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Unveiling the Potential of ICT as a Growth Driver in Egypt

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ABSTRACT

This study examines the role of information and communications technology (ICT) in driving economic growth, with a focus on Egypt. Using the autoregressive distributed lag (ARDL) cointegration approach of Pesaran et al. (2001), Kaldor's first and third growth laws were estimated for the period 1983–2021. The absence of a comprehensive and consistent employment dataset precluded the estimation of the second law. To address a similar data gap in the third law, we proposed an alternative specification, using total factor productivity (TFP) to capture the overall effect of the ICT sector on the economy. The findings show that the ICT sector proxied by telecommunications, has potential to stimulate economic growth. However, its contribution is largely through adding value to the economy as a producing sector, while its ability to enhance productivity in other sectors remains underutilized. Barriers such as digital divide, low ICT adoption by SMEs, and institutional constraints hinder broader impacts. This study contributes to the literature by proposing a new formulation for Kaldor's third law, applying Kaldor's growth framework to assess ICT as a growth driver, and offering the first empirical evaluation of ICT's role in Egypt's economic growth using Kaldor's laws.

Keywords: Economic Growth, Kaldor's Growth Laws, ICT, ARDL, Bound Testing Approach, Developing Countries
JEL Classifications: O47, E12, O11

1. INTRODUCTION

In his inaugural lectures at Cambridge in 1966 and Cornell in 1967, Kaldor presented a sectoral view of growth in which manufacturing serves as the engine of growth. He argued that faster growth in manufacturing output leads to higher GDP growth. According to Kaldor, manufacturing is the only sector that possesses two key characteristics qualifying it as the engine of growth: firstly, manufacturing exhibits increasing returns to scale; and secondly, it has a positive impact on the productivity of other sectors in the economy.

The view of the manufacturing sector as the sole engine of growth dominated heterodox economic literature from the mid-1950s through the 1970s and 1980s. However, this view has been significantly challenged since the mid-1990s with the rise of services and the shift in their perception from a weak productivity sector to a potential driver of growth. Currently, the information and communication technology (ICT) sector has emerged as a leading candidate for this role.

There are two main channels through which ICT can affect economic growth. The first is the direct channel resulting from the increase in productivity of ICT as an economic activity producing goods and services. The second is the enabling role of the ICT sector, which enhances productivity in other sectors using ICT and contributes to capital deepening by investing in ICT equipment. These two channels suggest the possibility for the ICT sector to assume the role of the engine of growth in line with Kaldor's proposition (Qiang et al., 2004)

Egypt, like many other developing countries, began investing in the ICT sector in the mid-1980s; since then, the sector has shown gradual improvement in its performance indicators. The

ICT sector constitutes approximately 5% of the GDP in fiscal year (FY) 2021/2022, up from 3.2% in 2017/2018. Furthermore, Egypt's digital exports reached US$4.9 billion in FY 2021/2022, depicting a 36% rise from US$3.6 billion in FY 2018/2019. Despite these improvements, the effect of the ICT sector on economic growth in Egypt remains understudied. Furthermore, the vast majority of these studies have used descriptive statistics to determine its relative contribution to the economy in terms of GDP, investment, exports, and revenues as well as gauging the degree of development using various indicators representing infrastructure, accessibility, and affordability. Therefore, to the best of our knowledge, no empirical study has utilized econometric techniques to examine the notion that Egypt's ICT sector acts as an engine of growth (Ministry of Communications and Information Technology, 2022).

In light of the above, the objective of this study is to estimate Kaldor's growth equations to investigate whether the ICT sector can be regarded as Egypt's engine of growth during the period 1983–2021.

The present work adds to the body of knowledge in three primary ways. First, it adds to the economic literature on Kaldor's growth laws by proposing a new specification for Kaldor's third law. Second, it is considered one of the few studies that utilized Kaldor's growth framework to examine the role of ICT as an engine of growth. Finally, this study is a pioneering effort to apply Kaldor's growth laws to evaluate the role of ICT in the Egyptian economy and the channels through which it influences the economy.

Following the introduction, Section 2 provides a brief literature review of the impact of ICT on economic growth, with special reference to studies conducted in Egypt. Section 3 elaborates on Kaldor's growth laws, which represent the theoretical framework of the applied model, and Section 4 outlines the methodology employed in the empirical examination. This is followed by a presentation of the empirical findings and discussion of results in Section 5. Finally, Section 6 concludes the study and presents policy recommendations.

