The role of information and communication technologies in economic growth: Egypt's case

Dr. Hoda Mansour
Abstract: This study offers a new perspective on information and communication technology (ICT) as a driver of economic growth. The study gives information on the role of ICT to national economic growth via the transmission channels. This study scrutinizes the relationship between economic growth and the degree of investment in ICT in Egypt using time series and an error-correcting model. The findings demonstrate that there is a long-term positive association between economic growth and capital in the digital economy. Furthermore, Granger's causality analysis demonstrates the existence of unidirectional causality and claims that investments in information and communication technologies promote economic growth, not the reverse. Thus, the development of ICT provides a potential for Egypt to achieve sustained economic growth.

Keywords: digital economy, economic growth, ICT, sustainable development.

I. Introduction

Since the mid-1990s, ICT have advanced significantly in all economic, social, political, and cultural sectors, affecting economic actors. ICT is used as a technique in a variety of areas of the economy, including manufacturing, health, education, commerce, and government (Alzouma, 2008). Economists have long been interested with the development of information and communication technologies and its implications for markets. According to Dholakia and colleagues (2002), infrastructural improvements shaped both established and emerging market patterns. They established that the internet shaped markets by lowering transaction and agency costs and by introducing network externalities. Digital technologies have fundamentally altered organizational and production practices, consumer behavior, and, more broadly, the functioning of economies. The term "digital economy" was used by the US Department of Commerce in 1998 to refer to an economy that evolved significantly quicker than earlier societies due to ICT innovation. The digital economy is viewed as a necessary precursor to a knowledge-based society. Drucker 1969 and Bell 1973 characterized the knowledge-based society in specific terms, claiming that knowledge would be determined by policy decisions and that knowledge workers responsible for creating and utilizing information would become more crucial. In this context, ICT refers to the collection of tools required for the treatment of information, most notably computers and software, as well as other technical provisions necessary for the management and storage of information in technological formats that enable information to be distributed, exchanged, searched, and retrieved (Gollac et al., 2000; Antonelli, 1988). According to the
OECD (1999), the ICT sector is divided into three sub-sectors, or sectors: information technology, telecommunications, and electronics. ICT will refer to telecommunications (particularly fixed and mobile telephony and the Internet) in this study due to its importance in comparison to the other two subsectors in Egypt and, on the other hand, the modest contribution of the other subsectors to domestic output. The information and communication technology sector has made a direct and significant contribution to the cycle of expansion and job creation that has characterized the majority of countries over the last several decades. Indeed, greater ICT output benefits national production, job creation, and increased export revenues, all while increasing productivity, competitiveness, and growth. Governments can benefit from ICT by becoming more efficient, transparent, and responsible (Joseph, 2002). The spread of ICT has had repercussions akin to those of the great technological waves of the industrial revolutions.

Today, digital technology permeates all global economy sectors, thus playing an essential role in its growth. Industrialized countries have proven that the digital economy in general and ICTs in particular Today, digital technology pervades every sector of the global economy, playing a critical role in its growth. The industrialized world has demonstrated that the digital economy in general and ICTs contribute directly to up to 5.6 percent of GDP in Europe and 7.5 percent in the United States in 2015. (European Commission, 2015). The digital economy is critical to the North's economies regaining competitiveness; it now accounts for 30% of global economic growth. In 2011, these countries had a global gain of 4.3 percent in the digital market, totaling 3070 billion. ICT's debut is a growth and development engine; it represents a major and exploitable asset in national production (McKinsey report); in 2015, the digital industry contributed 5.2 percent to national GDPs. Another McKinsey report from 2013 emphasizes the contribution of digital initiatives to 10% GDP growth in 2025, equating to an actual value of $ 300 billion. This digitization surge is being heralded as the start of Africa's digital economy. On the other hand, telecoms grew at a rate of 5% of global growth; this is explained by the fact that access to communication means is nearly unequal. Given the number of users who account for 5% of the world's population, we see a disadvantaged situation: Three internet connections per 1000 persons, five telephone connections per 100 inhabitants on average, and less than one telephone connection per 1000 inhabitants in remote areas. Africans are still far from possessing all of the circumstances necessary to make the huge leap into this more advanced economy, owing to the high cost and near-inaccessibility of the essential means and instruments for the majority of people. Africa is the only continent that
lacks adequate technology. Only a few select countries, such as Senegal (1st in Africa in terms of technology), South Africa, Nigeria, Kenya, and several Maghreb countries, have been able to capitalize on the evolution of information and communication technologies, transforming them into growth levers. The development challenge in this new, more immaterial economy is represented in the production capacity and well-being that it will provide to populations. In Kenya and Nigeria, the digital economy contributed 8% and 11% to GDP, respectively (Mutegi 2016). (Adepetun 2016).

