectively. This means that political stability is an important factor for increasing the effectiveness of ICT usage and leads to economic growth in the MENA countries. In other words, the countries that are frequently caught up in conflicts and experience political instability usually suffer from weak infrastructure (in this case, ICT infrastructure). ICT usage and access are decreased because of weakness in the infrastructure (Meso et al. 2006). To sum up, a higher level of political stability increases investment which, in turn, results in improved ICT infrastructure, making it easier for ICT diffusion to proceed. This leads to raising the effectiveness of ICT usage.

Finally, models (1.7 and 2.7) show the marginal effect of the interaction between VA and *USAGE* and *ACCESS*. At the governance level of 1, a one percentage increase in *USAGE* and *ACCESS* lifts *RGDPG* by 0.298 and 2.092 percentage points, respectively. At the governance level of 2 for the same models, a one percentage increase in *USAGE* and *ACCESS* increases *RGDPG* by 0.537 and 3.581 percentage points, respectively. This result indicates that voice and accountability is a significant factor for increasing the effectiveness of ICT usage on economic growth in the MENA region. In other words, a higher level of democracy (or *VA*) leads to an improved number of internet users and improved accessibility. Democracy means that there are no restrictions on ICT usage and access. For example, in the non-democratic countries of the region, the regimes have attempted to limit the use of and access to ICT as a means of limiting the flow of ideas and the spread of dissent, which impacts negatively on economic growth (Wilson and Corey 2012). This claim is in accordance with studies by Weare (2002) and Balkin (2004). They show that when citizens enjoy democracy, there is an increase in ICT usage effectiveness and, therefore, economic growth. Table 7.1 illustrate the marginal effects of the proxy variables of ICT usage on economic growth at the governance levels of 1 and 2.

Table 7.1: Marginal Effects of ICT Usage on Economic Growth at the Governance Levels of 1 and 2.

	Governance of level 1	Governance of level 2	Sig
Internet Users (USAGE)			
GOV (Model 1.1)	0.414	0.632	X
CC (Model 1.2)	0.846	1.123	✓
RL (Model 1.3)	0.148	0.274	✓
GE (Model 1.4)	0.474	0.763	✓
RQ (Model 1.5)	0.436	0.589	✓
PV (Model 1.6)	0.300	0.428	✓
VA (Model 1.7)	0.298	0.537	X
Internet Access (ACCESS)			
	Governance of level 1	Governance of level 2	Sig
GOV (Model 2.1)	0.677	1.082	✓
CC (Model 2.2)	0.655	1.219	✓
RL (Model 2.3)	0.207	0.565	✓
GE (Model 2.4)	0.870	1.709	✓
RQ (Model 2.5)	0.664	1.091	✓
PV (Model 2.6)	0.32	0.186	✓
VA (Model 2.7)	2.092	3.581	✓
Mobile Subscriptions (MOB)			
	Governance of level 1	Governance of level 2	Sig
GOV (Model 3.1)	0.351	0.604	✓
CC (Model 3.2)	1.300	2.565	✓
RL (Model 3.3)	0.605	1.075	X
GE (Model 3.4)	0.164	0.133	✓
RQ (Model 3.5)	0.649	0.985	X
PV (Model 3.6)	0.172	0.403	✓
VA (Model 3.7)	-0.100	-0.099	X

Note: USAGE is the individuals using the internet as a percentage of the population; ACCESS is the proportion of households with internet access at home as a percentage of the population; MOB is the mobile cellular subscriptions per 100 people; GOV is the average of the six governance indicators: CC is the control of corruption, GE is government effectiveness, RL is the rule of law, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability. X means insignificant.

To sum up, the results show that when governance quality is of a high level, it leads to increases in the effectiveness of ICT usage, and therefore leads to a boost in economic growth. This indicates that governance quality indicators are important factors for improving the effectiveness of ICT usage variables of economic growth in MENA countries. This finding aligns with that in the studies by Huang and Ho (2017), Meso et al. (2006), and Meso et al.

(2009), which found that quality governance increases ICT diffusion, and in turn, ICT exposure in the citizens increases, which leads to raising the effectiveness of ICT usage for economic growth. This means that governance is important for improving economic activities and increasing economic growth.

Furthermore, the results indicate that adding governance indicators to some models leads to an increase in the response of ICT usage variables (*USAGE*, *ACCESS*, and *MOB*) to positively impact *RGDPG*. These indicators assess the moderating role of the average of six governance indicators (*GOV*) that cover efficiency of governance (*GE* and *RQ*), transparency (*PV* and *VA*), and responsiveness (*CC* and *RL*) on the impact of ICT usage on economic growth in MENA countries. The provision of an environment that has a low level of corruption, a low level of political instability, and a government that is able to effectively formulate and implement sound policies, all lead to improvements in providing public services. These indicators are important tools for stimulating ICT usage because the provision of this kind of environment enhances a country's technological exposure and raises the levels of efficient and widespread ICT usage. These results are also consistent with those of previous studies by Cooray (2009) and Meyer and Sinani (2009). They show the significance of improving governance quality to increase the efficiency of all sectors, including the ICT sector. Furthermore, improving governance quality attracts new technology, which in turn boosts the country's exposure to new technologies, and this in turn boosts ICT usage and labour productivity, therefore leading to a boost for economic growth.

7.3. MARGINAL EFFECT OF ICT INVESTMENT

This section shows the results of the marginal effect of ICT investment on economic growth in the MENA region. It is evident from models (4.1, 4.3, 4.4, and 4.5) that *INV* has an insignificant impact on economic growth. Conversely, model 4.2 demonstrates the marginal effect of the interaction between *CC* and *INV*. At the governance level of 1, a one percentage increase, in turn, improves *RGDPG* by 0.656 percentage points. At the governance level of 2 for the same model, a one percentage increase in *INV* increases RGDPG by 2.668 percentage points. Next, model 4.6 shows the marginal effect of the interaction between *PV* and *INV*. The result shows that at the governance level of 1, a one percentage increase in *INV* raises *RGDPG* by 1.048

percentage points. At the governance level of 2 for the same model, a one percentage increase in *INV* improves *RGDPG* by 2.644 percentage points.

Previous results of the marginal effect of the interaction between *CC*, *PV*, and *INV* show that they positively affect economic growth in the MENA region. The results imply that countries with high governance quality (especially control of corruption and political stability) are more likely to obtain major investment flows, including ICT investment, which, in turn, improves economic growth. These findings are consistent with other studies, such as those by Al-Rawashdeh et al. (2013) and Tang and Abosedra (2014), which demonstrate that the quality of governance has a significant impact on the environment of ICT investment.

Finally, model (4.7) presents the marginal effect of the interaction between *VA* and *INV*. At the governance level of 1, a one percentage increase in *INV* increases *RGDPG* by 0.778 percentage points. At the governance level of 2 for the same model, a one percentage increase in *INV* improves *RGDPG* by 3.422 percentage points. This result shows that a higher level of democracy (or *VA*) improves the effectiveness of ICT investment, which then leads to a boost in economic growth. This result indicates that countries with the highest degree of democracy and civil liberties are able to enjoy more economic growth. Furthermore, the result is in line with Scully (2014), who demonstrates that enhanced democracy and economic growth go side by side. Table 7.2 presents the marginal effects of *INV* on economic growth at the governance levels of 1 and 2.

Table 7.2: Marginal Effects of ICT Investment on Economic Growth at the Governance Levels of 1 and 2.

	Capital Investment in Telecommunication (INV)		
	Governance of level 1	Governance of level 2	Sig
GOV (Model 4.1)	0.345	0.505	X
CC (Model 4.2)	0.656	2.668	✓
RL (Model 4.3)	-0.165	-0.969	X
GE (Model 4.4)	0.409	2.757	X
RQ (Model 4.5)	0.22	1.376	X
PV (Model 4.6)	1.048	2.644	✓
VA (Model 4.7)	0.778	3.422	✓

Note: INV is the capital investment in telecommunications as a percentage of GDP; GOV is the average of the six governance indicators: CC is the control of corruption, GE is government effectiveness, RL is the rule of law, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability. X means insignificant.

To conclude, the marginal effect of ICT investment has a positive and significant impact on economic growth in the MENA countries, regardless of the level of quality of governance in some models, such as *CC*, *PV*, and *VA*. Indicators such as *PV* and *VA* represent transparency, and CC partially represents government responsiveness. These indicators are linked with the vision of investors, who may be afraid to invest in risky environments with a high level of political instability and a high level of corruption or in countries that are not respectful of civil liberties. These findings, with regard to the positive and significant effect of *INV* when including *PV*, *VA*, and *CC* governance indicators, on economic growth in the MENA region, are largely in line with the view of Sabir et al. (2019), who argued that investors tend to shy away from risky countries with poor governance. In other words, investors look for countries with good governance—in particular, countries that have good control over corruption, a good level of political stability, and democracy (Godinez and Liu 2015; Méon and Sekkat 2008). Finally, the results show that improvement in the levels of *VA*, *CC*, and *PV* lead to an increase in the effectiveness of ICT investment, and therefore leads to a boost for the economic growth of the MENA countries.

7.4. CONCLUDING REMARKS

This chapter finds that the interaction variables between governance indicators and ICT investment and usage positively affect economic growth. In other words, the quality of governance indicators are important factors in the association between ICT investment and usage, and economic growth in the MENA region. Accordingly, the findings are consistent with other research that shows that countries with a good quality of governance typically experience rapid economic growth. Further, local and foreign investors seek ways to ensure that their investments are secure, and their business practices are predictable. Hence, the MENA region needs to improve governance quality by reducing political instability and corruption and by enhancing regulatory quality to become an investment-friendly destination, and thus gain more benefits from ICT investment and usage.

These results are in line with my expectations, as the interaction terms among *USAGE*, *ACCESS*, *MOB*, and *INV* and governance indicators are positive and statistically significant in almost all models (see Tables 7.1 and 7.2). This suggests that ICT investment and usage increase economic growth as the levels of governance indicators improve. In other words, the final effect of ICT investment and usage on economic growth in the region depends on the quality of governance indicators. At higher levels of governance indicators, more ICT investment and usage lead to higher economic growth in the region.

The significant impact of ICT variables in MENA countries support, to some extent, Hypothesis 1 of this study—in particular, the effect of ICT usage on economic growth. Hence, in MENA countries, ICT usage improves and accelerates economic growth. However, ICT investment does not play a significant role in contributing to economic growth in the MENA region.

Furthermore, the results support, to some extent, the second hypothesis (H2) and its sub-hypotheses (H2.1–H2.6) concerning ICT investment and usage—i.e., that the effect of ICT usage on economic growth in the MENA region depends on the quality of governance indicators. At higher levels of governance indicators, more ICT usage leads to higher economic growth in the region. However, to enhance the effectiveness of ICT investment and increase economic growth, an environment is needed where all governance quality indicators are high (Bellos and Subasat 2012; Glaeser et al. 2004). This is shown in Table 7.3.

Table 7.3: Summary of the Research Hypotheses Outcomes.

Research hypotheses	Outcomes (ICT usage)	Actual findings (ICT usage)	Outcomes (ICT Investment)	Actual findings (ICT Investment)
H1	Confirmed	(+)	Not confirmed	(NS)
H2	Confirmed	(+)	Not confirmed	(NS)
H2.1	Confirmed	(+)	Confirmed	(+)
H2.2	Confirmed	(+)	Not confirmed	(NS)
H2.3	Confirmed	(+)	Not confirmed	(NS)
H2.4	Confirmed	(+)	Not confirmed	(NS)
H2.5	Confirmed	(+)	Confirmed	(+)
H2.6	Confirmed	(+)	Confirmed	(+)

Note: "NS" represents the insignificant.

CHAPTER 8: ROBUSTNESS ANALYSIS

8.1. ROBUSTNESS ANALYSIS

To confirm the validity of the main findings, two robustness checks are conducted, which this chapter is structured into two sub-sections. Subsection 8.1.1 presents the robustness findings for the classification of the governance indicators. This subsection shows that rather than capture the effects of governance variables by entering the governance measures individually in the regressions as discussed in chapter 6. More precisely, to enable us to test hypothesis H2, this study assesses the results by using an overall index or classifying them into economic, political, and institutional. It makes sense to investigate which of them have a robust influence, direct or indirect, on the ICT usage and investment-economic growth relationship.

Subsection 8.1.2 deals with the robustness findings demonstrating the effect of ICT investment and usage on economic growth, when this study uses the alternative measures of governance. This study constructed alternative governance indicators to ensure that the study findings are consistent. For example, this study sums up the values of 'political rights' and 'civil liberties' as alternative measures of political institutions. The economic freedom index uses as an alternative measure of economic institutions. Finally, this study uses the average of 4 elements to measure institutional governance: 'business freedom', 'monetary freedom', 'investment freedom', and 'financial freedom'.[69]

8.1.1. Classification of the Governance Indicators

This study uses the classification proposed by Eicher and Leukert (2009), which distinguishes between measures of economic and political institutions to provide adequate cross-country coverage and facilitate proper comparisons among the range of measures used to proxy for institutions. This study employs institutional indicators that have been widely used in related studies to create this classification (Kose et al. 2009; Li and Tanna, 2019).

[69] Please see Table (D.1) for more explanation of the variables to this chapter.

Accordingly, this study captures the impact of economic governance using indicators for the rule of law and control of corruption and the impact of political governance using democracy and political stability (Kose et al. 2009). As discussed in chapter 4, several studies have referred to the importance of institutions in affecting economic growth. Apart from the previous individual measures of governance indicators included in the main benchmark estimation. This section constructs three aggregate indices (institutions governance index, political governance index, and economic governance index) by summing up the values of respective individual measures, following previous studies which have employed such aggregated or combined measures of institutions (e.g., Kose et al. 2009; Li and Tanna, 2019).

Based on the above discussion, to verify the robustness of main results, this study conducts additional tests by classifying the governance indicators into three classifications; each classification includes two indicators, which these classifications measured the Political, Economic, and Institutional governance, as follows:

(1) An index representing 'Political governance' (*POL*), constructed by summing up the values of two governance indicators: Voice and accountability and political stability:

a.) Voice and accountability (*VA*): perceptions of the extent to which citizens of a country can participate in choosing their government, as well as freedom of expression, freedom of association, and free media.

b.) Political stability and absence of violence (*PV*): perceptions of the likelihood of political instability and/or politically motivated violence.

(2) An index representing 'Economic governance' (*ECO*), built by summing up the values of two governance indicators: rule of law and corruption control:

a.) Rule of law (*RL*): perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

b.) Control of corruption (*CC*): perceptions of the extent to which public power is exercised for private gain or advantage, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests.

(3) An index representing 'Institutional governance' (*INS*), generated by summing up the values of four governance indicators: government effectiveness and regulatory quality.

a.) Government effectiveness (*GE*): perceptions of the quality of public services, the quality of the civil/public service and the degree of its independence from political pressures, quality of policy formulation and implementation, and credibility of the government's commitment to such policies.

b.) Regulatory quality (*RQ*): perceptions of the government's ability to formulate and implement sound policies and regulations that permit and promote private sector development.

The results of this robustness check are presented in Tables 8.1, 8.2, 8.3, and 8.4. In line with the main individual measures of governance indicators analyses in chapter 6, the effect of ICT investment, usage, and economic growth (see columns 1-4 Tables 8.1, 8.2, 8.3, and 8.4) are positive and statistically significant in almost all estimated models. The study also finds that the interaction term between all governance classifications (political, economic, and institutional governance) with ICT usage (see columns 1-3 of Tables 8.1, 8.2, and 8.3) are positively associated with *RGDPG*. This study also shows that more ICT investment leads to higher economic growth in MENA countries with better political and economic governance environments (see column 4 of Tables 8.1, 8.2, and 8.3).

Table 8.1: ARDL Results of Governance Indicators Groups- Political Governance.