2. THE CONTRIBUTION OF ICT TO ECONOMIC GROWTH - LITERATURE REVIEW

There is a wealth of empirical research measuring the impact of ICT on economic growth. Most of these studies have adopted a neoclassical growth model, while few studies have used Kaldor's growth laws to investigate their validity for sectors other than manufacturing, including the ICT sector. Empirical studies that employ a neoclassical growth model fall into two main categories:

The first category examines the impact of the ICT sector on economic growth by either estimating the production function or conducting a growth accounting analysis. In both approaches, a distinction is made between ICT and non-ICT capital, reflecting the view of ICT as a form of capital. Early studies in this group focused mainly on developed countries and reached a consensus on the positive impact of ICT on economic growth and productivity. More recent studies have demonstrated that the magnitude of impact varies among developed nations, particularly between the US and the rest of the developed countries, especially during the 1990s. (e.g. Cette et al., 2001; Cette, 2014; Daveri, 2002; Van Ark, 2002)

With the widespread use of ICT in developing countries, an increasing number of empirical studies have focused on its impact on the economic growth of this group. Early studies have found no significant relationship between ICT and economic growth in developing countries. These studies include those by Dewan and Kraemer (2000), Pohjola (2000), and Qiang et al. (2004).

According to, the lack of a significant relationship between IT investments and economic growth in these earlier studies could be attributed to the fact that the data for these studies date back to the 1980s to the mid-1990s, when developing countries had low levels of IT capital investments and limited IT expertise.

More recent studies, including those by Dedrick et al. (2013), Dimelis and Papaioannou (2010), Niebel (2014), and Papaioannou and Dimelis (2007) have found a significant relationship between ICT and economic growth in developing countries. However, there is no consensus on whether this impact differs significantly between developed and developing countries.

The second category of studies focused on testing the impact of ICT diffusion/spread and its level of development on economic growth, utilizing various variables to measure these aspects. Examples include Batuo (2008), Das et al. (2016), Adeleye and Eboagu (2019), Remeikiene et al. (2021), and Sapuan and Roly (2021). All these studies confirmed the existence of a positive correlation between ICT diffusion and economic growth. However, there were variations with respect to the specific ICT diffusion variables that were found to significantly affect economic growth.

Focusing on Arab countries, Dahmani et al. (2022) assessed the impact of ICT diffusion on economic growth in Tunisia from 1997 to 2017 using a panel of 17 economic sectors. The study found that, despite the presence of a significant positive relationship between ICT and economic growth in Tunisia, economic growth was primarily explained by traditional factors (labor and physical capital). Furthermore, the effect of ICT on value added varies by sector. Hodrob et al. (2016) found a positive impact of ICT on the economic growth of a selected sample of 18 Arab countries from the Middle East and North Africa from 1995 to 2013.

Moving beyond the neoclassical growth model, a limited number of studies have employed Kaldor's growth laws to examine the role of ICT as an engine of growth. Di Meglio et al. (2015) estimated Kaldor's growth laws for several service sectors in 29 developing countries in Asia, Latin America, and Sub-Saharan Africa. ICT services were classified under two service categories: transport, communications, and business services (including computer services). The study found that the engine of growth hypothesis holds for business services, particularly in Asia and Latin America, driven by increasing returns to scale and productivity spillovers. In contrast, it did not hold for transport and communications, although this sector still exhibited increasing returns and positive productivity effects, with regional variations.

Jessen-Thiesen (2020) estimated Kaldor's growth laws for the Indian economy over the period 1980–2017. The economy was disaggregated into 12 sectors, including telecommunications. With respect to this sector, the study did not reach a definitive conclusion as the results varied depending on the estimated equation.

Pieper (2001) estimated Kaldor's second law, testing the increasing returns to scale hypothesis in the leading sector of growth, for nine sectors, including transport and communications. The study concluded that this sector exhibits increasing returns to scale; however, it cannot be conclusively asserted that the result pertains specifically to the communications sector given the aggregation of both sectors.

In light of the above, it can be argued that studies employing Kaldor's model have not reached conclusive results regarding the role of the ICT sector as a growth engine. This is partly attributable to the absence of consistent, detailed, and long-term data on the sector, which hinders the ability to isolate the specific impact of ICT from that of other integrated economic activities.