The concept of sustainable growth is a goal shared by all of the world's economies, even though the majority of associated work is unaware of the evolution and intrinsic impact of technology instruments. ICTs have made an unquestionable contribution to the production process. The purpose of this article is to offer a new perspective on ICT as a driver of economic progress. Thus, after discussing the situation of Egypt's digital economy and economic growth, we outline the study's design, data, and analytical approach. Following that, we give the results of our investigation, the theoretical model, and a discussion of our findings. Finally, we review the findings of the study given in this work and offer concluding observations and recommendations for future research.

II. Literature review

Numerous routes of ICT's impact on economic growth have been identified in the economic literature. The first channel is financial. The multiplier effect of ICT investment is explained by the fact that businesses obtain outputs from the ICT industry as products investment, intermediate consumer goods, and final consumer goods. Prices are the second route via which the effect of ICT on growth is transmitted. The decline in the cost of goods and services in the ICT sector has prompted businesses to significantly boost their investment in digital technology. The third channel is concerned with quality. The quality effect is explained by the fact that ICT can be linked to gains in intangible output components such as variety, consumer convenience, and services. These benefits will enhance consumers' utility functions without affecting the price or nominal quantity of ICT-enabled products (Youssef and M'Henni, 2004). The fourth channel is the effect of capital substituting for labor. ICT contributes to the development of capital in comparison to work and skilled work in comparison to unskilled work (David, 2001; Jorgenson, 2001). The fifth channel is related to the aggregate factor productivity effect. These primary routes would facilitate the dissemination of ICT performance at the macroeconomic level. Additionally, they perceive ICT as a technology that enables economic potential for countries that incorporate it into their manufacturing processes.
These benefits, however, are contingent upon a country's status as an ICT producer or importer (Dirk and Lee, 2001), its size, international specialization, and starting factororial (Antonelli, 2003), as well as the presence or absence of complementary assets. Numerous empirical studies have shown that information and communication technologies (ICTs) greatly increase a country's growth economy and have a beneficial effect on countries' productivity and economic performance. Kraemer and Dedrick (1993) examined the effect of ICTs on economic growth in Pacific Asian countries and established a positive correlation between ICT and economic growth. Lau and Tokutsu (1992) used the production function approach to study the relationship between ICT and economic growth in the United States. They demonstrate that ICTs account for around half of total national production. Apart from the fact that the United States of America is an amazing illustration of how ICT supports production growth, other countries gain from better economic growth as a result of ICT investments. According to Lee and Khatri (2003), ICT capital in Malaysia generates a threefold return on investment compared to non-ICT capital. Studies utilizing the accounting approach reveal that ICT has a favorable effect on growth. Niininen (1998) decomposes economic growth into capital and labor productivities, as well as multi-factor productivity. The study indicated that information and communication technologies considerably contribute to the country's economic prosperity. Daveri (2000) stated in another study conducted in OECD countries that ICT contributes to the economic growth of most OECD countries, particularly during the 1990s. Colecchia and Schreyer (2002) estimate that information and communication technology contribute between 20% and 50% of national growth in nine OECD nations. Using a similar technique, Oulton (2001) investigates the role of ICT to economic growth in the United Kingdom and concludes that ICTs contribute significantly to the country's economic growth. Mas and Quesada (2005) found that ICT investments increase Spain's economic performance.