Dependent variable: RGDPG				
	lnUSAGE	lnACCESS	lnMOB	lnINV
Long-run coefficients:				
$lnICT_{i,t}$	0.149*	0.072	0.124	0.589**
	(1.917)	(0.776)	(0.676)	(2.082)
$POL_{i,t}$	-0.109	1.080***	1.238**	0.947
	(-0.583)	(3.070)	(2.395)	(1.097)
$lnICT_{i,t} * POL_{i,t}$	0.067**	0.202**	0.258**	0.235*
	(1.986)	(2.190)	(2.235)	(1.992)
$lnLF_{i,t}$	6.645***	1.600***	1.228***	1.255**
	(3.893)	(11.799)	(4.736)	(2.025)
$lnGFCF_{i,t}$	0.451	1.255***	1.262***	0.619
	(0.863)	(8.114)	(4.789)	(1.375)
$lnTRDAE_{i,t}$	-0.676	1.668***	1.218***	0.096
	(-1.073)	(9.965)	(4.429)	(0.269)
$DSPRING_{i,t}$	-1.920***	-2.338***	-2.555***	-1.468***
	(-11.617)	(-17.031)	(-16.297)	(-8.714)
Short-run coefficients:				
Error correction term	-0.954***	-1.016***	-1.129***	-0.711***
	(-6.827)	(-4.278)	(-4.114)	(-6.759)
Observations	349	304	304	349
Number of lags (ARDL)	(2, 1, 1, 1, 1, 1, 1, 1)	(5, 1, 1, 1, 1, 1, 1, 1)	(5, 1, 1, 1, 1, 1, 1, 1)	(1, 2, 2, 2, 2, 2, 2, 2)

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; POL is the summing up the values of two governance indicators: Voice and accountability and political stability; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The test values are significant at * $p < 0.1$, **$p < 0.05$, ***$p < 0.01$. *t*-statistics are reported in parentheses.

Table 8.2: ARDL Results of Governance Indicators Groups-Economic Governance.

Dependent variable: RGDPG				
	lnUSAGE	lnACCESS	lnMOB	lnINV
Long-run coefficients:				
$lnICT_{i,t}$	0.199**	0.072	0.124	0.589**
	(2.215)	(0.776)	(0.676)	(2.082)
$ECO_{i,t}$	3.251***	1.080***	1.238**	0.947
	(7.091)	(3.070)	(2.395)	(1.097)
$lnICT_{i,t} * ECO_{i,t}$	0.685***	0.202**	0.258**	0.235*
	(5.770)	(2.190)	(2.235)	(1.869)
$lnLF_{i,t}$	0.971**	1.600***	1.228***	1.255**
	(2.233)	(11.799)	(4.736)	(2.025)
$lnGFCF_{i,t}$	0.139	1.255***	1.262***	0.619
	(0.274)	(8.114)	(4.789)	(1.375)
$lnTRDAE_{i,t}$	0.165	1.668***	1.218***	0.096
	(0.369)	(9.965)	(4.429)	(0.269)
$DSPRING_{i,t}$	-0.952***	-2.338***	-2.555***	-1.468***
	(-4.505)	(-17.031)	(-16.297)	(-8.714)
Short-run coefficients:				
Error correction term	-0.793***	-1.016***	-1.129***	-0.711***
	(-6.211)	(-4.278)	(-4.114)	(-6.759)
Observations	349	304	304	349
Number of lags (ARDL)	(2, 1, 1, 1, 1, 1, 1, 1)	(5, 1, 1, 1, 1, 1, 1, 1)	(5, 1, 1, 1, 1, 1, 1, 1)	(1, 2, 2, 2, 2, 2, 2, 2)

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; ECO is the summing up the values of two governance indicators: rule of law and control of corruption; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The test values are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *t*-statistics are reported in parentheses.

Table 8.3: ARDL Results of Governance Indicators Groups-Institutional Governance.

Dependent variable: RGDPG				
	lnUSAGE	lnACCESS	lnMOB	lnINV
Long-run coefficients:				
$lnICT_{i,t}$	0.215***	0.051*	0.283***	0.357*
	(3.210)	(1.689)	(2.580)	(1.697)
$INS_{i,t}$	0.557*	2.250***	1.232***	1.026*
	(1.669)	(9.231)	(3.116)	(1.739)
$lnICT_{i,t} * INS_{i,t}$	0.068*	0.595***	0.035	0.038
	(1.805)	(7.018)	(0.691)	(0.438)
$lnLF_{i,t}$	7.417***	0.785**	6.381***	3.884*
	(6.703)	(2.186)	(5.859)	(1.714)
$lnGFCF_{i,t}$	-0.558	1.444***	-0.204	1.971**
	(-1.211)	(5.121)	(-0.404)	(2.466)
$lnTRDAE_{i,t}$	-0.612	0.460	-0.385	2.110**
	(-0.976)	(1.442)	(-0.608)	(2.232)
$DSPRING_{i,t}$	-2.164***	-1.086***	-2.185***	-1.297***
	(-13.732)	(-18.421)	(-14.642)	(-5.206)
Short-run coefficients:				
Error correction term	-0.961***	-0.874***	-1.041***	-0.997***
	(-6.510)	(-3.796)	(-6.728)	(-7.933)
Observations	349	320	336	350
Number of lags (ARDL)	(2, 1, 1, 1, 1, 1, 1, 1)	(4, 1, 1, 1, 1, 1, 1, 1)	(3, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1)

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; INS is the summing up the values of four governance indicators: government effectiveness and regulatory quality; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The test values are significant at * $p < 0.1$, **$p < 0.05$, ***$p < 0.01$. t-statistics are reported in parentheses.

8.1.2. Alternative Measures of Governance

As another robustness check, we use alternative measures of institutions and use different political, economic, and institutional governance measures.

First, our alternative measure of political governance (*poly*) is the average of political rights and civil liberties as alternative measures of political governance; see Li et al. (2021) and Flachaire et al. (2014). Both measures are obtained from the Freedom House database. They range in value from 1 to 7, which 1 implies the best rights/liberties for the country while 7 is the worst value. Thus, higher values of these variables signify poor political governance.

Second, this study measures the economic governance (*eco*) using Fraser Institute's Economic Freedom of the World (EFW) index; see Gwartney and Lawson (2019) for the original description of the data. This variable has been used to measure economic governance in previous studies. This variable has also been applied in several previous studies, such as those by Azman-Saini et al. (2010), Alguacil et al. (2011), and Slesman (2015). Economic freedom measures property rights and the ability to engage in voluntary transactions are considered. Respect for individual choices, market coordination, freedom to enter and compete, and protection of people's and their property from aggression by others are all taken under consideration in this measure. Unweighted averages of five factors, including the size of government and legal structure; security of property rights; access to sound money; freedom of trade; and regulation of credit and business, are used to calculate this index.

Third, to measure the institutional governance (*ins*), this study uses the index is an average of 4 elements, including Business freedom, monetary freedom, investment freedom, and financial freedom; see Slesman (2015); Li and Tanna (2018) and Li et al. (2021). This measure considers the respect of the efficiency of government regulation of business, the price stability with an assessment of price controls, investment freedom, without restriction, and government effectiveness in organizing the financial sector.[70]

[70] Please see the appendix D1 for the list of variables and data sources.

Finally, I add the government expenditure to the model. This measure considers the potentially explain cross-country differences in technological developments, which this variable includes all government expenditures for purchases of goods and services. The goods and services include defines, roads, communications, education, and health, to mention a few.

The findings from this robustness test with an alternative estimator are similar to those of the main ARDL regressions (see columns 1-3 of Tables 8.4, 8.5, and 8.6). As can be seen from columns 1-3, the coefficients of proxies of ICT usage and the interaction term between *USAGE*, *ACCESS*, and *MOB* with *poly*, *eco*, and *ins* are positive and significant. These results again imply that *poly*, *eco*, and *ins* magnify the positive relationship between ICT usage and *RGDPG* in the study sample of the MENA region. These results are in line with the studies of Kim et al. (2009), Lio et al. (2011) and Quibria et al. (2003), who argue that in order to improve the effectiveness of ICT usage, governments must implement effective political, economic and institutional governance. Furthermore, countries with effective governance measures will positively impact the development of information infrastructure, which in turn increases the likelihood of technology exposure and use (Oruame 2008).

Regarding the ICT investment, this robustness test shows that the coefficients of *INV* and the interaction term between (*INV* × *poly*) and (*INV* × *eco*) are again found to be positively and significantly correlated with *RGDPG* in the MENA region (see column 4 of Tables 8.4, and 8.5), but the coefficient of the interaction term between *INV* and *ins* is not statistically significant (see column 4 of Table 8.6). These results support the main study findings. Hence, these results are consistent with previous studies such as those by Barro (1996a) and Helliwell (1994). They have shown a positive interaction between political and economic governance with investment. This implies that countries with high levels of civil liberties tend to be the most investing and prosperous. This result echoes Scully's (2014) findings that increased civil liberties and economic growth go hand in hand.

Turning to control variable (government expenditure). The results show that the coefficients of *EXP* are positive and statistically significant on *RGDPG* in MENA countries (see columns 1-4 of Tables 8.4, 8.5, and 8.6). This implies that countries with higher government expenditure can increase their economic growth through increased infrastructure spending, such as communications, roads, and so on, which leads to increased investment and an increase in the probability of technology exposure and usage. This result is consistent with Loizides and Vamvoukas (2005) argue that government expenditure on social and physical infrastructure can spur economic growth. Communications and education expenditure by the government, for example, has been shown to increase labour productivity and economic growth. In other words, investment in infrastructure can increase and accelerate economic growth. According to proponents of this theory, increasing government expenditure leads to increased economic growth (Cooray 2009).

Table 8.4: ARDL Results of Alternative Measures of Institutions-Political Governance.

Dependent variable: RGDPG								
	lnUSAGE		lnACCESS		lnMOB		lnINV	
Long-run coefficients:	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$lnICT_{i,t}$	1.805*** (5.504)	1.857*** (5.882)	1.953*** (3.809)	1.479*** (5.276)	1.420** (2.270)	0.369 (0.478)	0.874* (1.832)	0.865** (1.970)
$poly_{i,t}$	1.616*** (5.973)	1.247*** (5.164)	1.809*** (4.684)	1.153*** (5.461)	1.015* (1.808)	0.389 (0.983)	1.195* (1.726)	1.578*** (3.440)
$lnICT_{i,t} * poly_{i,t}$	0.338*** (4.935)	0.357*** (5.933)	0.403*** (4.149)	0.283*** (5.237)	0.239** (2.025)	-0.085 (-0.988)	0.223* (1.942)	0.291*** (3.337)
$lnLF_{i,t}$	1.126** (2.129)	-2.554 (-1.283)	-0.388 (-0.128)	0.739* (1.872)	0.874 (1.137)	0.534 (0.886)	4.210* (1.908)	-0.280 (-0.406)
$lnGFCF_{i,t}$	0.326 (0.697)	1.528*** (2.659)	1.886 (1.685)	1.646*** (4.365)	1.795*** (3.223)	1.794*** (5.358)	1.174 (1.536)	1.957*** (6.052)
$lnTRDAE_{i,t}$	0.020 (0.047)	-0.564 (-0.952)	3.443*** (2.993)	0.005 (0.016)	0.364 (0.773)	-0.230 (-0.871)	2.976*** (3.205)	0.357 (0.225)
$DSPRING_{i,t}$	-1.757*** (-10.850)	-1.648*** (-10.754)	-1.877*** (-6.290)	-1.434*** (-9.531)	-1.677*** (-7.022)	-1.392*** (-10.208)	-1.394*** (-5.364)	-0.988*** (-6.138)
$lnEXP_{i,t}$		0.712 (0.972)		1.287** (2.430)		1.352*** (2.766)		2.500*** (5.731)
Short-run coefficients:								
Error correction term	-0.864*** (-5.367)	-0.884*** (-4.873)	-0.765*** (-8.491)	-0.905*** (-5.658)	-0.771*** (-8.406)	-0.930*** (-5.752)	-1.035*** (-7.292)	-0.846*** (-7.695)
Observations	349	344	363	344	366	346	350	345
Number of lags (ARDL)	(2, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1, 1)

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; poly is average of two political governance indicators: political rights and civil liberties; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The test values are significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *t*-statistics are reported in parentheses.

Table 8.5: ARDL Results of Alternative Measures of Institutions-Economic Governance.

	Dependent variable: RGDPG							
	lnUSAGE		lnACCESS		lnMOB		lnINV	
Long-run coefficients:	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$lnICT_{i,t}$	0.902* (1.886)	1.038*** (2.800)	2.588*** (3.516)	1.599*** (2.780)	1.712*** (2.670)	0.088 (0.103)	2.825** (2.386)	2.348*** (4.033)
$eco_{i,t}$	0.001 (0.006)	-0.042 (-1.604)	0.156*** (3.855)	0.145*** (3.574)	0.137*** (2.794)	0.161*** (2.771)	0.349*** (3.420)	0.113*** (2.294)
$lnICT_{i,t} * eco_{i,t}$	0.013* (1.701)	0.018*** (2.786)	0.040*** (3.551)	0.027*** (2.904)	0.027*** (2.753)	-0.056*** (-4.038)	0.050*** (2.637)	0.035*** (4.048)
$lnLF_{i,t}$	-0.474 (-0.159)	2.617*** (5.721)	-0.345 (-0.471)	3.051*** (4.570)	1.128 (1.540)	1.764*** (2.408)	1.830 (0.946)	1.601*** (2.070)
$lnGFCF_{i,t}$	-0.690 (-0.657)	1.013*** (5.722)	1.911*** (2.982)	1.171** (2.376)	1.852*** (3.460)	-0.467 (-0.970)	2.036*** (3.298)	0.308 (0.981)
$lnTRDAE_{i,t}$	3.364*** (3.242)	0.188*** (2.043)	2.005*** (3.233)	0.857* (1.778)	0.639 (1.451)	2.914*** (5.212)	-0.397 (-0.598)	2.134*** (5.903)
$DSPRING_{i,t}$	-1.216*** (-3.593)	-1.480*** (-8.127)	-0.866*** (-4.041)	-0.937*** (-4.266)	-1.559*** (-9.371)	-1.948*** (-11.386)	-1.193*** (-6.074)	-1.608*** (-11.333)
$lnEXP_{i,t}$		2.704*** (4.912)		2.398*** (3.774)		2.574*** (5.388)		2.413*** (7.767)
Short-run coefficients:								
Error correction term	-0.864*** (-5.367)	-0.786*** (-4.747)	-0.765*** (-8.491)	-0.738*** (-5.711)	-0.771*** (-8.406)	-0.626*** (-2.748)	-1.035*** (-7.292)	-0.672*** (-5.562)
Observations	349	331	363	330	366	305	350	331
Number of lags (ARDL)	(2, 1, 1, 1, 1, 1, 1, 1)	(3, 1, 1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1, 1)	(3, 1, 1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1, 1)	(5, 1, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1)	(3, 1, 1, 1, 1, 1, 1, 1, 1)

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; eco is economic freedom index; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The test values are significant at * p < 0.1, **p < 0.05, ***p < 0.01. *t*-statistics are reported in parentheses.

Table 8.6: ARDL Results of Alternative Measures of Institutions-Institutional Governance.