Finally, reviewing the studies conducted on the impact of the ICT sector on the Egyptian economy, Helmy (2009) examined the ICT sector's potential as a growth engine by assessing its direct impact on macroeconomic variables. The author concluded that, while the ICT sector has been one of the fastest-growing sectors in Egypt since the beginning of the millennium, it could not qualify as an engine of growth. The reasons behind this are twofold: first, the relatively small size of the sector in terms of its contribution to the economy and second, its relatively weak indirect effect as an enabler to other sectors in the economy.

While Kamel (2021) analyzed the potential effects of digital transformation on the Egyptian economy. He concluded that despite Egypt's progress toward digitization, the country has not greatly benefited from the opportunities presented by this shift. This results from a primary focus on enablement coupled with a low uptake of ICT by various businesses, particularly SMEs, and the existence of a digital divide.

Nour (2002) compared the ICT markets in Egypt and Gulf countries, questioning the presence of a complementary relationship between ICT and economic growth. The study concluded that there is a two-way complementary relationship between the two variables, although the significance of this relationship remains unclear.

After examining the ICT value chain, Said (2022) concluded that Egypt's ICT industry still lags behind its competitors. Despite gradual improvements in performance indicators across the value chain, Egypt's ICT sector continues to exhibit a sluggish growth trajectory compared with the more dynamic pace of the industry globally.

Furthermore, Zaki (2023) utilized a range of ICT macro indicators along with firm-level data for the year 2022 to assess Egypt's digitalization efforts and their impact on firm performance. Zaki's findings revealed that Egypt lags significantly behind several comparable economies in terms of digitalization indicators at the macro level. At the micro level, most firms have yet to embrace digital technologies. However, when firms adopt digital solutions, they experience positive impacts on various indicators of firm performance including exports and sales.

Considering the above, the following sections provide a brief overview of Kaldor's growth laws, followed by an empirical investigation of the role of the ICT industry as an engine of growth in Egypt.

3. THEORETICAL FRAMEWORK: KALDOR'S GROWTH LAWS

Kaldor articulated his sectoral view of growth in three long-run relationships, known as Kaldor's growth laws, as follows.

3.1. First Growth Law

The first law, often referred to as "The engine of growth hypothesis," posits a positive relationship between the growth of manufacturing output and GDP growth. Mathematically, this law can be expressed as:

$$q_{GDP} = \theta_1 + \theta_2 q_m + \varepsilon \qquad \theta_2 > 0 \qquad \text{(1-A)}$$

where q_{GDP} represents the GDP growth rate and q_m denotes the growth rate of manufacturing output. To mitigate the potential spurious correlations arising from manufacturing production being a component of GDP, empirical studies estimate this law using two-sided tests:

First side test:

$$\mathrm{q}_{nm} = \theta_1 + \theta_2(\mathrm{q}_m) + \epsilon \qquad \theta_2 > 0 \qquad \text{(2-A)}$$

Second side test:

$$\mathrm{q}_{GDP} = \theta_1 + \theta_2(\mathrm{q}_m - \mathrm{q}_{nm}) + \epsilon \qquad \theta_2 > 0 \qquad \text{(3-A)}$$

where q_{nm} is the growth rate of non -manufacturing output.

According to Kaldor, the manufacturing sector has two characteristics that qualify it as an engine of growth. These characteristics form the core of Kaldor's second and third growth laws.

3.2. Second Growth Law (Verdoorn's Law)

The first reason the manufacturing sector assumes a leading role is its ability to benefit from increasing returns to scale, both statically and dynamically. Dynamic returns to scale occur due to capital accumulation and technical progress, whereas static returns to scale are associated with a decrease in average cost as the sector's output increases.

A key implication of increasing returns to scale in manufacturing is the positive relationship between the growth rate of manufacturing labor productivity and the growth rate of manufacturing output. This relationship can be expressed in two ways:

$$p_m = \alpha_1 + \alpha_2 (q_m) + \varepsilon \qquad \alpha_2 > 0 \qquad (2\text{-A})$$

Where p_m is the growth rate of labor productivity in manufacturing sector

$$e_m = \alpha_1 + \alpha_2 (q_m) + \varepsilon \qquad \alpha_2 > 0 \qquad (2\text{-B})$$

where e_m is the employment growth rate in the manufacturing sector

3.3. Third Growth Law

The second justification for the leading role of manufacturing in the economy is its positive impact on the productivity of the other sectors. As the manufacturing sector expands, labor shifts from low-productivity sectors to manufacturing, thereby raising productivity in those sectors because of diminishing returns to scale elsewhere in the economy. This phenomenon closely aligns with Kaldor's assumption of disguised unemployment in non-manufacturing sectors, implying that redistributing employment to manufacturing will increase productivity in those sectors.