Other studies aim to demonstrate that ICTs also have an impact on emerging countries' social and cultural plans. Donner (2007) examined the influence of telephone service on small enterprises in Rwanda and concluded that its use enabled the development of a network of local entrepreneurs. In Niger, Acker (2008) asserts that mobile phone use alters rural marketplaces and expands farmers' entrepreneurial prospects. According to Tall (2004), the telephone facilitates the reunion of extended families, particularly in rural Senegal. Exchanges (particularly financial ones) between distant members and those left behind have increased in frequency and regularity. Access to high-quality internet and mobile phone services allows economic and social development at
all levels (Zhen-Wei Qiang and al., 2004). Numerous areas, in this context, are devoted to ICT development initiatives and projects. In the educational sphere, for example, “e-learning” enables remote communities to be reached and compensates for lack of connectivity, electricity, or road infrastructure. In the subject of health, the application of ICT is frequently referred to as “e-health,” which encompasses telemedicine and the use of ICTs to combat disease. Commercially, we can mention e-commerce, to which we can add e-banking and mobile money, which facilitate and expedite access to financial services. ICTs are employed to increase well-being and poverty alleviation in all of these areas.

III. ICT and economic growth in Egypt

Egypt is rapidly developing its technology industry to become a "smart" country, where all services and utilities are automated and where the upcoming Internet of Things (IoT) era elevates business to new heights. Deregulation of the ICT market, combined with large-scale initiatives to promote ICT and the Internet, has resulted in increased affordability of cellphones, personal computers, tablets, and telecommunications services, as well as an increase in the number of Egyptians with online aptitude. Additionally, the government wishes to develop an integrated database for the Egyptian populace to expedite the resolution of numerous other economic difficulties.

Egypt's Ministry of Communications and Information Technology has produced a National Internet Plan with the goal of expanding high-speed broadband coverage throughout the country. The program's objectives include transforming government operations digitally, creating jobs, and closing the digital divide between urban and rural areas. MCIT is currently developing Egypt's national strategy for e-commerce promotion. When fully operational, it is a strategic asset whose considerable contribution has the potential to significantly alter the national and, why not, international situation. As a serious impediment to reaching 2020 digital emergence targets and emerging by 2030, this technology's condition remains precarious. Egypt placed 99th out of 138 countries in terms of technological readiness, according to the GCI ratings. Egypt's Information and Communications Technology (ICT) sector is booming, growing at a rate higher than Egypt's overall GDP growth rate of 15.2% in 2019/2020. Its GDP contribution increased from 3.5 percent in 2018/2019 to 4.4 percent in 2019/2020. In 2019/2020, total sector investments grew 35% to $3.5 billion. The Egyptian government is upgrading its infrastructure and digital government services as part of its ICT 2030 strategy. The strategy calls for new initiatives in capacity building, electronics design and manufacturing, and
technology parks to maximize the ICT sector's contribution to Egypt's economic growth. The strategy also includes plans to digitally transform education, healthcare, and government services. The MCIT's "Our Future is Digital" initiative aims to train 100,000 young Egyptians in high-demand ICT skills like website design, data analysis, and digital marketing.

In 2020, the ministry launched "Our Digital Opportunity" to engage SMEs in digital transformation. This is part of the ministry's Digital Egypt Project. At a cost of 6 billion Egyptian Pounds (approximately $375 million), this process has been completed in 5,300 government buildings across Egypt. With a target move-in date of mid-2021, the New Administrative Capital (NAC) will eventually house most central government offices. The government intends to make the NAC a “Smart City” by heavily investing in its telecommunications and ICT infrastructure. The first phase of “Knowledge City” inside the NAC is finished. It will have applied research centers for technology, software, and data design. Cost: 12 billion Egyptian Pounds ($750 million). They plan to set up Creative Innovation Hubs in the city to help promote innovation and entrepreneurship.