Dependent variable: RGDPG								
	lnUSAGE		lnACCESS		lnMOB		lnINV	
Long-run coefficients:	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$lnICT_{i,t}$	-0.018 (-0.028)	2.346** (2.301)	0.951* (1.794)	1.229*** (4.105)	1.222** (2.224)	-0.251 (-0.808)	0.940* (1.801)	-0.394 (-0.811)
$ins_{i,t}$	0.039 (1.009)	0.033 (0.574)	0.037 (0.993)	0.089*** (3.486)	0.137*** (3.477)	-0.008 (-0.305)	0.146* (1.844)	0.118** (2.452)
$lnICT_{i,t} * ins_{i,t}$	0.001 (0.022)	0.026* (1.820)	0.015* (1.927)	0.020*** (4.501)	0.018** (2.284)	0.002 (0.363)	0.023 (1.558)	0.015 (1.461)
$lnLF_{i,t}$	1.868*** (2.740)	-1.695 (-0.541)	1.529 (0.515)	1.995*** (5.464)	1.705** (2.261)	1.749*** (4.874)	-4.814** (-2.176)	0.450 (0.682)
$lnGFCF_{i,t}$	1.927*** (3.085)	0.969 (-0.738)	1.805* (1.725)	1.807*** (5.201)	0.582 (0.966)	1.645*** (5.093)	2.475*** (2.998)	1.237*** (2.661)
$lnTRDAE_{i,t}$	0.740 (1.540)	0.707 (0.536)	2.063* (1.871)	0.564 (1.475)	0.175 (0.359)	-0.092 (-0.388)	2.526*** (2.782)	0.008 (0.022)
$DSPRING_{i,t}$	-1.344*** (-4.366)	1.539*** (2.582)	-1.077*** (-2.855)	-0.779*** (-3.886)	-2.059*** (-8.017)	-1.501*** (-9.022)	-0.910*** (-3.088)	-1.034 (0.022)
$lnEXP_{i,t}$		7.426*** (9.098)		2.486*** (5.356)		2.108*** (5.627)		2.118*** (4.288)
Short-run coefficients:								
Error correction term	-0.726*** (-7.380)	-0.784*** (-9.098)	-0.821*** (-11.133)	-0.967*** (-6.468)	-0.732*** (-7.818)	-1.030*** (-5.708)	-0.925*** (-5.025)	-0.804*** (-12.087)
Observations	357	351	354	336	360	326	344	353
Number of lags (ARDL)	(1, 1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1, 1)	(3, 1, 1, 1, 1, 1, 1, 1, 1)	(2, 1, 1, 1, 1, 1, 1, 1)	(1, 1, 1, 1, 1, 1, 1, 1, 1)

Note: RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of the population; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; ins is the index is an average of 4 elements: Business freedom, monetary freedom, investment freedom, and financial freedom; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011, lnEXP is the natural logarithm of government expenditure as a percentage of GDP. The test values are significant at * p < 0.1, **p < 0.05, ***p < 0.01. *t*-statistics are reported in parentheses.

To conclude, the robustness analysis indicates that, just as in the main benchmark estimation, political, economic, and institutional governance play a moderating role in the relationship between ICT usage and economic growth. Furthermore, the robustness analysis results show that political and economic governance plays a vital positive role in the association between ICT investment and economic growth in the MENA countries. At the higher levels of political and economic governance indicators, more ICT investment leads to higher economic growth in the MENA countries. This leads to the conclusion that to obtain the expected economic benefits from ICT investment, an appropriate environment is needed for political and economic governance.

8.2. CONCLUDING REMARKS

Both classification and alternative governance measures were used to confirm the validity of the main findings in this chapter's robustness analyses. The findings show that governance quality significantly impacts the association between ICT investment and economic growth in MENA countries. According to the findings, the classification of governance indicators and alternative measures of governance have confirmed the study results.

The robustness analysis reveals that political, economic, and institutional governance all play a moderating role in the relationship between ICT usage and economic growth. Moreover, the results of the robustness analysis reveal that political and economic governance plays a critical role in the relationship between ICT investment and economic growth in the MENA region. A higher level of political and economic governance indicators indicates that more ICT investment will result in higher economic growth in the MENA region. It may be concluded that an appropriate political and economic governance environment is required to reap the anticipated economic benefits from ICT investment.

CHAPTER 9: CONCLUSION

9.1. RECAPITULATION

The current study provides panel data evidence on the effect of ICT investment and usage on economic growth in MENA countries. The panel analysis of this study focuses on the period of ICT spread in the MENA region and is based on data starting from 1995, which most reports suggest as the start of the rise of ICT globally, particularly in the MENA countries. Moreover, this study examines the moderating role of the quality of governance on the impact of ICT investment and usage on economic growth in MENA countries, and how these effects vary with the level of quality governance, as discussed in Chapter 1.

Chapter 2 commenced with an overview of the MENA countries, covering economic growth, ICT and governance. This chapter provided an overview of the lack of quality of governance in this region, established the fundamental association between ICT and economic growth, and briefly discussed the association between quality of governance and economic growth. In addition, this chapter explained ICT investment and usage and how the lack of quality of governance can limit the use of, and investment in, technology in the MENA region.

Chapter 3 discussed relevant theories about the ICT–economic growth nexus. In addition, this chapter reviewed the potential effect of the quality of governance on economic growth and the theories related to the moderating impacts of quality of governance on economic growth. Emphasis was placed on recent evidence for the association between ICT and economic growth, as well as the theories suggesting that governance plays a moderating role in association with economic growth.

Chapter 4 reviewed the empirical literature on the ICT–economic growth nexus, the effects of governance quality on economic growth, and the moderating impact of the quality of governance on economic growth. Furthermore, this chapter identified the shortcomings of previous empirical studies and exposed the research gap which needed to be addressed. This chapter also discussed the main study hypotheses about the impact of ICT investment and usage on economic growth in the MENA countries, and the moderating impact of quality of governance on the association between ICT variables and economic growth in this region. The main conclusion drawn from the literature review was that a limited number of empirical studies examine the moderating role of governance factors on the ICT–economic growth nexus. That is, the majority of studies have focused on the proximate effect of ICT on economic growth without taking into account the moderating roles of governance on this relationship.

The data and methodology are explained in Chapter 5. This chapter elaborated on the procedures employed in examining the effect of ICT variables on economic growth. The application of the ARDL model as a form of dynamic panel data analysis was also explained in this chapter. The chapter pointed out that use of the ARDL model is of utmost significance for addressing several issues—among them, the difference in stationarity of variables and the endogeneity problem inherent in econometric analysis. In particular, in this study, the ARDL model was used to examine the effects of ICT investment and usage on economic growth in the MENA region. In addition, the chapter investigated the moderating role of governance quality on the impact of ICT investment and usage on economic growth in the MENA region.

Chapter 6 presented the ARDL results and investigated the stationarity of the variables using panel unit root tests. Panel cointegration tests were used to examine the long-run equilibrium relations among the variables. Next, the lag length selection was tested to find the appropriate number of lags for the variables in each model. The empirical results of the ARDL model revealed that all variables of interest, including internet users, internet access, mobile subscription, and capital investment in telecommunication, have a positive and significant effect on economic growth. In addition, the results demonstrated that the final effect of ICT investment and usage on economic growth depends on the quality of governance indicators.

Chapter 7 discussed the results of the marginal impact of ICT investment and usage at the level of quality of governance. This chapter aimed to calculate the marginal effect of the quality of governance on the association between ICT investment and usage and economic growth. This study used 1 and 2 as governance level values; these values show that improvement in the level of governance leads to an increase in the effectiveness of ICT investment and usage on economic growth in the MENA region. The results demonstrate that improvements in governance indicators improve the effectiveness of ICT investment and usage on economic growth in the MENA countries.

Two robustness analyses conducted in Chapter 8 confirmed that governance quality plays a moderating role in the relationship between ICT investment and economic growth in MENA countries. The study findings are robust after applying classification of the governance indicators and using alternative measures of governance.

9.2. KEY FINDINGS

This section summarises the key findings of this study. The results of the correlation matrix suggest, as discussed in Section 6.2, that the correlation coefficients between governance indicators are highly correlated with each other. In addition, all variables of ICT were highly correlated with each other. Hence, this study added the governance indicators and ICT variables in the regressions one by one.

Section 6.3 presented the results of the Im et al. (2003) panel unit root test, the null hypothesis of which states that there is a unit root. The results revealed that all variables are stationary at level, with the exception of the labour force, the average of governance quality, control of corruption, government effectiveness, and political stability and absence of violence, which are stationary in their 1st difference. Due to these mixed orders of stationarity, they needed to be examined using the panel cointegration test.

Section 6.4 reported the panel cointegration tests between real GDP growth rate and all explanatory variables. Two approaches were used to test whether there is a long-run equilibrium relationship between the variables: Pedroni (1999) and Kao (1999). These approaches have the same null hypothesis of non-cointegration. The results of the panel cointegration tests revealed that the null hypothesis of non-cointegration was rejected. These results strongly support the existence of long-run equilibrium relations among the dependent variable (economic growth) and the explanatory variables.

Section 6.5 gave the results of the estimation of the panel ARDL model. The ARDL results showed a long-run effect of explanatory variables on the dependent variable (*RGDPG*), which was not evident in the short run. The results of this study help close the research gap, which this study focuses on and investigating the effect of ICT usage and investment on economic growth and the role of governance indicators in this relationship in the MENA region. This is important, because, globally many countries are taking advantage of ICT adoption for their economic growth. The long-run effect of the ARDL model revealed that ICT usage would contribute to real GDP growth in MENA countries. Moreover, the present study results imply that ICT investment has an insignificant impact on economic growth in the MENA region. This implies that the MENA countries have not invested enough in ICTs during the last two decades. Further, like most developing economies, the MENA economies do not benefit economically from investing in ICT, as do the developed countries. Also, the results further shows that the quality of governance plays an important positive role in the association between ICT investment, usage, and economic growth in the MENA countries. In addition, the direct effect of the governance quality indicators has a positive effect on economic growth. Meanwhile, all control variables positively impact economic growth in the MENA countries, except the dummy variable of the Arab Spring, which shows a negative impact on economic growth. This led to the conclusion that, without effective governance, no improvements to economic growth can be expected from ICT investment and usage in the MENA region.

Sections 7.2 and 7.3 reported the results of the interaction term between ICT investment, usage, and the quality of governance. The interaction term was measured by estimating the marginal impact of ICT investment and usage at two levels of quality of governance (1 and 2). The results showed that ICT investment and usage lead to economic growth in the MENA region when governance indicators improve in this region.

Section 8.1 performed the robustness test to check the robustness of the main results. The robustness tests results revealed that the quality of governance indicators plays a critical role in the relationship between ICT investment, usage, and economic growth in the MENA region. Therefore, this study considers two robustness tests to address the robustness analyses: i) classification of the governance indicators; and ii) alternative measures of governance.

9.3. POLICY IMPLICATIONS

Economic development in the MENA region is the defining challenge for its policymakers. This widespread issue can be linked to the region’s lack of good governance and slow adoption of new technologies. This study has revisited the empirical evidence on the effect of ICT investment and usage on economic growth under different levels of governance quality. Thus, the current study's findings hold important implications for the policymakers of the MENA countries for two reasons. First, it is important to know and understand the capability of ICT contributions to economic growth in MENA countries of different levels of governance quality.

Consequently, policymakers in the MENA countries should be guiding ICT investment and usage to increase and accelerate economic growth. Second, MENA countries have wide ICT coverage and poor governance quality. This study shows that quality of governance influences the effectiveness of ICT investment and usage, impacting economic growth. That is, governance quality is instrumental in improving the effectiveness of ICT and economic growth. Therefore, the results imply that policymakers in the MENA countries need to make proper decisions to formulate policies to enhance governance quality. These decisions should aim at increasing ICT investment and usage. Finally, without a good quality of governance, ICT investment and usage will not bring about positive changes to the economic growth of the MENA countries.

The preliminary review in Chapter 2 has shown that the low and middle-income countries in the MENA region suffer from a lack of quality of governance, except for High-income countries, which have good quality governance. The low and middle-income countries lack quality of governance due to civil wars leading to extensive destruction of a country's infrastructure. Therefore, wars and political instability have negatively affected ICT investment and usage and economic growth in these countries. So, an important policy implication that flows from this study is that the low and middle-income countries in the MENA region aiming to maximise growth benefits from ICT investment and usage should focus on improving political and economic governance such as political stability by reducing the risk of violence, at minimum. However, a sound economic and political environment that fosters good governance, protection of property rights, and democratic accountability are essential for economic development. But a regime that is successful in enforcing and maintaining political stability is most critical for stimulating growth effects from ICT investment and usage, vis-à-vis other institutions that enforce the regulatory quality and government effectiveness.

Furthermore, they have to increase the levels of civil liberties tend to enhance the investing and prosperity in the ICT sector. In other words, that will lead to the development of information infrastructure, which in turn increases the likelihood of technology exposure, use and then boost economic growth.

For example, in Sudan the average governance quality is low, as shown in Figure 9.1, due to the civil war and the political instability, which this reflected in the effectiveness of ICT investment and usage on economic growth over time in this country.

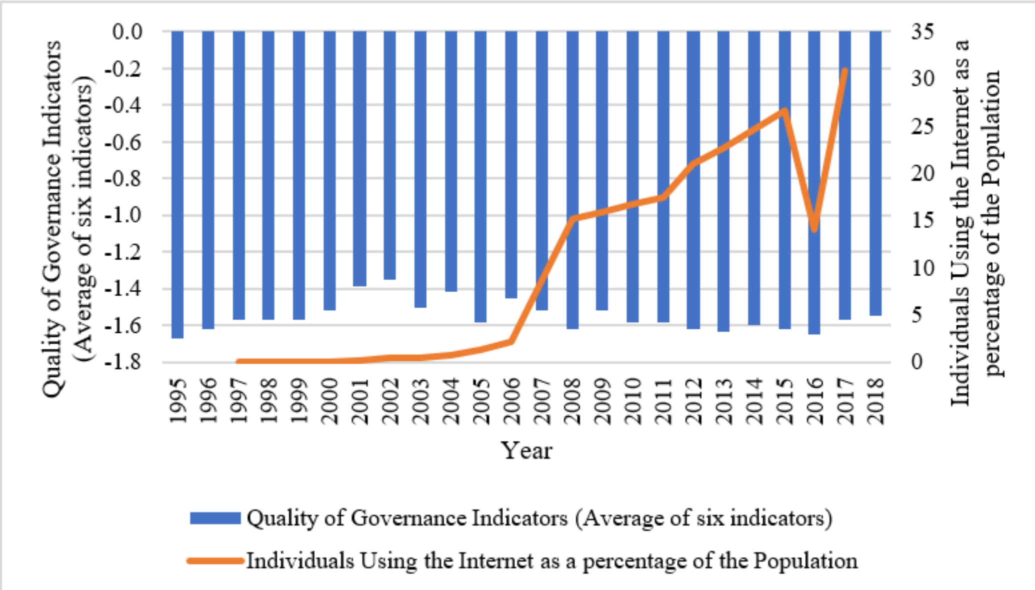

Figure 9.1: ICT Usage and Quality of Governance of Sudan.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

To conclude, this study suggests that low and middle-income countries in the MENA region should focus on improving political and economic governance, including political stability by reducing the risk of violence. Economic growth requires a stable economic and political environment that protects property rights and promotes democratic accountability. A regime that successfully enforces and maintains political stability is critical for stimulating ICT investment and usage.

Regarding the High-income countries in the MENA region, they have placed a high priority to enhance the quality of governance level and this, in turn, developed the ICT investment and usage, therefore leading to a boost for economic growth. But these countries still have an opportunity to gain more benefits from ICT investment and usage, by enhancing regulatory quality to become a more investment-friendly destination. The regulatory approaches have a significant impact on ICT usage. Increasing regulatory quality and promoting market competition will help high-income countries by increasing internet access and usage and offering greater potential benefits to the country as a whole.

For example, UAE is one of the best countries that provide the most ease of doing business in the ICT sector in the MNEA region (World bank 2019).[71] The policymakers in this country succeed to formulate and implementing sound policies and regulations that permit and promote ICT sector development. These policies helped to attract new ICT investors to the country, which, in turn, led to gains in information infrastructure expansion and usage. In addition to that, there are no restrictions on ICT users and access, as seen in Figure 9.2.