Mathematically, this relationship can be expressed using one of the following equations:

$$q_{GDP} = \beta_1 + \beta_2 (e_m) \qquad \text{with } \beta_2 > 0 \qquad (3\text{-A})$$

Or alternatively

$$q_{GDP} = \beta_1 + \beta_2 (e_m) + \beta_3 e_{nm} \qquad \text{with } \beta_2 > 0 \ \& \beta_3 < 0 \quad (3\text{-B})$$

$$P_{GDP} = \beta_1 + \beta_2 (q_m) + \beta_3 e_{nm} \qquad \text{with } \beta_2 > 0 \ \& \beta_3 < 0 \quad (3\text{-C})$$

where e_m is the growth rate of employment in other economic sectors and P_{GDP} is labor productivity in the economy (Thirlwall, 2015).

In what follows, we conduct an empirical investigation of the Egyptian ICT sector's role as a growth engine, using Kaldor's growth laws. In Section 3, we first outline the methodology used, highlighting data limitations. Subsequently, the results are presented in Section 4.

4. METHODOLOGY

This study investigates whether the ICT sector functions as an engine of growth in the Egyptian economy by estimating Kaldor's first and third growth laws. The unavailability of a comprehensive and consistent data series on employment precluded the estimation of the second law.

While employment data are also crucial for testing Kaldor's third law, we introduce an alternative specification to the one initially employed by Kaldor and commonly used in empirical studies. This new specification not only addresses the absence of comprehensive and coherent employment data series but also better captures the unique characteristics of the ICT industry and the channels through which it influences the productivity of the broader economy. Further elaboration on this will be provided below.

The ICT sector by definition covers both the electronics industry and a diversified array of ICT services, including software publishing, telecommunications, computer programming, consultancy and related services, data processing and hosting, web portals, and repair of computers and communication equipment. However, due to the lack of comprehensive and consistent data series covering the entire ICT sector, the estimation will rely on the telecommunications services as a proxy for the ICT sector. In the case of Egypt, this subsector is considered a suitable proxy for several reasons as follows:

Firstly, an examination of the structure of Egypt's ICT sector reveals the relatively modest contribution of the electronics industry. According to the most recent economic census for 2017–2018, the electronics sector constitutes only 12% of the net value added in the ICT sector and 8% of all establishments. Moreover, this sector heavily relies on imported parts, which comprise approximately 46% of all primary inputs.

Secondly, within the services component of the ICT sector, telecommunications emerge as the dominant segment. Telecommunications account for 82% of ICT service industries' net value added and 80% of employment. Furthermore, data from United Nations Conference on Trade and Development (UNCTAD) indicate that telecommunication exports accounted for 55% of ICT services exports in 2021. Thus, although our empirical investigation focuses only on the telecommunications industry, we will discuss the findings of the investigation with reference to the overall ICT sector.

In our empirical investigation, we employed the autoregressive distributed lag cointegration approach (ARDL) proposed by Pesaran, et al., (2001). This cointegration technique offers several advantages: it accommodates variables with different degrees of integration (I(0) and I(1)), resolves the endogeneity issue arising from potential bidirectional causality, and is applicable to small sample sizes (Yamak et al.,2016). While the ARDL technique estimates both short- and long-run parameters, our focus is primarily on long-run parameters, as Kaldor's growth laws fundamentally represent long-run relationships.

Regarding Kaldor's first growth law, we estimated the original equation proposed by Kaldor, as shown in equation (1-A), along with the two additional side tests outlined in equations (1-B) and (1-C) to mitigate the risk of spurious correlation.

Moreover, to ensure the accuracy of our findings, we introduced two control variables: openness to trade and FDI flows as a percentage of GDP. These variables are commonly employed in empirical growth models as determinants of the GDP growth rate, with an anticipated positive impact on GDP growth. Previous studies supporting this notion include Alwafi (2017), Hossain et al. (2022), and Naveed and Shabbir (2006).