Mobile penetration in Egypt is 110 percent, and around 37.8 percent of Egyptians, including those in rural regions, utilize the Internet, indicating a sizable market size. Telecom Egypt's ongoing deployment of fourth-generation wireless mobile telecommunications technology (4G) will greatly boost internet services. These initiatives, combined with the passage of e-commerce-friendly legislation, such as the 2004 e-signature law and the 2006 consumer protection law, have paved the way for more Egyptians to engage in e-commerce, hence expanding the online consumer market. Additionally, the country has a strong data center infrastructure and is well positioned to build its cloud computing business.

Mobile phone ownership is another critical developing measure of adolescent ICT proficiency. In 2015, the percentage of people who own mobile phones as a percentage of total people reached 84.8 percent. International Internet Bandwidth serves as the primary entry point for Egypt's digital economy, serving as the Internet’s core supply element. It climbed more than 500% in five years, from 2,040 Bits in 2011 to 12,727 Bits in 2016. Individuals' share of global internet bandwidth increased to 1,134 Bits in 2016. Egypt is ranked higher globally in terms of gross expenditure on research & development than on education in general. Egypt spent 0.7 percent of GDP on research and development in 2017. In comparison to 0.2 percent in 1996, growth has averaged 7.88 percent annually (ranked 51st out of 107 countries). It spent 3.8 percent of GDP on education in 2012 (ranking 85th out of 107 nations) (WBD, 2017). Additionally, Egypt is a significant player in information technology exports; high-technology exports were valued at $52.092 million in
2016 (CEIC, 2018), with a developed software development and systems integration sector. Its local electronics and home appliance manufacturing industries are also expanding. Local manufacturing and service firms thrive in industries that could benefit from e-commerce marketing (such as textiles, agro and food processing, and tourism). While the majority of enterprises are tiny and many operate in the informal sector, there is a developed retail market and a variety of national retail brands in large cities.

Numerous efforts have been made over the last few years to maintain a competitive environment for ICT companies and to bring an increasing amount of value to the economy. As illustrated in Figure 2, the Egyptian ICT sector generated 3.2 percent of GDP in 2017. Between 90 and 95 thousand employment have been created in the outsourcing industry area alone. In 2016, the outsourcing industry generated over $1.7 billion in exports and approximately $1.87 billion in 2017. The ICT sector had a considerable inflow of targeted investments, both domestic and foreign, resulting in a total growth of almost 16%. In 2016, the number of newly founded enterprises in the ICT sector surpassed 1,000. Additionally, investments began to flow into the electronic design sector to capitalize on the promise of the promising new sector. These flows are the result of policies and planning aimed at increasing the efficiency of the telecommunications infrastructure, strengthening the export sector's ability to export, and fostering a competitive environment that fosters work and innovation. This will ultimately increase sector productivity and benefit the local economy through added value, job generation, and cost savings. The free flow of information and the decrease in transaction costs will turn civilization into a digital economy.

Finally, this section discussed two aspects, namely ICT and economic growth in Egypt, and concluded that the country's status is favorable. Economic growth continues to fluctuate today, even though it has improved in recent years. However, the digital economy has the potential to accelerate Egypt's economic growth and contribute to the country's ambitious Sustainable Development Agenda by 2030.

IV. Methodology

4.1 Model Specification
The purpose of this study is to determine the impact of ICT on Egypt's economic growth using a neoclassical production function. To do this, we employed the Cobb-Douglas production function to demonstrate the link between national ICT policy and long-term economic growth in an endogenous growth framework.

\[ Y_t = A k^{\alpha} I C T_t^{\beta} H U M_t^{\gamma} \]  

(1)
where $Y_t$ denotes real Gross Domestic Product (GDP) as a function of information and communication technology (kICT), capital stock excluding ICT (khICT), average human capital (kHUM), and other factors (A) affecting national product during each time $t$. In Egypt, ICT capital is mostly derived from mobile telephony, which accounts for more than 95% of investments in the ICT sector. The gross admittance rate to the highest level of school is used to approximate the average human capital variable. It is proportional to the percentage of students that complete their high school education. It indicates the percentage of pupils that successfully complete their senior year of high school.