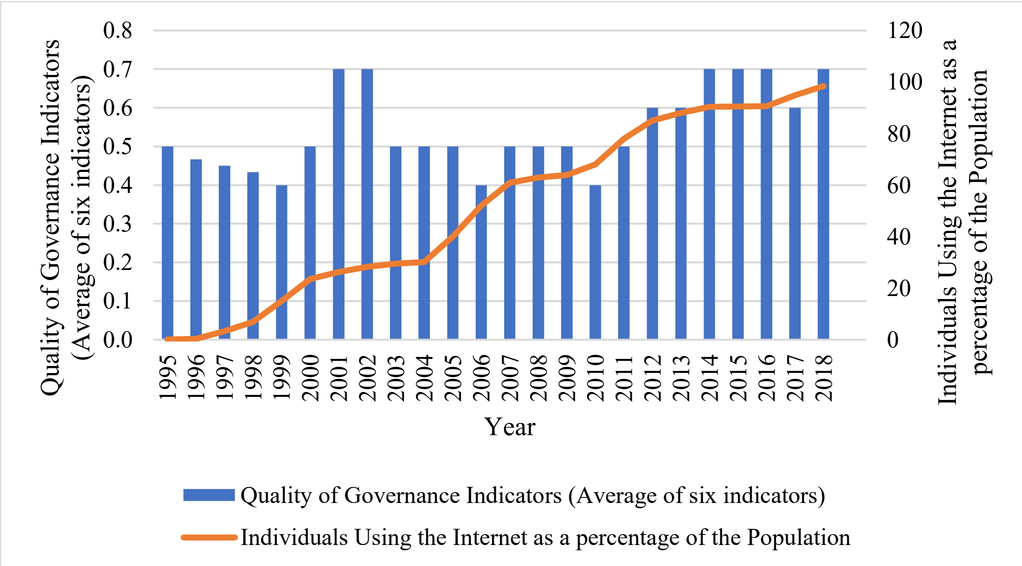

Figure 9.2: ICT Usage and Quality of Governance of UAE.

Source: World Development Indicators (WDI) of the World Bank and Euromonitor International database.

These results show that the High-income countries in the MENA region can improve ICT investment and usage by easing entry restrictions and increasing ICT competition. This can be achieved by allowing a larger share of the MENA population to use the internet. Promoting ICT competition can increase internet use in developing countries. This recommendation is in

[71] The United Arab Emirates is ranked 16 among 190 economies in the ease of doing business, according to the latest World Bank annual ratings. The rank of the United Arab Emirates it was 11 in 2018.

line with Wallsten's (2005) study, who finds that regulatory policies in developing countries significantly impact ICT usage and accessibility.

9.4. LIMITATIONS AND AVENUES FOR FUTURE RESEARCH

In this section, some of this study's limitations are highlighted. Further, the implications of the current empirical results are discussed in terms of possible future research.

The first limitation of the current study is caused by the limited availability of data on the ICT variables (for example, broadband internet subscriptions, revenue from all telecommunication services, annual investment in telecommunication services, percentage of the population covered by at least a 3G mobile network, etc.) for most of the 21 MENA countries. More data on ICT variables would render the sample larger, which, in turn, would enhance the robustness of the empirical analysis and provide more generalisable and comprehensive insights. Thus, as a future research direction, researchers may extend the analysis to include data for additional developing and emerging countries using more variables (subject to data availability) over a longer time period.

The second limitation of the present study is that the investigation of the MENA countries was applied at country level. Future research could use data at the firm or sector levels to provide a complete and more detailed picture of the direct impacts of ICT investment and usage on the real economy.

9.5. CONCLUDING REMARKS

The evidence obtained from the ARDL model suggests that the moderating role of quality of governance increases the effectiveness of ICT usage for economic growth. Furthermore, good quality of governance increases the effectiveness of ICT investment for economic growth in some models. The ARDL model results further suggest to MENA policymakers that enhancing economic growth in their countries cannot be achieved solely through ICT investment. The evidence points to the necessity of providing a high quality of governance that can help to increase the effectiveness of ICT investment and usage in economic growth. In other words, the final effectiveness of ICT investment and usage for increasing the economic growth in the MENA countries depends on governance quality.

These findings contribute to the ICT literature in terms of understanding that low governance quality hinders optimal ICT usage and investing in ICT. This should motivate policymakers to formulate well-informed and applicable policies that aim to stimulate ICT investment and usage, which will lead to improved economic growth. ICT investment and usage in the MENA region will not lead to economic growth without effective governance. Finally, this study highlights the significance of understanding the contribution determinants of governance quality in MENA countries by investigating each country's key laws and the ways they are applied.

As mentioned earlier, this study considers the importance of investigating the effect of all governance indicators on economic growth, because investigating only one or two governance indicators will not measure the real influence of governance in the MENA countries. This is very important given the fact that the MENA countries suffer from poor governance. Thus, all indicators should be taken into account to determine which indicator has the biggest effect on economic growth in the MENA countries. The results of this study show a set of governance indicators that are able to improve the effectiveness of ICT investment and usage and that can therefore lead to higher economic growth in the MENA countries. These indicators are as follows in Table 9.1.

Table 0.1: Summary of the Main Importance of Governance Indicators in the MENA Countries.

Quality of Governance Indicators	**ICT investment**	**ICT usage**
Average of the six governance indicators (GOV)	Not confirmed	Confirmed
Control of Corruption (CC)	Confirmed	Confirmed
Government Effectiveness (GE)	Not confirmed	Confirmed
Regulatory Quality (RQ)	Not confirmed	Confirmed
Rule of Law (RL)	Not confirmed	Confirmed
Political stability and Absence of violence (PV)	Confirmed	Confirmed
Voice and Accountability (VA)	Confirmed	Confirmed

Note: GOV is the average of the six governance indicators: CC is the control of corruption, GE is government effectiveness, RL is rule of law, RQ is regulatory quality, PV is political stability and absence of violence, and VA is voice and accountability.

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APPENDIX A

This appendix shows the cointegration analysis for all empirical exercises. To begin, I tested the first group models presented in Chapter 6 – USAGE, ACCESS, and MOB – with the individual measures of quality of governance indicators. I employed approaches by Pedroni (1999) and Kao (1999) due to their popularity in the literature. Pedroni (1999) advocates two statistics, both based on a group-mean approach. Tables (A1 to A21) display those results.

Next, I tested the cointegration analysis on the models in the second group; INV with the individual measures of the quality of governance indicators as mentioned in Chapter 6. See tables A22 to A28. To conserve space in the main text, I make the cointegration analysis tables available in this appendix.

A Tables: Results for panel cointegration analysis (ICT Usage, ICT Investment), with individual measures the quality of governance indicators.

Group One:

Table A1: Panel cointegration analysis (USAGE and the average of the quality of governance indicators).

RGDPG lnUSAGE GOV (lnUSAGE × GOV) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.880	0.998			
Panel P-Stat.	1.937	0.974	Group P-Stat.	2.832	0.997
Panel PP-Stat.	-10.849	0.000	Group PP-Stat.	-15.218	0.000
Panel ADF-stat.	-7.307	0.000	Group ADF-Stat.	-7.952	0.000
Trend and Intercept					
Panel v-Stat.	-2.092	0.982			
Panel P-Stat.	0.946	0.828	Group P-Stat.	1.9171	0.972
Panel PP-Stat.	-10.552	0.000	Group PP-Stat.	-14.586	0.000
Panel ADF-stat.	-7.887	0.000	Group ADF-Stat.	-9.096	0.000
No Trend or Intercept					
Panel v-Stat.	-2.093	0.982			
Panel P-Stat.	0.947	0.828	Group P-Stat.	1.917	0.972
Panel PP-Stat.	-10.552	0.000	Group PP-Stat.	-14.586	0.000
Panel ADF-stat.	-7.887	0.000	Group ADF-Stat.	-9.096	0.000
Kao Residual Cointegration Test					
ADF	-5.919	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; GOV is the average of the quality of governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A2: Panel cointegration analysis (USAGE and the control of corruption indicator).

RGDPG lnUSAGE CC (lnUSAGE × CC) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat..	-2.758	0.997			
Panel P-Stat.	1.682	0.954	Group P-Stat.	2.695	0.997
Panel PP-Stat.	-9.227	0.000	Group PP-Stat.	-13.173	0.000
Panel ADF-stat.	-7.363	0.000	Group ADF-Stat.	-7.423	0.000
Trend and Intercept					
Panel v-Stat.	-4.349	1.000			
Panel P-Stat.	2.775	0.997	Group P-Stat.	3.620	0.999
Panel PP-Stat.	-12.387	0.000	Group PP-Stat.	-15.379	0.000
Panel ADF-stat.	-9.102	0.000	Group ADF-Stat.	-8.304	0.000
No Trend or Intercept					
Panel v-Stat.	-1.950	0.974			
Panel P-Stat.	0.789	0.785	Group P-Stat.	1.943	0.974
Panel PP-Stat.	-8.493	0.000	Group PP-Stat.	-10.942	0.000
Panel ADF-stat.	-7.391	0.000	Group ADF-Stat.	-7.461	0.000
Kao Residual Cointegration Test					
ADF	-6.125	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; CC is the control of corruption; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A3: Panel cointegration analysis (USAGE and the government effectiveness indicator).

RGDPG lnUSAGE GE (lnUSAGE × GE) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.420	0.992			
Panel P-Stat.	1.515	0.935	Group P-Stat.	2.769	0.997
Panel PP-Stat.	-10.020	0.000	Group PP-Stat.	-17.829	0.000
Panel ADF-stat.	-7.572	0.000	Group ADF-Stat.	-9.282	0.000
Trend and Intercept					
Panel v-Stat.	-3.896	1.000			
Panel P-Stat.	2.462	0.993	Group P-Stat.	3.515	0.998
Panel PP-Stat.	-13.743	0.000	Group PP-Stat.	-18.64	0.000
Panel ADF-stat.	-10.365	0.000	Group ADF-Stat.	-11.539	0.000
No Trend or Intercept					
Panel v-Stat.	-1.883	0.970			
Panel P-Stat.	0.964	0.832	Group P-Stat.	2.268	0.988
Panel PP-Stat.	-8.475	0.000	Group PP-Stat.	-13.883	0.000
Panel ADF-stat.	-7.428	0.000	Group ADF-Stat.	-9.169	0.000
Kao Residual Cointegration Test					
ADF	-5.985	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; GE is the government effectiveness; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A4: Panel cointegration analysis (USAGE and the Rule of law indicator).

RGDPG lnUSAGE RL (lnUSAGE × RL) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.257	0.988			
Panel P-Stat.	2.184	0.986	Group P-Stat.	3.150	0.999
Panel PP-Stat.	-9.917	0.000	Group PP-Stat.	-15.736	0.000
Panel ADF-stat.	-9.161	0.000	Group ADF-Stat.	-9.784	0.000
Trend and Intercept					
Panel v-Stat.	-3.923	1.000			
Panel P-Stat.	3.335	0.999	Group P-Stat.	4.136	1.000
Panel PP-Stat.	-10.834	0.000	Group PP-Stat.	-16.951	0.000
Panel ADF-stat.	-10.180	0.000	Group ADF-Stat.	-10.428	0.000
No Trend or Intercept					
Panel v-Stat.	-1.431	0.924			
Panel P-Stat.	1.429	0.924	Group P-Stat.	2.654	0.996
Panel PP-Stat.	-9.918	0.000	Group PP-Stat.	-17.280	0.000
Panel ADF-stat.	-9.452	0.000	Group ADF-Stat.	-10.183	0.000
Kao Residual Cointegration Test					
ADF	-5.822	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; RL is the rule of law; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A5: Panel cointegration analysis (USAGE and the regulatory quality indicator).

RGDPG lnUSAGE RQ (lnUSAGE × RQ) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			**Group (between dimension)**		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.300	0.989			
Panel P-Stat.	2.424	0.992	Group P-Stat.	3.413	0.999
Panel PP-Stat.	-7.189	0.000	Group PP-Stat.	-12.086	0.000
Panel ADF-stat.	-6.526	0.000	Group ADF-Stat.	-8.271	0.000
Trend and Intercept					
Panel v-Stat.	-3.875	1.000			
Panel P-Stat.	3.309	0.999	Group P-Stat.	4.118	1.000
Panel PP-Stat.	-7.881	0.000	Group PP-Stat.	-16.531	0.000
Panel ADF-stat.	-7.290	0.000	Group ADF-Stat.	-5.634	0.000
No Trend or Intercept					
Panel v-Stat.	-1.529	0.937			
Panel P-Stat.	1.712	0.957	Group P-Stat.	2.750	0.997
Panel PP-Stat.	-6.988	0.000	Group PP-Stat.	-9.781	0.000
Panel ADF-stat.	-7.173	0.000	Group ADF-Stat.	-7.916	0.000
Kao Residual Cointegration Test					
ADF	-6.342	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; RQ is the regulatory quality; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A6: Panel cointegration analysis (USAGE and the political stability and absence of violence indicator).

RGDPG lnUSAGE PV (lnUSAGE × PV) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.679	0.996			
Panel P-Stat.	1.899	0.971	Group P-Stat.	2.889	0.998
Panel PP-Stat.	-9.165	0.000	Group PP-Stat.	-15.804	0.000
Panel ADF-stat.	-7.059	0.000	Group ADF-Stat.	-8.107	0.000
Trend and Intercept					
Panel v-Stat.	-4.375	1.000			
Panel P-Stat.	2.996	0.997	Group P-Stat.	3.794	1.000
Panel PP-Stat.	-9.499	0.000	Group PP-Stat.	-12.843	0.000
Panel ADF-stat.	-7.548	0.000	Group ADF-Stat.	-8.042	0.000
No Trend or Intercept					
Panel v-Stat.	-1.949	0.974			
Panel P-Stat.	0.858	0.805	Group P-Stat.	1.903	0.971
Panel PP-Stat.	-8.826	0.000	Group PP-Stat.	-11.360	0.000
Panel ADF-stat.	-6.972	0.000	Group ADF-Stat.	-7.643	0.000
Kao Residual Cointegration Test					
ADF	-5.641	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; PV is the political stability and absence of violence; lnLF is the natural logarithm of labour force participation rate as a percentage of the population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A7: Panel cointegration analysis (USAGE and the voice and accountability indicator).

RGDPG lnUSAGE VA (lnUSAGE × VA) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			**Group (between dimension)**		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-1.883	0.970			
Panel P-Stat.	1.599	0.945	Group P-Stat.	3.114	0.991
Panel PP-Stat.	-11.810	0.000	Group PP-Stat.	-18.258	0.000
Panel ADF-stat.	-7.419	0.000	Group ADF-Stat.	-9.188	0.000
Trend and Intercept					
Panel v-Stat.	-3.494	0.999			
Panel P-Stat.	2.763	0.997	Group P-Stat.	4.270	1.000
Panel PP-Stat.	-12.874	0.000	Group PP-Stat.	-19.068	0.000
Panel ADF-stat.	-7.591	0.000	Group ADF-Stat.	-8.453	0.000
No Trend or Intercept					
Panel v-Stat.	-1.231	0.891			
Panel P-Stat.	0.658	0.745	Group P-Stat.	2.368	0.991
Panel PP-Stat.	-10.450	0.000	Group PP-Stat.	-17.823	0.000
Panel ADF-stat.	-7.429	0.000	Group ADF-Stat.	-9.301	0.000
Kao Residual Cointegration Test					
ADF	-5.997	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A8: Panel cointegration analysis (ACCESS and the average of the quality of governance indicators).