For Kaldor's third growth equation, we proposed the utilization of total factor productivity (TFP) to assess the impact of the telecommunications sector on the productivity of other sectors in the economy.

According to Kaldor, the engine of growth sector should positively influence the productivity of other sectors by reallocating labor from low-productivity sectors with pervasive unemployment, thereby enhancing their productivity. However, this mechanism may not accurately capture how ICT affects productivity in other sectors. First, the ICT value chain encompasses numerous high-value activities that require specialized skills that are not readily transferable from low-skill sectors, even after retraining. Second, ICT is expected to boost the productivity of other economic sectors not only by raising labor productivity, as suggested by Kaldor, but also through capital deepening, efficiency enhancement, and cost reduction. Thus, a more suitable representation may involve regressing the real TFP on the growth rate of telecommunications output.

Moreover, this specification mitigates the risk of spurious correlation and considers the impact of capital deepening while adhering to Kaldor's premise that higher output growth in the engine of growth sector corresponds to productivity growth in other sectors of the economy.

The linear ARDL specifications, as outlined by Pesaran et al. (2001), for Kaldor's first and third equations and their extended versions described in Section II are as follows:

4.1. Kaldor First Growth Law: Original Equation

$$Dg\_gdp_t = \alpha_o + \alpha_1 g\_tel_{t-1} + \alpha_2 g\_gdp_{t-1} + \sum_{i=1}^{K}\beta_i \mathrm{D}g\_gdp_{t-i} + \sum_{i=0}^{K}\delta_i Dg\_tel_{t-i} + \epsilon_{it} \quad (1)$$

- First side test

$$Dg\_gdp_t = \alpha_o + \alpha_1\ diff_{t-1} + \alpha_2 g\_gdp_{t-1} + \sum_{i=1}^{K}\beta_i \mathrm{D}g\_gdp_{t-i} + \sum_{i=0}^{K}\delta_i Ddiff_{t-i} + \epsilon_{it} \quad (2)$$

- Second side test

$$Dg\_ntel_t = \alpha_o + \alpha_1 g\_tel_{\ t-1} + \alpha_2 g\_ntel_{t-1} + \sum_{i=1}^{K}\beta_i \mathrm{D}g\_ntel_{t-i} + \sum_{i=0}^{K}\delta_i Dg\_tel_{t-i} + \epsilon_{it} \quad (3)$$

4.2. Extended Kaldor's Original Equation

$$Dg\_gdp_t = \alpha_o + \alpha_1 g\_tel_{t-1} + \alpha_2 g\_gdp_{t-1} + \alpha_3 open_{t-1} + \alpha_4 fdi\_gdp_{t-1} + \sum_{i=1}^{K}\beta_i \mathrm{D}g\_gdp_{t-i} + \sum_{i=0}^{K}\delta_i Dg\_tel_{t-i} + \sum_{i=0}^{K}\theta_i Dopen_{t-i} + \sum_{i=0}^{K}\sigma_i Dfdi\_gdp_{t-i} + \epsilon_{it} \quad (4)$$

- Extended first side test

$$Dg\_gdp_t = \alpha_o + \alpha_1 diff_{t-1} + \alpha_2 g\_gdp_{t-1} + \alpha_3 open_{t-1} + \alpha_4 fdi\_gdp_{t-1} \sum_{i=1}^{K}\beta_i \mathrm{D}g\_gdp_{t-i} + \sum_{i=0}^{K}\delta_i Ddiff_{t-i} + \sum_{i=0}^{K}\theta_i Dopen_{t-i} + \sum_{i=0}^{K}\sigma_i Dfdi\_gdp_{t-i} + \epsilon_{it} \quad (5)$$

- Extended second side test

$$Dg\_ntel_t = \alpha_o + \alpha_1 g\_tel_{t-1} + \alpha_2 g\_ntel_{\ t-1} + \alpha_3 open_{t-1} + \alpha_4 fdi\_gdp_{t-1} \sum_{i=1}^{K}\beta_i \mathrm{D}g\_ntel_{t-i} + \sum_{i=0}^{K}\delta_i Dg\_tel_{t-i} + \sum_{i=0}^{K}\theta_i Dopen_{t-i} + \sum_{i=0}^{K}\sigma_i Dfdi\_gdp_{t-i} + \epsilon_{it} \quad (6)$$