The economic literature devoted to analyzing the contribution of ICT to economic growth uses the distinction between ICT and non-ICT capital stock (Youssef and M'Henni, 2004; Jorgenson and Stiroh, 2000; Jorgenson, 2001). This discrepancy is primarily explained by the fact that capital depreciation rates are different in the ICT sector and that wages are greater in the ICT sector than in other sectors (Youssef & M'Henni, 2004). Using the explanatory variables mentioned previously, we obtain the following equation:

$$\ln Y_t = \ln(A) + \alpha \ln(KICT_t) + \beta \ln(KHICT_t) + \gamma \ln(KHUM_t) + \varepsilon_t$$ (2)

$\ln$ denotes the natural logarithm. $t$ denotes the independent and normally distributed error term. Along with the independent variables, we will incorporate the variable teledensity (LINES) in the empirical linear model, which is the number of functioning fixed telephone lines per thousand persons. This variable indicates the extent to which different ICT networks are used in Egypt, considering that access to a reliable Internet connection is contingent upon the availability and quality of the fixed telephone network. This variable may have a beneficial effect on Egypt's productivity. The final empirical model appears as follows:

$$\ln GDP = n_0 + n_1 \ln KICT + n_2 \ln KHICT + n_3 \ln KHUM + n_4 \ln LINES + \varepsilon_t$$ (3)

The parameters $\eta_i$ are the elasticities of production to factors of production.

4.2 Data and Variables

The dataset for this article was derived from two primary sources: first, the World Bank's World Development Indicators (World Development Indicators, 2016). It contains the most up-to-date and accurate information accessible on global development. The second is the International Telecommunications Union's WTI (World Telecommunications Indicators, 2016) database, which includes information on access, use, service quality, income, and investment in telephone networks, both fixed and mobile, as well as on the Internet. Additionally, it provides statistics on a country's demography and macroeconomics. The data span the years 1995 to 2015. However, these databases do not contain information about the capital stock; rather, they contain
information about investments. As a result, the capital stocks were estimated using the following formula:

\[ K_{t+1} = (1 - \delta)K_t + I_{t+1} \]  (4)

The capital stock during a year \( t + 1 \) noted \( K_{t+1} \) is equal to the capital stock in year \( t \) \( K_t \) minus capital depreciation \( \delta K_t \) and plus new investment \( I_{t+1} \). In previous work on econometric estimates of the contribution of information and communication technologies to growth, ICT capital is assumed to depreciate over an eight-year period while non-ICT capital depreciates more slowly over a period of eight years. Thus, many authors (Lee et al., 2005; Youssef and M’Henni, 2004; Schreyer, 2000) propose a depreciation rate of \( \delta_{KHICT} = 8\% \) for non-ICT capital and \( \delta_{KICT} = 12.5\% \) for ICT capital. For simplification, this study adopted the same rates of capital depreciation. Using time-series and an error correction model, this study analyzes the link between economic growth and the level of investment in ICT in Egypt.

V. Results and Discussion

5.1. Unit root test

A unit root test is required prior to analyzing the time series data. We establish the order of integration of the time series using the conventional augmented Dickey-Fuller (ADF) tests on our variables. The basic ADF tests for the null hypothesis of series non-stationarity, that is, the existence of a unit root in the series under consideration. The ADF non-stationarity tests are carried out sequentially in three steps. The unit root test, which is derived from the standard Augmented Dickey-Fuller test, yields the results shown in Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test with Intercept P value</th>
<th>Test with Intercept and trend P value</th>
<th>Test with Intercept P value</th>
<th>Test with Intercept and trend P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lGDP</td>
<td>0.56</td>
<td>80.5</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>lKICT</td>
<td>540.</td>
<td>0.60</td>
<td>0.0001</td>
<td>0.0002</td>
</tr>
<tr>
<td>lKHICT</td>
<td>350.</td>
<td>250.</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>kHUM</td>
<td>0.44</td>
<td>.350</td>
<td>0.0002</td>
<td>0.0003</td>
</tr>
<tr>
<td>LINES</td>
<td>80.8</td>
<td>10.8</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Table 1: Augmented Dickey – Fuller Unit Root Test Results