RGDPG lnACCESS GOV (lnACCESS × GOV) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.670	0.996			
Panel P-Stat.	2.311	0.989	Group P-Stat.	3.051	0.999
Panel PP-Stat.	-8.989	0.000	Group PP-Stat.	-12.183	0.000
Panel ADF-stat.	-6.949	0.000	Group ADF-Stat.	-7.658	0.000
Trend and Intercept					
Panel v-Stat.	-4.125	1.000			
Panel P-Stat.	3.289	0.999	Group P-Stat.	3.918	1.000
Panel PP-Stat.	-12.622	0.000	Group PP-Stat.	-15.599	0.000
Panel ADF-stat.	-7.929	0.000	Group ADF-Stat.	-8.132	0.000
No Trend or Intercept					
Panel v-Stat.	-1.826	0.966			
Panel P-Stat.	1.284	0.900	Group P-Stat.	2.086	0.982
Panel PP-Stat.	-9.617	0.000	Group PP-Stat.	-13.399	0.000
Panel ADF-stat.	-8.122	0.000	Group ADF-Stat.	-9.176	0.000
Kao Residual Cointegration Test					
ADF	-5.211	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; GOV is the average of the quality of governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE represent the lnTRADE openness as a percentage of GDP.

Table A9: Panel cointegration analysis (ACCESS and the control of corruption indicator).

RGDPG lnACCESS CC (lnACCESS × CC) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-1.698	0.955			
Panel P-Stat.	1.426	0.923	Group P-Stat.	2.879	0.998
Panel PP-Stat.	-8.230	0.000	Group PP-Stat.	-10.679	0.000
Panel ADF-stat.	-7.643	0.000	Group ADF-Stat.	-7.647	0.000
Trend and Intercept					
Panel v-Stat.	-3.007	0.999			
Panel P-Stat.	2.215	0.9867	Group P-Stat.	3.762	0.999
Panel PP-Stat.	-11.051	0.000	Group PP-Stat.	-12.564	0.000
Panel ADF-stat.	-9.808	0.000	Group ADF-Stat.	-8.587	0.000
No Trend or Intercept					
Panel v-Stat.	-0.964	0.833			
Panel P-Stat.	0.678	0.751	Group P-Stat.	2.275	0.989
Panel PP-Stat.	-7.619	0.000	Group PP-Stat.	-11.164	0.000
Panel ADF-stat.	-7.753	0.000	Group ADF-Stat.	-8.237	0.000
Kao Residual Cointegration Test					
ADF	-5.284	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A10: Panel cointegration analysis (ACCESS and government effectiveness indicator).

RGDPG lnACCESS GE (lnACCESS × GE) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.165	0.985			
Panel P-Stat.	1.967	0.975	Group P-Stat.	3.148	0.999
Panel PP-Stat.	-7.778	0.000	Group PP-Stat.	-18.157	0.000
Panel ADF-stat.	-6.069	0.000	Group ADF-Stat.	-8.814	0.000
Trend and Intercept					
Panel v-Stat.	-3.489	0.999			
Panel P-Stat.	3.033	0.999	Group P-Stat.	3.892	1.000
Panel PP-Stat.	-12.388	0.000	Group PP-Stat.	-20.126	0.000
Panel ADF-stat.	-7.824	0.000	Group ADF-Stat.	-9.280	0.000
No Trend or Intercept					
Panel v-Stat.	-1.472	0.995			
Panel P-Stat.	1.273	0.786	Group P-Stat.	2.518	0.987
Panel PP-Stat.	-7.319	0.000	Group PP-Stat.	-14.502	0.000
Panel ADF-stat.	-7.253	0.000	Group ADF-Stat.	-9.959	0.000
Kao Residual Cointegration Test					
ADF	-5.224	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; GE is the government effectiveness; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A11: Panel cointegration analysis (ACCESS and the regulatory quality indicator).

RGDPG lnACCESS RQ (lnACCESS × RQ) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.069	0.981			
Panel P-Stat.	2.236	0.987	Group P-Stat.	3.546	0.999
Panel PP-Stat.	-7.224	0.000	Group PP-Stat.	-10.050	0.000
Panel ADF-stat.	-6.566	0.000	Group ADF-Stat.	-6.629	0.000
Trend and Intercept					
Panel v-Stat.	-3.386	0.999			
Panel P-Stat.	3.139	0.999	Group P-Stat.	4.219	1.000
Panel PP-Stat.	-9.129	0.000	Group PP-Stat.	-12.328	0.000
Panel ADF-stat.	-6.697	0.000	Group ADF-Stat.	-6.710	0.000
No Trend or Intercept					
Panel v-Stat.	-1.442	0.925			
Panel P-Stat.	1.375	0.916	Group P-Stat.	2.767	0.997
Panel PP-Stat.	-7.499	0.000	Group PP-Stat.	-9.977	0.000
Panel ADF-stat.	-7.329	0.000	Group ADF-Stat.	-7.219	0.000
Kao Residual Cointegration Test					
ADF	-5.455	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; RQ is the regulatory quality; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE represent the trade openness as a percentage of GDP.

Table A12: Panel cointegration analysis (ACCESS and the rule of law indicator).

RGDPG lnACCESS RL (lnACCESS × RL) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-1.535	0.938			
Panel P-Stat.	2.383	0.991	Group P-Stat.	3.352	0.999
Panel PP-Stat.	-7.161	0.000	Group PP-Stat.	-12.685	0.000
Panel ADF-stat.	-7.065	0.000	Group ADF-Stat.	-8.979	0.000
Trend and Intercept					
Panel v-Stat.	-2.845	0.998			
Panel P-Stat.	3.216	0.999	Group P-Stat.	0.998	1.000
Panel PP-Stat.	-10.909	0.000	Group PP-Stat.	0.999	0.000
Panel ADF-stat.	-9.165	0.000	Group ADF-Stat.	0.000	0.000
No Trend or Intercept					
Panel v-Stat.	-0.878	0.810			
Panel P-Stat.	1.378	0.916	Group P-Stat.	2.619	0.996
Panel PP-Stat.	-6.624	0.000	Group PP-Stat.	-12.662	0.000
Panel ADF-stat.	-6.506	0.000	Group ADF-Stat.	-8.761	0.000
Kao Residual Cointegration Test					
ADF	-5.215	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; RL is the rule of law; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A13: Panel cointegration analysis (ACCESS and the political stability and absence of violence indicator).

RGDPG lnACCESS PV (lnACCESS × PV) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.296	0.989			
Panel P-Stat.	1.861	0.969	Group P-Stat.	3.232	0.999
Panel PP-Stat.	-8.594	0.000	Group PP-Stat.	-13.765	0.000
Panel ADF-stat.	-7.837	0.000	Group ADF-Stat.	-8.353	0.000
Trend and Intercept					
Panel v-Stat.	-3.720	0.999			
Panel P-Stat.	2.765	0.997	Group P-Stat.	4.033	1.000
Panel PP-Stat.	-11.866	0.000	Group PP-Stat.	-16.656	0.000
Panel ADF-stat.	-9.092	0.000	Group ADF-Stat.	-8.375	0.000
No Trend or Intercept					
Panel v-Stat.	-1.725	0.957			
Panel P-Stat.	0.708	0.761	Group P-Stat.	2.213	0.986
Panel PP-Stat.	-8.224	0.000	Group PP-Stat.	-12.083	0.000
Panel ADF-stat.	-7.331	0.000	Group ADF-Stat.	-8.110	0.000
Kao Residual Cointegration Test					
ADF	-4.900	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; PV is the political stability and absence of violence; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A14: Panel cointegration analysis (ACCESS and the voice and accountability indicator).

RGDPG lnACCESS VA (lnACCESS × VA) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-1.827	0.966			
Panel P-Stat.	1.546	0.939	Group P-Stat.	3.009	0.999
Panel PP-Stat.	-8.905	0.000	Group PP-Stat.	-15.294	0.000
Panel ADF-stat.	-8.640	0.000	Group ADF-Stat.	-9.822	0.000
Trend and Intercept					
Panel v-Stat.	-3.181	0.999			
Panel P-Stat.	2.647	0.996	Group P-Stat.	4.008	1.000
Panel PP-Stat.	-12.393	0.000	Group PP-Stat.	-24.624	0.000
Panel ADF-stat.	-9.724	0.000	Group ADF-Stat.	-10.071	0.000
No Trend or Intercept					
Panel v-Stat.	-1.161	0.877			
Panel P-Stat.	0.746	0.772	Group P-Stat.	2.196	0.986
Panel PP-Stat.	-8.343	0.000	Group PP-Stat.	-14.462	0.000
Panel ADF-stat.	-8.363	0.000	Group ADF-Stat.	-10.261	0.000
Kao Residual Cointegration Test					
ADF	-5.142	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth, lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A15: Panel cointegration analysis (MOB and the average of the quality of governance indicators).

RGDPG lnMOB GOV (lnMOB × GOV lnLF) lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.305	0.989			
Panel P-Stat.	1.756	0.961	Group P-Stat.	2.839	0.998
Panel PP-Stat.	-8.960	0.000	Group PP-Stat.	-11.895	0.000
Panel ADF-stat.	-8.095	0.000	Group ADF-Stat.	-9.025	0.000
Trend and Intercept					
Panel v-Stat.	-3.747	0.999			
Panel P-Stat.	2.733	0.997	Group P-Stat.	3.890	0.999
Panel PP-Stat.	-11.658	0.000	Group PP-Stat.	-15.145	0.000
Panel ADF-stat.	-9.463	0.000	Group ADF-Stat.	-8.676	0.000
No Trend or Intercept					
Panel v-Stat.	-1.599	0.945			
Panel P-Stat.	0.669	0.748	Group P-Stat.	1.736	0.959
Panel PP-Stat.	-8.332	0.000	Group PP-Stat.	-10.945	0.000
Panel ADF-stat.	-8.479	0.000	Group ADF-Stat.	-10.038	0.000
Kao Residual Cointegration Test					
ADF	-7.803	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; GOV is the average of the quality of governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A16: Panel cointegration analysis (MOB and the control of corruption indicator).

RGDPG lnMOB CC (lnMOB × CC) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.172	0.985			
Panel P-Stat.	1.644	0.949	Group P-Stat.	2.504	0.994
Panel PP-Stat.	-7.849	0.000	Group PP-Stat.	-11.811	0.000
Panel ADF-stat.	-6.812	0.000	Group ADF-Stat.	-7.100	0.000
Trend and Intercept					
Panel v-Stat.	-3.587	0.999			
Panel P-Stat.	2.631	0.996	Group P-Stat.	3.254	0.999
Panel PP-Stat.	-10.539	0.000	Group PP-Stat.	-14.467	0.000
Panel ADF-stat.	-8.645	0.000	Group ADF-Stat.	-8.323	0.000
No Trend or Intercept					
Panel v-Stat.	-1.533	0.937			
Panel P-Stat.	0.925	0.823	Group P-Stat.	1.900	0.971
Panel PP-Stat.	-7.694	0.000	Group PP-Stat.	-10.732	0.000
Panel ADF-stat.	-7.105	0.000	Group ADF-Stat.	-6.986	0.000
Kao Residual Cointegration Test					
ADF	-7.929	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; Institutional indicators; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A17: Panel cointegration analysis (MOB and government effectiveness indicator).

RGDPG lnMOB GE (lnMOB × GE) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.621	0.996			
Panel P-Stat.	1.798	0.964	Group P-Stat.	2.827	0.998
Panel PP-Stat.	-7.797	0.000	Group PP-Stat.	-18.590	0.000
Panel ADF-stat.	-6.249	0.000	Group ADF-Stat.	-9.726	0.000
Trend and Intercept					
Panel v-Stat.	-4.018	1.000			
Panel P-Stat.	2.846	0.998	Group P-Stat.	3.662	0.999
Panel PP-Stat.	-12.418	0.000	Group PP-Stat.	-22.232	0.000
Panel ADF-stat.	-8.748	0.000	Group ADF-Stat.	-10.823	0.000
No Trend or Intercept					
Panel v-Stat.	-2.109	0.983			
Panel P-Stat.	1.256	0.896	Group P-Stat.	2.101	0.982
Panel PP-Stat.	-6.312	0.000	Group PP-Stat.	-11.827	0.000
Panel ADF-stat.	-5.815	0.000	Group ADF-Stat.	-7.637	0.000
Kao Residual Cointegration Test					
ADF	-7.729	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; GE is the government effectiveness; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A18: Panel cointegration analysis (MOB and the rule of law indicator).

RGDPG lnMOB RL (lnMOB × RL) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			**Group (between dimension)**		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.551	0.995			
Panel P-Stat.	2.251	0.988	Group P-Stat.	2.868	0.998
Panel PP-Stat.	-6.668	0.000	Group PP-Stat.	-12.599	0.000
Panel ADF-stat.	-6.889	0.000	Group ADF-Stat.	-10.071	0.000
Trend and Intercept					
Panel v-Stat.	-3.927	1.000			
Panel P-Stat.	3.548	0.994	Group P-Stat.	3.880	0.999
Panel PP-Stat.	-11.907	0.000	Group PP-Stat.	-17.908	0.000
Panel ADF-stat.	-10.168	0.000	Group ADF-Stat.	-11.884	0.000
No Trend or Intercept					
Panel v-Stat.	-2.008	0.978			
Panel P-Stat.	1.734	0.959	Group P-Stat.	2.241	0.988
Panel PP-Stat.	-5.109	0.000	Group PP-Stat.	-11.449	0.000
Panel ADF-stat.	-6.179	0.000	Group ADF-Stat.	-9.985	0.000
Kao Residual Cointegration Test					
ADF	-7.694	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; RL is the rule of law; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A19: Panel cointegration analysis (MOB and the regulatory quality indicator).

RGDPG lnMOB RQ (lnMOB × RQ) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-1.800	0.9641			
Panel P-Stat.	2.069	0.9807	Group P-Stat.	3.215	0.999
Panel PP-Stat.	-6.557	0.000	Group PP-Stat.	-9.831	0.000
Panel ADF-stat.	-6.718	0.000	Group ADF-Stat.	-8.069	0.000
Trend and Intercept					
Panel v-Stat.	-3.264	1.000			
Panel P-Stat.	3.124	0.997	Group P-Stat.	4.153	0.999
Panel PP-Stat.	-7.260	0.000	Group PP-Stat.	-11.982	0.000
Panel ADF-stat.	-7.076	0.000	Group ADF-Stat.	-7.827	0.000
No Trend or Intercept					
Panel v-Stat.	-1.085	0.996			
Panel P-Stat.	1.339	0.881	Group P-Stat.	2.428	0.998
Panel PP-Stat.	-6.897	0.000	Group PP-Stat.	-10.213	0.000
Panel ADF-stat.	-7.299	0.000	Group ADF-Stat.	-8.172	0.000
Kao Residual Cointegration Test					
ADF	-8.023	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; RQ is the regulatory quality; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A20: Panel cointegration analysis (MOB and the political stability and absence of violence indicator).

RGDPG lnMOB PV (lnMOB × PV) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			**Group (between dimension)**		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.686	0.996			
Panel P-Stat.	2.075	0.981	Group P-Stat.	3.063	0.999
Panel PP-Stat.	-8.835	0.000	Group PP-Stat.	-16.293	0.000
Panel ADF-stat.	-8.381	0.000	Group ADF-Stat.	-9.366	0.000
Trend and Intercept					
Panel v-Stat.	-4.237	1.000			
Panel P-Stat.	3.244	0.999	Group P-Stat.	3.940	1.000
Panel PP-Stat.	-10.222	0.000	Group PP-Stat.	-16.310	0.000
Panel ADF-stat.	-9.752	0.000	Group ADF-Stat.	-10.063	0.000
No Trend or Intercept					
Panel v-Stat.	-1.947	0.974			
Panel P-Stat.	0.911	0.819	Group P-Stat.	1.781	0.963
Panel PP-Stat.	-7.700	0.000	Group PP-Stat.	-11.502	0.000
Panel ADF-stat.	-6.449	0.000	Group ADF-Stat.	-6.779	0.000
Kao Residual Cointegration Test					
ADF	-7.620	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnMOB is the mobile cellular subscriptions per 100 people; PV is the political stability and absence of violence; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A21: Panel cointegration analysis (MOB and the voice and accountability indicator).