4.3. Kaldor Third Growth Law

$$DReal\_tfp_t = \alpha_o + \alpha_1 g\_tel_{\ t-1} + \alpha_2 real\_tfp_{t-1} + \sum_{i=1}^{K}\beta_i \mathrm{D}real\_tfp_{t-i} + \sum_{i=0}^{K}\delta_i Dg\_tel_{t-i} + \epsilon_{it} \quad (7)$$

Where D is the first difference, "*g _gdp*" signifies the real GDP growth rate, "*g_ntel*" denotes the real growth rate of non-telecommunications output and "*g_tel*" is the real growth rate of telecommunications output, "diff" is the difference in the real growth rates of telecommunications output and non–telecommunications output, "*real_tfp*" represents real TFP, "*open*" signifies openness to trade and "*fdi_gdp*" denotes the share of foreign direct investment to GDP. Here, (t)denotes times and (i) represents the lag order.

Following the estimation of the aforementioned regressions, F-statistics are employed to test the null hypothesis, which posits that there is no cointegration, against the alternative hypothesis, which suggests that cointegration exists.

This study utilized annual data from 1983 to 2021, with all variables measured in real terms. GDP and value-added data for the telecommunications and non-communications sectors were obtained from the Ministry of Planning, Economic Development and International Cooperation national accounts database. Unification of the data series' base year was conducted using 2017 as the base year. Data on trade and FDI were sourced from

World Development Indicators (WDI) expressed in a constant local currency. The FDI data series was deflated using GDP deflator. Finally, data on real TFP was obtained from Penn World Table version 10.01; however, the data was available only till 2019; thus, Kaldor's third equation was estimated for the period 1983–2019.

5. EMPIRICAL FINDINGS AND DISCUSSION

The initial step of the cointegration analysis was to test for the stationarity of the utilized time series. This was conducted using augmented Dickey (ADF) tests applied to all variables included in Kaldor's 1st and 3rd growth laws. The results of the test revealed that, for the variables g_tel, diff, and open, the null hypothesis of non-stationarity was rejected at a significance level of 5%, suggesting that these variables exhibit stationarity at the level. Conversely, for the variables g_gdp, g_ntel, fdi_gdp, and real_tfp, the null hypothesis of non-stationary could not be rejected, indicating their non- stationarity at the level. Upon differencing these variables and retesting for stationarity, the null hypothesis of non-stationarity was rejected, indicating that they were integrated of degree I (1). Since all variables were either I(0) or I(1), the ARDL approach can be applied to examine possible long-run relationships.

The conditions necessary for conducting the bounds test were examined for each equation. The findings revealed no evidence of serial correlation, as indicated by correlograms and confirmed by the Breusch-Godfrey Test, where the calculated chi-square's p-value exceeded 0.05 for all equations.

Regarding the stability of the estimated models, both the CUSUM and CUSUMSQ tests indicated model stability, except for equation (5), Kaldor's extended first side test. While the CUSUM test suggested stability for this model, the CUSUMSQ test revealed instability. The number of lags was determined based on the Akaike Information Criterion (AIC).

With respect to the rest of the diagnostic tests, the results of the Breusch-Pagan-Godfrey test indicated the absence of heteroscedasticity, with the calculated chi-square p-value surpassing 0.05. Finally, the Jarque-Berra test affirmed the normality of the distribution. The detailed results of these tests are presented in Table 1.

For each equation, bounds tests were applied to assess co-integration. The results presented in Table 2 show that, in all equations, the calculated F-statistics exceed the upper critical value bounds at the 5% level of significance. This suggests the presence of a long-term relationship between the variables, except for equation (5), where the F-statistic falls below the upper critical value. Therefore, the existence of a long-term relationship could not be confirmed. Accordingly, the results this equation were not discussed.

The long-run coefficients for all equations are presented in Table 3. In the first column, the coefficient of the growth of telecommunications output was found to be significant and positively correlated with the growth of GDP. This observation was consistent across both the first and second side tests, as shown in the second and third columns, confirming the engine-of-growth hypothesis for the Egyptian telecommunications industry as proposed by Kaldor. In all three equations, the coefficient was less than one, suggesting that the growth of the telecommunications sector exceeds that of the non-telecommunications sectors. Specifically, in both Kaldor's basic equation and the second side test, a one-percentage-point increase in the growth rate of telecommunications output corresponds to a 0.37 percentage point increase in GDP growth or non-telecommunications output growth. However, the coefficient increases to 0.61 in the first side test, indicating a higher impact of the growth differential between telecommunications and non-telecommunications output on GDP growth.