At a given level of 5%, the critical values of individual variables are less than the statistical ADF values. We accept the null hypothesis that all series contain a unit root. Thus, the gross domestic product (GDP), ICT (lKICT) and non-ICT
(IKHICT) capital, human capital (kHUM), and the number of lines per 1000 persons (LINES) are not stationary. On the other hand, in first difference, all of the model's series are stationary, because the ADF test's critical values are bigger than the ADF's statistical values at the 5% level. As a result, all series are integrated in ascending order at the 5% level. According to economic theory, these series are believed to have long-term economic linkages. As a result, we will conduct a cointegration test to assess whether these variables have a long-term relationship.

### 5.2. Johansen cointegration test

We employ the Johansen cointegration test to ascertain the number of long-term equilibrium linkages that exist between integrated variables. This test enables the identification of long-term relationships in integrated time series and the extraction of all cointegration vectors in a multivariate context. The findings of two tests are presented in the Johansen cointegration study: the trace test and the maximum eigenvalue test. When the findings of the two tests disagree, we normally keep the results of the trace test since its power is greater than that of the maximum eigenvalue test (Cadoret et al., 2009). We employ the trace of cointegration test in our analysis. The results of the cointegration trace test are shown in Table 2.

<table>
<thead>
<tr>
<th>hypothesis</th>
<th>Trace statistic</th>
<th>Maximum eigenvalue statistic</th>
<th>5% critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null*</td>
<td>0.645555</td>
<td>73.6899</td>
<td>60.06141</td>
</tr>
<tr>
<td>Max 1*</td>
<td>0.524555</td>
<td>42.8899</td>
<td>40.17493</td>
</tr>
<tr>
<td>Max 2</td>
<td>0.25000</td>
<td>18.14544</td>
<td>24.27496</td>
</tr>
<tr>
<td>Max 3</td>
<td>0.17211</td>
<td>6.454444</td>
<td>12.32090</td>
</tr>
<tr>
<td>Max 4</td>
<td>0.03121</td>
<td>0.787477</td>
<td>4.129906</td>
</tr>
</tbody>
</table>

* implies rejection at the 5% level.  
CE = cointegration equation

The trace test statistics indicate that there is at least one (01) cointegration link between the variables national production, ICT capital, non-ICT capital, human capital, and teledensity because of the cointegration test. The statistic of the trace (42.8899) is bigger than the critical value under the null hypothesis \( r = 1 \) (40.17493). As a result, our model's variables are cointegrated at the 5% level. In other words, over the period 2000–2015, these variables exhibit parallel patterns. As a result, we employ an error correction model. The Engle-Granger
two-step error correction model and Hendry's one-step error correction model are two ways for estimating the error correction model. To discover cointegrating associations, we use the first method, which involves estimating long-term relationships between variables using the ordinary least squares method. Second, the ordinary least squares approach is used to estimate the short-term associations between the variables.

5.2. Results of the long-term relationship estimation

Table 3 shows results of the estimation of the long-term relationship between production and the explanatory variables using the ordinary least squares method.

Table 3: Results of the estimation of the long-term relationship

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>Probabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGDP</td>
<td>0.07423</td>
<td>0.0321**</td>
</tr>
<tr>
<td>IKICT</td>
<td>0.17455</td>
<td>0.0034***</td>
</tr>
<tr>
<td>IKHICT</td>
<td>0.00857</td>
<td>0.0008***</td>
</tr>
<tr>
<td>kHUM</td>
<td>0.016478</td>
<td>0.7031</td>
</tr>
<tr>
<td>LINES</td>
<td>7.64111</td>
<td>0.0000***</td>
</tr>
</tbody>
</table>

***coefficient significant at 1% **coefficient significant at 5%.

The coefficient of determination ($R^2 = 0.9224$) and Fisher test statistics indicate that the model is suitable and that the exogenous variables in our model account for 92 percent of the variability observed at the national production level. The unit root test indicates that there is no unit root in the series of residuals for the long-term model residue. Indeed, at the fixed level of 5%, the crucial value exceeds the statistical ADF value at that level (-2.96 > -3.19). The long-term relationship's residue is immobile. This result suggests that cointegration exists between the model's variables. Then, the error correction model can be estimated, allowing for the analysis of the variables' short-term dynamics.