RGDPG lnMOB VA (lnMOB × VA) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-3.013	0.999			
Panel P-Stat.	1.0434	0.852	Group P-Stat.	2.742	0.997
Panel PP-Stat.	-14.505	0.000	Group PP-Stat.	-17.398	0.000
Panel ADF-stat.	-12.172	0.000	Group ADF-Stat.	-11.310	0.000
Trend and Intercept					
Panel v-Stat.	-4.545	1.000			
Panel P-Stat.	2.096	0.982	Group P-Stat.	3.861	1.000
Panel PP-Stat.	-19.332	0.000	Group PP-Stat.	-26.294	0.000
Panel ADF-stat.	-14.510	0.000	Group ADF-Stat.	-11.385	0.000
No Trend or Intercept					
Panel v-Stat.	-2.334	0.9902			
Panel P-Stat.	0.186	0.5739	Group P-Stat.	1.754	0.960
Panel PP-Stat.	-11.302	0.000	Group PP-Stat.	-14.406	0.000
Panel ADF-stat.	-11.451	0.000	Group ADF-Stat.	-11.140	0.000
Kao Residual Cointegration Test					
ADF	-7.790	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; VA is the voice and accountability; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Group Two:

Model (4): Capital Investment in Telecommunication with all the quality of governance indicators.

Table A22: Panel cointegration analysis (INV and the average of the quality of governance indicators).

RGDPG lnINV GOV (lnINV × GOV) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.355	0.991			
Panel P-Stat.	1.668	0.952	Group P-Stat.	2.895	0.998
Panel PP-Stat.	-6.997	0.000	Group PP-Stat.	-12.574	0.000
Panel ADF-stat.	-5.958	0.000	Group ADF-Stat.	-8.244	0.000
Trend and Intercept					
Panel v-Stat.	-3.808	0.999			
Panel P-Stat.	2.613	0.996	Group P-Stat.	3.735	0.999
Panel PP-Stat.	-8.073	0.000	Group PP-Stat.	-15.135	0.000
Panel ADF-stat.	-6.997	0.000	Group ADF-Stat.	-8.757	0.000
No Trend or Intercept					
Panel v-Stat.	-1.608	0.946			
Panel P-Stat.	0.444	0.671	Group P-Stat.	1.666	0.952
Panel PP-Stat.	-6.672	0.000	Group PP-Stat.	-10.857	0.000
Panel ADF-stat.	-6.087	0.000	Group ADF-Stat.	-9.625	0.000
Kao Residual Cointegration Test					
ADF	-7.940	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnINV is the capital investment in telecommunications as a percentage of GDP; CC is the average of the quality of governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A23: Panel cointegration analysis (INV and the control of corruption indicator).

RGDPG lnINV CC (lnINV × CC) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-1.743	0.959			
Panel P-Stat.	1.353	0.912	Group P-Stat.	2.279	0.989
Panel PP-Stat.	-7.057	0.000	Group PP-Stat.	-11.490	0.000
Panel ADF-stat.	-6.641	0.000	Group ADF-Stat.	-9.229	0.000
Trend and Intercept					
Panel v-Stat.	-3.290	1.000			
Panel P-Stat.	2.456	0.994	Group P-Stat.	3.369	0.999
Panel PP-Stat.	-9.625	0.000	Group PP-Stat.	-14.995	0.000
Panel ADF-stat.	-8.394	0.000	Group ADF-Stat.	-9.872	0.000
No Trend or Intercept					
Panel v-Stat.	-1.142	0.873			
Panel P-Stat.	0.225	0.589	Group P-Stat.	1.134	0.871
Panel PP-Stat.	-7.085	0.000	Group PP-Stat.	-10.933	0.000
Panel ADF-stat.	-7.615	0.000	Group ADF-Stat.	-10.956	0.000
Kao Residual Cointegration Test					
ADF	-7.921	0. 000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnINV is the capital investment in telecommunications as a percentage of GDP; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A24: Panel cointegration analysis (INV and government effectiveness indicator).

RGDPG lnINV GE (lnINV × GE) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-3.289	0.999			
Panel P-Stat.	2.109	0.983	Group P-Stat.	2.759	0.997
Panel PP-Stat.	-5.357	0.000	Group PP-Stat.	-14.177	0.000
Panel ADF-stat.	-5.132	0.000	Group ADF-Stat.	-10.076	0.000
Trend and Intercept					
Panel v-Stat.	-4.630	1.000			
Panel P-Stat.	2.836	0.997	Group P-Stat.	3.526	0.999
Panel PP-Stat.	-9.505	0.000	Group PP-Stat.	-19.199	0.000
Panel ADF-stat.	-8.443	0.000	Group ADF-Stat.	-11.820	0.000
No Trend or Intercept					
Panel v-Stat.	-2.685	0.996			
Panel P-Stat.	1.172	0.879	Group P-Stat.	1.656	0.951
Panel PP-Stat.	-4.795	0.000	Group PP-Stat.	-11.593	0.000
Panel ADF-stat.	-5.242	0.000	Group ADF-Stat.	-11.021	0.000
Kao Residual Cointegration Test					
ADF	-7.759	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnINV is the capital investment in telecommunications as a percentage of GDP; GE is the government effectiveness indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A25: Panel cointegration analysis (INV and the rule of law indicator).

RGDPG lnINV RL (lnINV × RL) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.413	0.992			
Panel P-Stat.	1.755	0.960	Group P-Stat.	3.444	0.999
Panel PP-Stat.	-10.987	0.000	Group PP-Stat.	-14.850	0.000
Panel ADF-stat.	-6.158	0.000	Group ADF-Stat.	-7.292	0.000
Trend and Intercept					
Panel v-Stat.	-4.122	1.000			
Panel P-Stat.	2.764	0.997	Group P-Stat.	4.206	1.000
Panel PP-Stat.	-11.772	0.000	Group PP-Stat.	-17.294	0.000
Panel ADF-stat.	-5.855	0.000	Group ADF-Stat.	-7.234	0.000
No Trend or Intercept					
Panel v-Stat.	-1.993	2.728			
Panel P-Stat.	0.677	-15.028	Group P-Stat.	0.977	0.997
Panel PP-Stat.	-10.669	0.000	Group PP-Stat.	0.751	0.000
Panel ADF-stat.	-3.935	0.000	Group ADF-Stat.	0.977	0.000
Kao Residual Cointegration Test					
ADF	1.636	0.051			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnINV is the capital investment in telecommunications as a percentage of GDP; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A26: Panel cointegration analysis (INV and the regulatory quality indicator).

RGDPG lnINV RQ (lnINV × RQ) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*	
Panel (within dimension)	Group (between dimension)

Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.076	0.981			
Panel P-Stat.	2.103	0.982	Group P-Stat.	2.933	0.998
Panel PP-Stat.	-7.289	0.000	Group PP-Stat.	-13.836	0.000
Panel ADF-stat.	-6.359	0.000	Group ADF-Stat.	-8.712	0.000
Trend and Intercept					
Panel v-Stat.	-3.692	0.999			
Panel P-Stat.	3.043	0.999	Group P-Stat.	3.737	1.000
Panel PP-Stat.	-8.632	0.000	Group PP-Stat.	-15.509	0.000
Panel ADF-stat.	-6.151	0.000	Group ADF-Stat.	-8.238	0.000
No Trend or Intercept					
Panel v-Stat.	-1.295	0.902			
Panel P-Stat.	0.893	0.814	Group P-Stat.	1.791	0.963
Panel PP-Stat.	-7.304	0.000	Group PP-Stat.	-12.422	0.000
Panel ADF-stat.	-7.884	0.000	Group ADF-Stat.	-11.395	0.000
Kao Residual Cointegration Test					
ADF	-8.244	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnINV is the capital investment in telecommunications as a percentage of GDP; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A27: Panel cointegration analysis (INV and the political stability and absence of violence indicator).

RGDPG lnINV PV (lnINV × PV) lnLF lnGFCF lnTRADE					
Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p

Individual Intercept					
Panel v-Stat.	-2.904	0.991			
Panel P-Stat.	2.212	0.959	Group P-Stat.	2.793	0.998
Panel PP-Stat.	-6.523	0.000	Group PP-Stat.	-16.714	0.000
Panel ADF-stat.	-6.525	0.000	Group ADF-Stat.	-10.869	0.000
Trend and Intercept					
Panel v-Stat.	-4.587	1.000			
Panel P-Stat.	3.263	0.999	Group P-Stat.	3.682	0.999
Panel PP-Stat.	-6.871	0.000	Group PP-Stat.	-16.433	0.000
Panel ADF-stat.	-7.219	0.000	Group ADF-Stat.	-11.045	0.000
No Trend or Intercept					
Panel v-Stat.	-2.262	0.988			
Panel P-Stat.	1.061	0.856	Group P-Stat.	1.600	0.945
Panel PP-Stat.	-6.633	0.000	Group PP-Stat.	-11.422	0.000
Panel ADF-stat.	-7.385	0.000	Group ADF-Stat.	-11.469	0.000
Kao Residual Cointegration Test					
ADF	-7.763	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnINV is the capital investment in telecommunications as a percentage of GDP; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

Table A28: Panel cointegration analysis (INV and the voice and accountability indicator).

RGDPG lnINV VA (lnINV × VA) lnLF lnGFCF lnTRADE

Pedroni Residual Cointegration Test*					
Panel (within dimension)			Group (between dimension)		
Statistics	Value	p	Statistics	Value	p
Individual Intercept					
Panel v-Stat.	-2.112	0.983			
Panel P-Stat.	2.326	0.990	Group P-Stat.	3.049	0.999
Panel PP-Stat.	-5.954	0.000	Group PP-Stat.	-13.897	0.000
Panel ADF-stat.	-4.831	0.000	Group ADF-Stat.	-9.194	0.000

Trend and Intercept					
Panel v-Stat.	-3.569	0.999			
Panel P-Stat.	3.282	0.998	Group P-Stat.	3.819	0.999
Panel PP-Stat.	-8.358	0.000	Group PP-Stat.	-17.992	0.000
Panel ADF-stat.	-8.588	0.000	Group ADF-Stat.	-10.809	0.000
No Trend or Intercept					
Panel v-Stat.	-1.461	0.928			
Panel P-Stat.	1.143	0.873	Group P-Stat.	1.740	0.959
Panel PP-Stat.	-5.679	0.000	Group PP-Stat.	-10.939	0.000
Panel ADF-stat.	-5.277	0.000	Group ADF-Stat.	-10.430	0.000
Kao Residual Cointegration Test					
ADF	-7.689	0.000			

Null Hypothesis: No Cointegration.

*Automatic lag length selection based on AIC.

RGDPG is real GDP growth; lnINV is the capital investment in telecommunications as a percentage of GDP; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP.

APPENDIX B

The purpose of this appendix to present the lag selection appropriate number for the variables in each model. To this end, I checked the entire lag selection for the empirical exercises presented in Chapter 6. The first set of lag selection criteria check is to estimate the first group models presented in Chapter 6 – USAGE, ACCESS, and MOB – with the individual measures of quality of governance indicators. Tables (B1 to B21) display those results.

As a second robustness exercise, I estimated the models in the second group; INV presented in the model specification section of Chapter 6, again with the individual measures of the quality of governance indicators. See tables B22 to B28. To conserve space in the main text, I make them available in this supplementary appendix.

B Tables: Estimate Model Selection Criteria with individual measures the quality of governance indicators

Model (1): USAGE with all the quality of governance indicators.

RGDPG*= f (lnUSAGE, GOV, lnUSAGE × GOV, lnLF, lnGFCF, lnTRADE, DSPRING)*

Table B1: Model Selection Criteria (USAGE and the average of the quality of governance indicators).

Model Selection Criteria Table					
RGDPG lnUSAGE GOV (lnUSAGE × GOV) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-649.625	4.680	6.524	5.414	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-676.726	4.743	6.411	5.407	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; GOV is the average of the six governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B2: Model Selection Criteria (USAGE and control of corruption indicator).

Model Selection Criteria Table					
RGDPG lnUSAGE CC (lnUSAGE × CC) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-357.419	3.668	6.763	4.900	ARDL(1, 2, 2, 2, 2, 2, 2, 2)
1	-619.218	4.532	6.384	5.269	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B3: Model Selection Criteria (USAGE and government effectiveness indicator).

Model Selection Criteria Table
RGDPG lnUSAGE GE (lnUSAGE × GE) lnLF lnGFCF lnTRADE DSPRING

Model	LogL	AIC*	BIC	HQ	Specification
1	-723.874	4.732	6.180	5.307	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; GE is the government effectiveness indicator; lnLF is the natural logarithm of the labour force as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B4. Model Selection Criteria (USAGE and rule of law indicator).

Model Selection Criteria Table					
RGDPG lnUSAGE RL (lnUSAGE × RL) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
3	-626.571	4.738	6.639	5.496	ARDL(3, 1, 1, 1, 1, 1, 1, 1)
2	-644.019	4.746	6.466	5.432	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-666.114	4.783	6.319	5.396	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B5: Model Selection Criteria (USAGE and regulatory quality indicator).

Model Selection Criteria Table					
RGDPG lnUSAGE RQ (lnUSAGE × RQ) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-654.725	4.709	6.554	5.443	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-675.694	4.738	6.405	5.401	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B6: Model Selection Criteria (USAGE and political stability and absence of violence indicator).

Model Selection Criteria Table
RGDPG lnUSAGE PV (lnUSAGE × PV) lnLF lnGFCF lnTRADE DSPRING

Model	LogL	AIC*	BIC	HQ	Specification
2	-643.262	4.643	6.488	5.378	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-669.839	4.704	6.372	5.368	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B7: Model Selection Criteria (USAGE and voice and accountability indicator).

Model Selection Criteria Table					
RGDPG lnUSAGE VA (lnUSAGE × VA) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-723.799	4.732	6.180	5.307	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Model (2): ACCESS with all the quality of governance indicators.

RGDPG*= f (lnACCESS, GOV, lnACCESS × GOV, lnLF, lnGFCF, lnTRADE, DSPRING)*

Table B8: Model Selection Criteria (ACCESS and the average of the quality of governance indicators).

Model Selection Criteria Table					
RGDPG lnACCESS GOV (lnACCESS × GOV) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
4	-520.614	4.498	6.841	5.433	ARDL(4, 1, 1, 1, 1, 1, 1, 1)
2	-556.351	4.521	6.488	5.306	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
3	-544.140	4.545	6.699	5.405	ARDL(3, 1, 1, 1, 1, 1, 1, 1)
1	-588.019	4.619	6.397	5.329	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; GOV is the average of the six governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B9: Model Selection Criteria (ACCESS and the control of corruption indicator).

Model Selection Criteria Table					
RGDPG lnACCESS CC (lnACCESS × CC) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-645.077	4.588	6.263	5.255	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-668.909	4.633	6.131	5.230	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B10: Model Selection Criteria (ACCESS and the government effectiveness indicator).

Model Selection Criteria Table					
RGDPG lnACCESS GE (lnACCESS × GE) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
4	-526.328	4.433	6.588	5.294	ARDL(4, 1, 1, 1, 1, 1, 1, 1)
3	-554.678	4.511	6.477	5.296	ARDL(3, 1, 1, 1, 1, 1, 1, 1)
2	-577.691	4.554	6.332	5.264	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-593.887	4.555	6.146	5.190	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; GE is the government effectiveness indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B11: Model Selection Criteria (ACCESS and the rule of law indicator).

Model Selection Criteria Table					
RGDPG lnACCESS RL (lnACCESS × RL) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-723.803	4.771	6.228	5.351	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of the population; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B12: Model Selection Criteria (ACCESS and the regulatory quality indicator).

Model Selection Criteria Table					
RGDPG lnACCESS RQ (lnACCESS × RQ) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-631.261	4.601	6.454	5.339	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-653.180	4.635	6.310	5.302	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth, lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B13: Model Selection Criteria (ACCESS and the political stability and absence of violence indicator).

Model Selection Criteria Table					
RGDPG lnACCESS PV (lnACCESS × PV) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-698.972	4.722	6.352	5.370	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B14: Model Selection Criteria (ACCESS and the voice and accountability indicator).