Extending the three equations to include the two control variables—openness to trade and share of FDI in GDP—confirmed the obtained results. In equations (4) and (6), the coefficients of telecommunications output growth are positive and significant at the 5% significance level. Moreover, the inclusion of both control variables is associated with an increase in the value of the coefficient to 0.4 in equations (4) and (6).

Results from equations (4) and (6) show that the control variables (openness to trade and the share of FDI in GDP) are statistically insignificant, indicating that they do not have a meaningful effect on GDP growth. This may be attributed to the high levels of imports in the Egyptian economy and the structure of its exports, which remain dominated by raw materials and resource-based products, constituting 49% of total exports in FY 2021/2022. The insignificance of the FDI as a share of GDP variable can also be explained by the relatively low levels of FDI inflows into Egypt.

Regarding Kaldor's third equation (equation 7), the estimation results show that the coefficient for the telecommunications output growth rate is insignificant with a positive sign, indicating that the growth of telecommunications output has no impact on TFP in

Table 1: Diagnostic tests results at 5% level of significance

Equation	Serial Correlation- prob χ^2 (Breusch-Godfrey test)	Heteroscedasticity prob χ^2 (Breusch-Pagan-Godfrey test)	Normality of Distribution (Prob Jarque-Berra Test)
Kaldor Basic Equation (1)	0.33	0.732	0.475
First Side test (2)	0.7	0.97	0.42
Second side test (3)	0.37	0.79	0.43
Extended Kaldor original Equation (4)	0.68	0.85	0.77
Extended first side test (5)	0.27	0.69	0.5
Extended second side test (6)	0.68	0.84	0.74
Kaldor third equation (7)	0.73	0.44	0.71

At 5% level of significance

the economy. The potential factors that lead to this are discussed in Section five below.

The estimation results for Kaldor's first and third growth laws, presented in the previous section, show that the effect of the telecommunications sector in Egypt comes primarily through value-added, with no discernible impact on TFP. Several factors may undermine the role of ICT in the growth of the Egyptian economy, including the following:

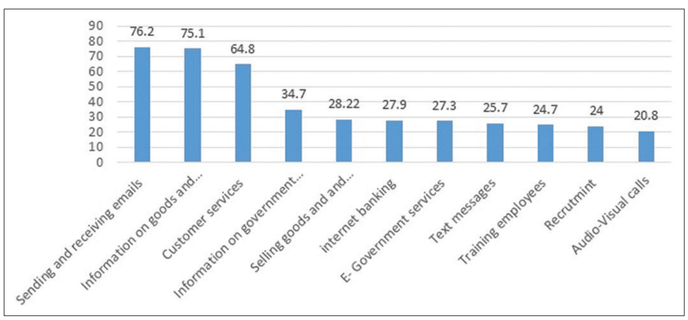
5.1. The Existence of Regional Digital Divide

Despite improvements in ICT indicators regarding basic telecommunications infrastructure and access levels, Egypt continues to suffer from a regional digital divide. According to data from the International Telecommunication Union (ITU), only 64% of households in rural areas of Egypt had access to the Internet by 2022, compared to 84% in urban areas.

5.2. Low Levels of ICT Diffusion among Egyptian Enterprises

Egyptian firms, particularly small and medium enterprises (SMEs) comprising over 80% of the country's enterprises, have yet to fully leverage the potential of ICT. Data from the UNCTAD reveal that although the majority of Egyptian enterprises possess computers, only 27% of employees regularly use them, and only 60% of enterprises use the Internet. Furthermore, the private sector predominantly employs the internet for communication and information retrieval, with less emphasis on business-related activities as shown in Figure 1.