5.4. Results of the short-term relationship estimation

Table 4 summarizes the results of the estimation of the short-term relationship.

Table 4: Results of the estimation of the short-term relationship

These results are derived by applying the ordinary least squares approach to an error correction model of the short-term dynamics represented by the variables in first difference.
Table 4: Results of the ECM

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>Probabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔlGDP</td>
<td>-0.59454</td>
<td>0.0063***</td>
</tr>
<tr>
<td>ΔlKICT</td>
<td>0.079154</td>
<td>0.0079***</td>
</tr>
<tr>
<td>ΔlKHICT</td>
<td>-0.002415</td>
<td>0.8955</td>
</tr>
<tr>
<td>ΔkHUM</td>
<td>0.001487</td>
<td>0.7811</td>
</tr>
<tr>
<td>ΔLINES</td>
<td>-0.06945</td>
<td>0.2154</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>0.03154</td>
<td>0.0039***</td>
</tr>
</tbody>
</table>

*** coefficient significant at 1% ** coefficient significant at 5% * coefficient significant at 10%

$R^2 = 0.551035$

F-Statistic = 5.891263

The coefficient of determination and Fisher test statistics indicate that the model is statistically significant. Prior to interpreting this finding, it is critical to examine the quality of the estimate using residual robustness tests. The Jarque-Bera test determines if the residuals are regularly distributed. In terms of error heteroscedasticity, White's test indicates that the residuals are homoscedastic. All of these tests contribute to the model's validation, the results of which may now be analyzed.

5.5. Results analysis

The error correction term's parameter is negative and significant at the 5% level, indicating the existence of an error correction mechanism: over the long run, the imbalances between the evolution of production and that of capital ICT, non-ICT capital, human capital, and the evolution of teledensity balance each other out, resulting in similar evolutions for the variables over the period. The error correction coefficient measures the pace at which any disparity in domestic output between desired and actual levels is addressed in the year following the shock. Thus, the figure 0.59454 denotes the rate of absorption of the imbalance. A one-year shock to Egypt's national production is entirely absorbed after two years. As a result, the error correction model is sufficient. Both in the short and long run, the model indicates that the coefficient of the ICT capital stock variable is positive and statistically significant at the 1% level.
This finding is consistent with Youssef and M’Henni’s (2004) finding that there is a positive association between ICT investments and economic growth in Tunisia. The elasticity of the ICT capital stock to domestic production in the short run is $0.079154$. Thus, a 10% increase in the ICT capital stock results in a 0.79% rise in national output. The comparatively low value of this elasticity suggests that Egypt has not yet completely reaped the benefits of ICTs' considerable ability to drive national output development. The positive elasticity observed in the long run is comparable to that observed in the short term. The comparatively late adoption of information and communication technologies in Egypt, which is often associated with the positive contribution of ICT (mobile phone and Internet) to growth, may explain the relative weakness of ICT’s capital effect on economic growth. These findings corroborate Cronin et al (1991)’s assertion that countries with more digital infrastructure have faster increase in their production.

In the long run, the capital stock variable excluding ICT (IKHICT) has a positive and statistically significant effect on national production. Due to the fact that investments made to raise the level of national output are relatively substantial. This finding, which emphasizes the importance of investment in economic growth, is consistent with often presented findings in economic theory. Indeed, all empirical evidence indicates that growth is associated with an increase in the per capita stock of capital (Aghion, 2006). Thus, investments serve as a catalyst for economic growth in Egypt.

Economic theory postulates that human capital is a critical factor in the expansion of domestic production and its quality. The findings of this study demonstrate that, in the case of Egypt, this theoretical conclusion has long-term support. Human resources appear to be one of the primary drivers of Egypt's economic progress.