Model Selection Criteria Table
RGDPG lnACCESS VA (lnACCESS × VA) lnLF lnGFCF lnTRADE DSPRING

Model	LogL	AIC*	BIC	HQ	Specification
2	-643.649	4.672	6.525	5.410	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-671.982	4.743	6.418	5.410	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth, ACC is the proportion of households with internet access at home as a percentage of population; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Model (3): Mobile with all the quality of governance indicators.

RGDPG*= ƒ (lnMOB, GOV, lnMOB × GOV, lnLF, lnGFCF, lnTRADE, DSPRING)*

Table B15: Model Selection Criteria (MOB and the average of the quality of governance indicators).

Model Selection Criteria Table					
RGDPG lnMOB GOV (lnMOB × GOV) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-677.064	4.809	6.646	5.541	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-694.999	4.821	6.481	5.482	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; GOV is the average of the six governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B16: Model Selection Criteria (MOB and the control of corruption indicator).

Model Selection Criteria Table					
RGDPG lnMOB CC (lnMOB × CC) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-722.667	4.774	6.384	5.414	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B17: Model Selection Criteria (MOB and the government effectiveness indicator).

Model Selection Criteria Table					
RGDPG lnMOB GE (lnMOB × GE) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-729.669	4.812	6.423	5.452	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; GE is the government effectiveness indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B18: Model Selection Criteria (MOB and the rule of law indicator).

Model Selection Criteria Table					
RGDPG lnMOB RL (lnMOB × RL) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
4	-528.479	4.523	7.422	5.677	ARDL(2, 2, 2, 2, 2, 2, 2, 2)
2	-562.677	4.627	7.349	5.710	ARDL(1, 2, 2, 2, 2, 2, 2, 2)
3	-687.542	4.792	6.456	5.454	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-706.993	4.811	6.299	5.404	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B19: Model Selection Criteria (MOB and the regulatory quality indicator).

Model Selection Criteria Table					
RGDPG lnMOB RQ (lnMOB × RQ) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-672.758821	4.784951	6.621849	5.516024	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-690.302808	4.793748	6.454656	5.454779	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B20: Model Selection Criteria (MOB and the political stability and absence of violence indicator).

Model Selection Criteria Table
RGDPG lnMOB PV (lnMOB × PV) lnLF lnGFCF lnTRADE DSPRING

Model	LogL	AIC*	BIC	HQ	Specification
2	-672.759	4.785	6.622	5.516	ARDL(2, 1, 1, 1, 1, 1, 1, 1)
1	-690.303	4.794	6.455	5.455	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B21: Model Selection Criteria (MOB and the voice and accountability indicator).

Model Selection Criteria Table					
RGDPG lnMOB VA (lnMOB × VA) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-746.743	4.818	6.258	5.390	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Model (4): Capital Investment in Telecommunication with all the quality of governance indicators.

***RGDPG**= ƒ (lnINV, GOV, lnINV × GOV, lnLF, lnGFCF, lnTRADE, DSPRING).*

Table B22: Model Selection Criteria (INV and the average of the quality of governance indicators).

Model Selection Criteria Table					
RGDPG lnINV GOV (lnINV × GOV) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-738.496	4.773	6.213	5.345	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; GOV is the average of the six governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B23: Model Selection Criteria (INV and the control of corruption indicator).

Model Selection Criteria Table					
RGDPG lnINV CC (lnINV × CC) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-690.849	4.688	6.468	5.395	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B24: Model Selection Criteria (INV and the government effectiveness indicator).

Model Selection Criteria Table					
RGDPG lnINV GE (lnINV × GE) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-453.382	4.185	7.260	5.409	ARDL(1, 2, 2, 2, 2, 2, 2, 2)
1	-657.967	4.714	6.555	5.447	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; GE is the government effectiveness indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B25: Model Selection Criteria (INV and the rule of law indicator).

Model Selection Criteria Table					
RGDPG lnINV RL (lnINV × RL) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-741.512	4.789	6.229	5.362	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B26: Model Selection Criteria (INV and the regulatory quality indicator).

Model Selection Criteria Table					
RGDPG lnINV RQ (lnINV × RQ) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
2	-537.111	4.481	7.203	5.564	ARDL(1, 2, 2, 2, 2, 2, 2, 2)

1	-687.160	4.698	6.186	5.290	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B27: Model Selection Criteria (INV and the political stability and absence of violence indicator).

Model Selection Criteria Table					
RGDPG lnINV PV (lnINV × PV) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-733.909	4.748	6.188	5.320	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

Table B28: Model Selection Criteria (INV and the voice and accountability indicator).

Model Selection Criteria Table					
RGDPG lnINV VA (lnINV × VA) lnLF lnGFCF lnTRADE DSPRING					
Model	LogL	AIC*	BIC	HQ	Specification
1	-692.714	4.698	6.479	5.405	ARDL(1, 1, 1, 1, 1, 1, 1, 1)

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. * The lag selection criteria in this model is Akaike's information criterion (AIC).

APPENDIX C

This appendix shows the short-run effect of the study variables on economic growth in MENA countries in all empirical exercises. To this end, I find the panel ARDL analysis for in model specification in chapter 6. As usual in this part of the study, I find the short-run effect for the governance indicators and ICT indicators in the regression one by one Busse and Hefeker (2007), as mentioned in the model specification section in chapter 6. Tables (C1 to C1.28) display those results.

C Tables: Estimate Short Run Coefficients using the Panel ARDL Approach for ICT usage with individual measures the quality of governance indicators

Model (1): USAGE with all the quality of governance indicators.

RGDPG= *f (lnUSAGE, GOV, lnUSAGE × GOV, lnLF, lnGFCF, lnTRADE, DSPRING)*

Table C1: Short Run Coefficients using the Panel ARDL Approach (USAGE and the average of the quality of governance indicators).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.929	-6.758	0.000
Δ (RGDPG(-1))	0.153	1.759	0.080
Δ (LNUSAGE)	3.348	1.709	0.089
Δ (GOV)	-1.071	-0.098	0.922
Δ (GOV × LNUSAGE)	1.803	0.565	0.573
Δ (LNLF)	13.847	0.7301	0.466
Δ (LNGFCF)	7.125	1.968	0.050
Δ (LNTRADE)	5.017	1.366	0.174

Δ (DSPRING)	1.166	0.899	0.370
C	24.99	6.488	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; GOV is the average of the six governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011.
The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, usage, governance, the interaction between the usage and governance, education, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C2: Short Run Coefficients using the Panel ARDL Approach (USAGE and the control of corruption indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.847	-4.568	0.000
Δ (LNUSAGE)	-2.641	-1.128	0.262
Δ (LNUSAGE(-1))	1.596	1.017	0.312
Δ (CC)	-2.859	-0.386	0.700
Δ (CC(-1))	-3.986	-0.540	0.590
Δ (CC × LNUSAGE)	1.856	0.817	0.416
Δ (CC(-1) × LNUSAGE(-1))	0.484	0.232	0.817
Δ (LNLF)	66.809	0.936	0.352
Δ (LNLF(-1))	-9.217	-0.169	0.866
Δ (LNGFCF)	6.553	1.478	0.143
Δ (LNGFCF(-1))	3.342	0.673	0.502
Δ (LNTRADE)	6.423	1.621	0.108
Δ (LNTRADE(-1))	-3.319	-0.629	0.531
Δ (DSPRING)	-2.568	-1.123	0.264
Δ (DSPRING(-1))	-0.171	-0.071	0.944
C	-52.114	-4.299	0.000
@TREND	-0.342	-2.048	0.043

Δ is the first difference.
RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 2, 2, 2, 2, 2, 2) and the order of variables is: real GDP growth, usage, control of corruption indicator, the interaction between the usage and control of corruption indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C3: Short Run Coefficients using the Panel ARDL Approach (USAGE and the government effectiveness indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	0.185	2.629	0.009
Δ (LNUSAGE)	2.395	3.829	0.000
Δ (GE)	0.289	1.734	0.084
Δ (GE × LNUSAGE)	0.650	1.177	0.241
Δ (LNLF)	0.397	0.579	0.563
Δ (LNGFCF)	0.039	0.080	0.936
Δ (LNTRADE)	-1.538	-6.499	0.000
Δ (DSPRING)	0.185	2.629	0.009

Δ is the first difference.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; GE is the government effectiveness indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, usage, government effectiveness indicator, the interaction between the usage and government effectiveness indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C4: Short Run Coefficients using the Panel ARDL Approach (USAGE and the rule of law indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.827	-4.650	0.000
Δ (RGDPG(-1))	0.150	1.486	0.139
Δ (RGDPG(-2))	-0.015	-0.190	0.849
Δ (LNUSAGE)	-0.220	-0.204	0.838
Δ (RL)	-8.098	-1.035	0.302
Δ (LNUSAGE × RL)	2.475	1.470	0.143

Δ (LNLF)	3.715	0.264	0.792
Δ (LNGFCF)	7.725	1.752	0.081
Δ (LNTRADE)	4.869	1.246	0.214
Δ (DSPRING)	-0.827	0.275	0.784

Δ is the first difference.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (3, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, usage, rule of law indicator, the interaction between the usage and rule of law indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C5: Short Run Coefficients using the Panel ARDL Approach (USAGE and the regulatory quality indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-1.005	-6.521	0.000
Δ (RGDPG(-1))	0.173	2.087	0.038
Δ (LNUSAGE)	1.523	1.487	0.139
Δ (RQ)	-5.121	-1.357	0.176
Δ (LNUSAGE × RQ)	1.578	1.509	0.133
Δ (LNLF)	22.749	1.046	0.297
Δ (LNGFCF)	7.347	2.153	0.033
Δ (LNTRADE)	4.487	1.383	0.168
Δ (DSPRING)	0.857	0.888	0.376
C	33.810	6.393	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP Growth, usage, regulatory quality indicator, the interaction between the usage and regulatory quality indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C6: Short Run Coefficients using the Panel ARDL Approach (USAGE and the political stability and absence of violence indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.927	-6.986	0.000
Δ (RGDPG(-1))	0.122	1.440	0.151
Δ (LNUSAGE)	1.390	0.714	0.476
Δ (PV)	7.017	2.175	0.031
Δ (LNUSAGE × PV)	-1.989	-1.715	0.088
Δ (LNLF)	12.795	0.604	0.546
Δ (LNGFCF)	6.373	1.888	0.060
Δ (LNTRADE)	5.302	1.553	0.122
Δ (DSPRING)	0.856	0.838	0.403
C	24.313	6.797	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, usage, political stability indicator, the interaction between the usage and political stability indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C7: Short Run Coefficients using the Panel ARDL Approach (USAGE and the voice and accountability indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.751	-8.875	0.000
Δ (LNUSAGE)	1.398	1.134	0.258
Δ (VA)	-4.729	-0.569	0.569
Δ (LNUSAGE × VA)	1.549	0.653	0.514
Δ (LNLF)	5.806	0.378	0.706
Δ (LNGFCF)	7.313	2.150	0.033
Δ (LNTRADE)	7.206	1.651	0.100
Δ (DSPRING)	-0.519	-0.425	0.671

Δ is the first difference.

RGDPG is real GDP growth; lnUSAGE is the natural logarithm of individuals using the internet as a percentage of population; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, usage, voice and accountability indicator, the interaction between the usage and voice and accountability indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Model (2): ACCESS with all the quality of governance indicators.

RGDPG*= ƒ (lnACCESS, GOV, lnACCESS × GOV, lnLF, lnGFCF, lnTRADE, DSPRING)*

Table C8: Short Run Coefficients using the Panel ARDL Approach (ACCESS and the average of the quality of governance indicators).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-1.177	-5.360	0.000
Δ (RGDPG(-1))	0.398	2.159	0.032
Δ (RGDPG(-2))	0.129	1.129	0.260
Δ (RGDPG(-3))	0.118	1.684	0.094
Δ (LNACCESS)	3.414	1.188	0.237
Δ (GOV)	-18.323	-0.762	0.447
Δ (GOV × LNACCESS)	5.464	0.981	0.328
Δ (LNLF)	22.773	0.595	0.553
Δ (LNGFCF)	5.970	1.479	0.141
Δ (LNTRADE)	6.972	1.155	0.249
Δ (DSPRING)	2.005	1.519	0.130
C	30.758	5.114	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; GOV is the average of the six governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (4, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, access, governance, the interaction between the access and governance, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C9: Short Run Coefficients using the Panel ARDL Approach (ACCESS and the control of corruption indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.921	-6.590	0.000
Δ (RGDPG(-1))	0.101	1.453	0.148
Δ (LNACCESS)	2.781	0.939	0.349
Δ (CC)	-4.402	-0.507	0.613
Δ (CC × LNACCESS)	1.984	0.948	0.344
Δ (LNLF)	42.690	1.137	0.257
Δ (LNGFCF)	7.856	1.986	0.048
Δ (LNTRADE)	2.214	0.551	0.582
Δ (DSPRING)	0.243	0.249	0.803

Δ is the first difference.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, access, control of corruption indicator, the interaction between the access and control of corruption indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C10: Short Run Coefficients using the Panel ARDL Approach (ACCESS and the government effectiveness indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.795	-7.264	0.000
Δ (RGDPG(-1))	0.120	1.530	0.128
Δ (RGDPG(-2))	0.011	0.107	0.915
Δ (RGDPG(-3))	0.041	0.715	0.475
Δ (LNACCESS)	3.515	1.019	0.309
Δ (GE)	3.275	0.257	0.798
Δ (GE × LNACCESS)	0.472	0.148	0.883
Δ (LNLF)	26.357	1.206	0.229
Δ (LNGFCF)	8.140	1.851	0.066
Δ (LNTRADE)	4.019	1.017	0.310
Δ (DSPRING)	0.469	0.450	0.653

Δ is the first difference.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; GE is the government effectiveness indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (4, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, access, government effectiveness indicator, the interaction between the access and government effectiveness indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C11: Short Run Coefficients using the Panel ARDL Approach (ACCESS the rule of law indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.766	-9.259	0.000
Δ (LNACCESS)	1.965	0.944	0.346
Δ (RL)	-15.687	-1.730	0.0845
Δ (LNACCESS × RL)	3.856	1.891	0.060
Δ (LNLF)	4.719	0.296	0.767
Δ (LNGFCF)	7.958	2.066	0.040
Δ (LNTRADE)	3.038	0.775	0.439
Δ (DSPRING)	-0.385	-0.367	0.714

Δ is the first difference.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, access, rule of law indicator, the interaction between the access and rule of law indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C12: Short Run Coefficients using the Panel ARDL Approach (ACCESS the regulatory quality indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-1.077	-6.656	0.000
Δ (RGDPG(-1))	0.214	3.186	0.002
Δ (LNACCESS)	5.453	1.399	0.163
Δ (RQ)	-6.661	-0.596	0.552
Δ (LNACCESS × RQ)	0.751	0.275	0.784
Δ (LNLF)	37.964	1.109	0.269

Δ (LNGFCF)	5.658	1.556	0.121
Δ (LNTRADE)	4.036	1.176	0.241
Δ (DSPRING)	0.315	0.315	0.753
C	13.728	5.443	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, access, regulatory quality indicator, the interaction between the access and regulatory quality indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C13: Short Run Coefficients using the Panel ARDL Approach (ACCESS the political stability and absence of violence indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.833	-11.792	0.000
Δ (LNACCESS)	1.305	0.595	0.552
Δ (PV)	2.019	0.950	0.343
Δ (LNACCESS × PV)	0.016	0.025	0.980
Δ (LNLF)	16.671	1.045	0.297
Δ (LNGFCF)	4.543	1.278	0.203
Δ (LNTRADE)	3.551	1.145	0.254
Δ (DSPRING)	-0.047	-0.042	0.966
C	7.476	10.842	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, access, political stability indicator, the interaction between the access and political stability indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C14: Short Run Coefficients using the Panel ARDL Approach (ACCESS the voice and accountability indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.927	-5.757	0.000
Δ (RGDPG(-1))	0.146	1.423	0.156
Δ (LNACCESS)	2.852	0.678	0.498
Δ (VA)	-17.220	-1.322	0.188
Δ (LNACCESS × VA)	5.440	1.469	0.143
Δ (LNLF)	30.984	1.159	0.248
Δ (LNGFCF)	5.359	1.293	0.197
Δ (LNTRADE)	1.910	0.414	0.679
Δ (DSPRING)	0.778	0.495	0.621
C	-5.870	-4.910	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnACCESS is the natural logarithm of the proportion of households with internet access at home as a percentage of population; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, access, voice and accountability indicator, the interaction between the access and voice and accountability indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Model (3): Mobile with all the quality of governance indicators.