Finally, we observe that the fixed telephone network’s teledensity has no effect on Egypt’s national output growth. This outcome is understandable in light of the mobile phone’s substitution effect on the fixed phone in Egypt and, on the other hand, the near-zero level of investment carried out for over a decade on the fixed network, which has remained a public monopoly, blocking a more widespread deployment of this network.

5.6. Analysis of the direction of causality from the Granger causality test
Correlation between two variables does not always imply that one of them is the source of the other, and thus that they have a causal relationship. It is just as critical to understand the direction of causality as it is to demonstrate a relationship between economic variables. Indeed, understanding the direction of causality is critical and has economic policy ramifications. Thus, in order to
improve the results of the research of the relationship between ICT and the expansion of Egypt's economy, the study of the causal relationship between ICT capital and production is being considered using the Granger causality test. The underlying question is whether the accelerated development of the ICT sector has shifted causality in the sense that ICT statistically causes economic growth. In other words, have we reached a point in a forecasting framework where it would be economically more attractive to estimate economic growth based on present and historical rates of technology capital accumulation? The test's null hypothesis is "variable X does not cause variable Y in the Granger sense." A sufficiently small p-value in comparison to the selected confidence level results in the null hypothesis being rejected. Our level of confidence is 5% in this instance. Table 5 summarizes the results of the Granger causality test that was used.

<table>
<thead>
<tr>
<th>Null Hypothesis (X is not the cause of Y)</th>
<th>P-value</th>
<th>Is X the cause of Y?</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Y</td>
<td>0.0025</td>
</tr>
<tr>
<td>KICT</td>
<td>GDP</td>
<td>0.7454</td>
</tr>
</tbody>
</table>

The Granger causality test establishes a one-way relationship between ICT investment and economic growth. The causality test indicates that at the 1% threshold, the causality is more in the direction of ICT capital toward national production. It is preferable to forecast economic growth by tracking the accumulation of technology capital. This result is good for Egypt's ongoing changes in the technology sector. This gives us reason to hope that the effect of ICTs on economic growth in the coming years will be more beneficial to the Egyptian economy. However, this effect will be completely realized if the formation of an ICT manufacturing sector and an increase in the level of ICT dissemination in Egypt are observed.

VI. Conclusion and policy implications

Increased access to information and communication technologies results in increased employment opportunities, knowledge transfer, and economic efficiency and transparency. The advancement of ICTs provides developing countries with an opportunity to positively impact their economic growth. The analysis of ICTs' contribution to economic growth in Egypt enabled the definition of the concept, the prospective functions of ICTs, and all the channels via which ICTs' effects on growth are transmitted. Then, an update to the literature review enabled us to demonstrate that the dispute over the relationship
between ICT and growth is tilting in favor of a positive relationship, even though the discussion is far from settled on the magnitude of the effects. Finally, by employing error-corrected econometric modeling of time series, it was possible to evaluate the hypothesis of an association between ICT and economic growth in Egypt. The study concludes that increasing ICT capital has a positive effect on economic growth in Egypt.

Based on these findings, economic policy recommendations can be made. To begin, the state will need to increase its support for and encouragement of ICT investments. This entails strengthening the sector's resilience measures and implementing a comprehensive sector development strategy based on investments to ensure that the country effectively becomes a Middle Eastern digital district. Second, policies promoting ICTs should be explored at all levels to increase their spread and utilization. This includes promoting the use of ICT in government and education. Thirdly, it is critical to develop the business climate in the sector, which attracts investment and ensures both the promotion of ICT use and the contribution of ICT to poverty reduction. The influence of ICTs on poverty reduction can be understood using aggregate production function estimates derived from household and business surveys.

VII. References


15. *Egypt - Information and Communications Technology; and Digital Economy (trade.gov)*


43. STD-DOC 2005 (4): 1-56
44. UIT (2016), World telecommunications indicators, Geneva, Switzerland.

45. WDI (2016), World Development Indicators, World Bank, Washignton, D.C., United States.


47. World Bank data, https: data.worldbank.org-country-egypt-arab-rep