RGDPG*= ƒ (lnMOB, GOV, lnMOB × GOV, lnLF, lnGFCF, lnTRADE, DSPRING)*

Table C15: Short Run Coefficients using the Panel ARDL Approach (MOB and the average of the quality of governance indicators).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.969	-6.726	0.000
Δ (RGDPG(-1))	0.139	1.798	0.074
Δ (LNMOB)	3.641	1.478	0.141
Δ (GOV)	24.949	1.245	0.214
Δ (GOV × LNMOB)	-4.684	-1.070	0.286
Δ (LNLF)	17.865	0.796	0.427
Δ (LNGFCF)	7.999	1.972	0.048
Δ (LNTRADE)	3.308	0.946	0.345
Δ (DSPRING)	0.916	0.806	0.421
TREND	8.604	6.278	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; GOV is the average of the six Governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011.
The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, mobile cellular Subscription, governance, the interaction between the mobile cellular subscription and governance, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C16: Short Run Coefficients using the Panel ARDL Approach (MOB and the control of corruption indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.771	-8.829	0.000
Δ (LNMOB)	0.546	0.636	0.524
Δ (CC)	-2.052	-0.571	0.569
Δ (CC × LNMOB)	0.495	0.689	0.491
Δ (LNLF)	-10.912	-0.391	0.696
Δ (LNGFCF)	6.986	1.854	0.065
Δ (LNTRADE)	3.487	0.935	0.351
Δ (DSPRING)	-0.472	-0.493	0.623
C	5.694	7.356	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, mobile cellular subscriptions, control of corruption indicator, the interaction between the mobile cellular subscription and control of corruption indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C17: Short Run Coefficients using the Panel ARDL Approach (MOB and the government effectiveness indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.840	-9.833	0.000
Δ (LNMOB)	-0.949	-0.528	0.598
Δ (GE)	-12.061	-1.236	0.218
Δ (GE × LNMOB)	3.677	1.613	0.108
Δ (LNLF)	6.627	0.345	0.731
Δ (LNGFCF)	7.717	1.897	0.059
Δ (LNTRADE)	5.735	1.526	0.128
Δ (DSPRING)	-0.358	-0.358	0.721
C	14.802	9.657	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; GE is the government effectiveness indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, mobile cellular subscription, government effectiveness indicator, the interaction between the mobile cellular subscription and government effectiveness indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C18: Short Run Coefficients using the Panel ARDL Approach (MOB and rule of law indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.859	-4.839	0.000
Δ (RGDPG(-1))	-0.004	-0.028	0.978
Δ (LNMOB)	1.452	0.321	0.749
Δ (LNMOB(-1))	-1.048	-0.272	0.787
Δ (RL)	13.744	0.626	0.532
Δ (RL(-1))	17.053	0.809	0.420
Δ (LNMOB × RL)	-4.166	-0.853	0.396
Δ (LNMOB(-1) × RL(-1))	-4.352	-0.919	0.360
Δ (LNLF)	-9.386	-0.349	0.727
Δ (LNLF(-1))	-22.870	-0.674	0.502
Δ (LNGFCF)	6.021	1.343	0.182
Δ (LNGFCF(-1))	3.573	0.799	0.426
Δ (LNTRADE)	8.387	1.320	0.189
Δ (LNTRADE(-1))	-2.997	-0.767	0.444
Δ (DSPRING)	-1.464	-0.802	0.424
Δ (DSPRING(-1))	-0.814	-0.424	0.672

Δ is the first difference.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (2, 2, 2, 2, 2, 2, 2) and the order of variables is: real GDP growth, mobile cellular subscription, regulatory quality indicator, the interaction between the mobile and regulatory quality indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C19: Short Run Coefficients using the Panel ARDL Approach (MOB and the regulatory quality indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-1.029	-6.381	0.000
Δ (RGDPG(-1))	0.162	1.999	0.047
Δ (LNMOB)	4.933	1.005	0.316
Δ (RQ)	8.872	0.411	0.682
Δ (LNMOB × RQ)	-1.739	-0.390	0.697
Δ (LNLF)	14.490	0.667	0.505
Δ (LNGFCF)	7.484	1.750	0.082
Δ (LNTRADE)	5.424	1.342	0.181
Δ (DSPRING)	0.794	0.829	0.408
C	15.313	6.215	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011.

The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, mobile cellular subscription, rule of law indicator, the interaction between the mobile cellular subscription and rule of law indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C20: Short Run Coefficients using the Panel ARDL Approach (MOB and the political stability and absence of violence indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.833	-5.917	0.000
Δ (RGDPG(-1))	0.030	0.425	0.671
Δ (LNMOB)	-0.031	-0.017	0.986
Δ (PV)	9.237	1.717	0.087
Δ (LNMOB × PV)	-2.049	-1.427	0.155
Δ (LNLF)	-0.514	-0.028	0.978
Δ (LNGFCF)	7.036	2.062	0.040
Δ (LNTRADE)	3.913	1.173	0.242
Δ (DSPRING)	0.132	0.126	0.899

Δ is the first difference.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011.
The lag structure is ARDL (2, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, mobile cellular subscription, political stability indicator, the interaction between the mobile cellular subscription and political stability indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C21: Short Run Coefficients using the Panel ARDL Approach (MOB and the voice and accountability indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.784	-10.000	0.000
Δ (LNMOB)	0.555	0.641	0.522
Δ (VA)	-5.763	-1.140	0.255
Δ (LNMOB × VA)	1.460	1.058	0.291
Δ (LNLF)	2.577	0.149	0.882
Δ (LNGFCF)	7.438	2.108	0.036
Δ (LNTRADE)	5.266	1.499	0.135

Δ (DSPRING)	-0.509	-0.479	0.633

Δ is the first difference.

RGDPG is real GDP growth; lnMOB is the natural logarithm of mobile cellular subscriptions per 100 people; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP Growth, mobile cellular subscription, voice and accountability indicator, the interaction between the mobile cellular subscription and voice and accountability indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Model (4): Capital Investment in Telecommunication with all the quality of governance indicators.

RGDPG*= f (lnINV, GOV, lnINV × GOV, lnLF, lnGFCF, lnTRADE, DSPRING).*

Table C22: Short Run Coefficients using the Panel ARDL Approach (INV and the average of the quality of governance indicators).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.732	-9.671	0.000
Δ (LNINV)	-2.825	-1.231	0.220
Δ (GOV)	4.050	1.055	0.293
Δ (GOV × LNINV)	-5.092	-1.301	0.195
Δ (LNLF)	-14.976	-0.713	0.477
Δ (LNGFCF)	6.940	1.999	0.047
Δ (LNTRADE)	5.025	1.589	0.113
Δ (DSPRING)	-0.397	-0.483	0.630

Δ is the first difference.

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; GOV is the average of the six governance indicators; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, capital Investment in telecommunications, governance, the interaction between the capital investment in telecommunications and governance, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C23: Short Run Coefficients using the Panel ARDL Approach (INV and the control of corruption indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.885	-11.713	0.000
Δ (LNINV)	-1.188	-0.805	0.422
Δ (CC)	-4.427	-1.658	0.099
Δ (CC × LNINV)	-1.700	-0.85	0.396
Δ (LNLF)	3.984	0.265	0.792
Δ (LNGFCF)	4.813	1.420	0.157
Δ (LNTRADE)	3.221	1.094	0.275
Δ (DSPRING)	-0.598	-0.749	0.455
C	-0.926	-1.241	0.216
@TREND	-0.170	-4.424	0.000

Δ is the first difference.

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; CC is the control of corruption indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, capital investment in telecommunications, control of corruption indicator, the interaction between the capital investment in telecommunications and control of corruption indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C24: Short Run Coefficients using the Panel ARDL Approach (INV and the government effectiveness indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.821	-5.961	0.000
Δ (LNINV)	-3.683	-1.021	0.309
Δ (LNINV(-1))	4.470	0.975	0.332
Δ (GE)	-3.616	-0.393	0.695
Δ (GE(-1))	9.919	0.976	0.332
Δ (GE × LNINV)	-2.375	-0.366	0.715
Δ (GE(-1) × LNINV(-1))	-4.111	-0.519	0.604
Δ (LNLF)	92.258	2.168	0.032
Δ (LNLF(-1))	-41.148	-0.872	0.385
Δ (LNGFCF)	0.278	0.044	0.965
Δ (LNGFCF(-1))	1.803	0.480	0.632
Δ (LNTRADE)	17.786	2.067	0.041
Δ (LNTRADE(-1))	2.678	0.358	0.721
Δ (DSPRING)	-4.325	-1.943	0.055
Δ (DSPRING(-1))	-1.784	-0.767	0.445
C	-40.043	-5.811	0.000
@TREND	-0.178	-2.686	0.008

Δ is the first difference.

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; GE is the government effectiveness indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011.
The lag structure is ARDL (1, 2, 2, 2, 2, 2, 2) and the order of variables is: real GDP growth, capital investment in telecommunications, government effectiveness indicator, the interaction between the capital investment in telecommunications and government effectiveness indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C25: Short Run Coefficients using the Panel ARDL Approach (INV and the rule of law indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.772	-9.064	0.000
Δ (LNINV)	-0.037	-0.030	0.976
Δ (RL)	-0.658	-0.261	0.795
Δ (LNINV × RL)	-3.274	-1.499	0.135
Δ (LNLF)	-21.519	-0.751	0.453
Δ (LNGFCF)	7.649	2.248	0.026
Δ (LNTRADE)	3.307	1.066	0.287
Δ (DSPRING)	-0.164	-0.179	0.858

Δ is the first difference.

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; RL is the rule of law indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, capital investment in telecommunications, rule of law indicator, the interaction between the capital investment in telecommunications and rule of law indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C26: Short Run Coefficients using the Panel ARDL Approach (INV and the regulatory quality indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.843	-7.192	0.000
Δ (LNINV)	-0.557	-0.232	0.817
Δ (LNINV(-1))	0.934	0.438	0.662
Δ (RQ)	0.140	0.031	0.976
Δ (RQ(-1))	-7.334	-1.545	0.125
Δ (LNINV × RQ)	-3.041	-0.706	0.481
Δ (LNINV(-1) × RQ(-1))	-4.502	-1.171	0.244
Δ (LNLF)	12.372	0.435	0.665
Δ (LNLF(-1))	-44.129	-1.368	0.174
Δ (LNGFCF)	6.772	1.811	0.072
Δ (LNGFCF(-1))	4.417	1.356	0.177
Δ (LNTRADE)	9.512	2.097	0.038
Δ (LNTRADE(-1))	-6.208	-1.323	0.188
Δ (DSPRING)	-3.849	-2.279	0.024
Δ (DSPRING(-1))	-1.091	-0.513	0.609

Δ is the first difference.

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; RQ is the regulatory quality indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 2, 2, 2, 2, 2, 2) and the order of variables is: real GDP growth, capital investment in telecommunications, regulatory quality indicator, the interaction between the capital investment in telecommunications and regulatory quality indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C27: Short Run Coefficients using the Panel ARDL Approach (INV and the political stability and absence of violence indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.767	-9.946	0.000
Δ (LNINV)	3.394	0.904	0.367
Δ (PV)	-1.702	-0.385	0.700
Δ (LNINV × PV)	-3.495	-1.027	0.305
Δ (LNLF)	-27.668	-1.011	0.313
Δ (LNGFCF)	7.429	2.297	0.022
Δ (LNTRADE)	3.344	1.484	0.139
Δ (DSPRING)	-0.115	-0.113	0.910

Δ is the first difference.

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; PV is the political stability and absence of violence indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011. The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, capital investment in telecommunications, political stability indicator, the interaction between the capital investment in telecommunications and political stability indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

Table C28: Short Run Coefficients using the Panel ARDL Approach (INV and the voice and accountability indicator).

Dependent Variable RGDPG			
Independent Variable	**Coefficient**	**t-statistic**	**Prob.**
ECT(-1)	-0.864	-10.132	0.000
Δ (LNINV)	-3.409	-1.724	0.086
Δ (VA)	0.119	0.029	0.977
Δ (LNINV × VA)	-2.633	-1.046	0.297
Δ (LNLF)	1.901	0.115	0.909
Δ (LNGFCF)	4.082	1.188	0.236
Δ (LNTRADE)	6.232	1.414	0.159
Δ (DSPRING)	-0.254	-0.247	0.805
C	5.049	4.363	0.000
@TREND	-0.099	-2.497	0.013

Δ is the first difference.

RGDPG is real GDP growth; lnINV is the natural logarithm of capital investment in telecommunications as a percentage of GDP; VA is the voice and accountability indicator; lnLF is the natural logarithm of labour force participation rate as a percentage of population; lnGFCF is the natural logarithm of gross fixed capital formation as a percentage of GDP; lnTRADE is the natural logarithm of trade openness as a percentage of GDP; DSPRING is a dummy for the Arab Spring in 2011, which equals 1 in 2011 and onwards, and 0 in the years before 2011.
The lag structure is ARDL (1, 1, 1, 1, 1, 1, 1) and the order of variables is: real GDP growth, capital investment in telecommunications, voice and accountability indicator, the interaction between the capital investment in telecommunications and voice and accountability indicator, labour force, gross fixed capital formation, trade openness, and a dummy for the Arab Spring.

APPENDIX D

Table D1: List of Variables and Sources.

Variable/Code	Definition	Sources
Political governance index (*POL*)	An alternative measure of political governance index created by summing up the values of two constituent factors: voice and accountability and political stability; with higher values implying better governance quality.	Euromonitor International
Economic governance index (*ECO*)	An alternative measure of economic governance index, created by summing up the values of two constituent factors: rule of law and control of corruption; with higher values implying better governance quality.	Euromonitor International
Institutional governance index (*INS*)	An alternative measure of the institutional governance index created by summing up the values of two constituent indicators: government effectiveness and regulatory quality; with higher values implying better governance quality.	Euromonitor International
Political governance (*poly*)	An index ranging from 1 to 7, created by the average of the values of two constituent factors: political rights and civil liberties, with a higher score indicating a lower level of governance quality.	Freedom House
Economic Freedom index (*eco*)	Economic freedom measures property rights and the ability to engage in voluntary transactions are considered. This variable is created by the averages of five factors, including the size of government and legal structure; security of property rights; access to sound money; freedom of trade; and regulation of credit and business. This variable is used as an alternative measure of economic governance.	Gwartney, J., Lawson, R., & Hall, J. (2019). Economic Freedom Dataset, Published in Economic Freedom of the World: 2019 Annual Report, https://www.fraserinstitute.org/studies/economic-freedom-of-the-world-2018-annual-report.
Institutional governance (*ins*)	An index ranging from 1 to 100, created by the average of the values of four constituent factors: Business freedom, monetary freedom, investment freedom, and financial freedom. A higher score indicating better governance quality.	Freedom House
Government expenditure as a percentage of GDP (*EXP*)	General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security, but excludes government military expenditures that are part of government capital formation.	World Bank (2020)