Figure 1: Private sector internet usage: A breakdown by utilization type



Source: Ministry of Communications and Information Technology Yearbook, 2020

Table 2: Bound test results for all models

Equation	F statistics	I (0)	I (1)
Kaldor Basic Equation (1)	7.96	3.15	4.11
First Side test (2)	4.605	3.15	4.11
Second side test (3)	7.684	3.15	4.11
Extended Kaldor Basic Equation (4)	4.99	2.45	3.63
Extended first side test (5)	2.48	2.45	3.36
Extended second side test (6)	5.08	2.45	3.63
Kaldor third equation (7)	20.8	3.15	4.11

These critical values at 5% level of significance

5.3. Weak Digital Competitiveness

This is reflected in Egypt's weak performance across the four technology enablers of the Global Connectivity Index (GCI) compared to the global average. For broadband, Egypt's score is 41 compared with the global average of 62; for cloud computing, 30 relative to 42; for artificial intelligence, 24 compared with 30; and for the Internet of Things, 21 compared with 40. This weak performance reflects the need for stronger digital infrastructure and greater innovation capacity.

5.4. Value-Added Deprioritized

Priority is given to services where Egypt currently holds a competitive advantage, designating them as first-priority areas, while higher value-added services are relegated to a third-tier priority. This is reflected in Egypt's lagging position on the Investment in Future Technologies sub-index of the Network Readiness Index, ranking 73rd among 133 countries in 2025(Portulans Institute, 2025).

5.5. The Presence of Institutional Impediments

Institutional barriers remain a significant factor constraining the capacity of the ICT sector to fully contribute to economic growth in Egypt, these include but not limited to:

- Imbalances in the representation of the private sector within the various bodies responsible for shaping the sector's strategic framework persist. Government agencies remain the primary actors in formulating sectoral strategies. Although experts and the private sector are represented as members in certain councils, such as the Supreme Cybersecurity Council and the National Artificial Intelligence Council (with three members in each), such representation is entirely absent from the Supreme Council for the Digital Society. Overall, government dominance continues to characterize the composition of these councils and the decision-making processes within them.
- The multiplicity of entities issuing strategies for the sector, including the Ministry of Communications and Information Technology and the various supreme councils, is a challenge. This has resulted in variations across strategies regarding the inclusion of essential elements required for effective implementation, particularly the existence of clearly defined

Table 3: Long run coefficients

Coefficient	(1)	(2)	(3)	(4)	(6)	(7)
g_tel	*0.37 (14.38)		*0.37 (13.99)	*0.429 (4.78)	*0.47 (4.73)	0.018 (0.45)
diff		0.61* (7.56)				
openness				−0.020 (−0.40)	−0.025 (−0.49)	
fdi-gdp				0.021 (0.14)	0.01 (0.09)	

Table 3 summarizes estimation results for Equations (1)– (7), each estimated with a different set of explanatory variables. Coefficient estimates are reported only for variables included in the relevant equation. Blank entries denote exclusion of the variable from that equation.
Between brackets are the calculated t- statistics. T statistics at 5% level of significance is equal to 1.96. *Indicate significant

implementation programs, specified timelines, designated responsible authorities, and established monitoring and evaluation systems with well-defined key performance indicators. This has resulted in delays and slow progress in the implementation of some strategies, as well as limitations in objectively assessing their progress and monitoring their impact.

- The limited leadership role of the Ministry of Communications and Information Technology in advancing digital transformation across government bodies is a concern. Each entity implements and designs its own digitalization system with no general framework governing the process. This has negatively affected the efficiency of the digitalization efforts, especially with respect to the back-end systems. According to the World Bank (2021) report, the online government services offered to individuals and businesses are not supported by interoperable back-end systems, which hinders the possibility of data exchange between those systems. Moreover, the implementation of digitalization initiatives has been uneven across governorates.
- The legislative process faces delays, with several new laws awaiting passage, including the Freedom of Information law, National Data Management law, as well as laws and regulations addressing digital identity and data theft, and unified artificial intelligence law. Additionally, there is a need for amendments to existing laws such as the Intellectual Property Rights law. Moreover, there is a gap between the issuance of laws and their executive regulations. For instance, the Personal Data Protection Law (Law No. 151 of 2020) was enacted in 2020, yet its executive regulations have not been issued. Shortcomings also exist in the executive rules of certain laws, such as those pertaining to the cyber security law. Furthermore, procedural complexities hinder the implementation of some laws, notably the Telecommunications Regulatory Law (Kamel, 2021).

6. CONCLUSION

In this study, we examined the role of ICT as a growth engine in the Egyptian economy during 1983–2021 by applying an autoregressive distributed lag model (ARDL) to estimate Kaldor's first and third growth laws.

Most empirical studies examining how ICT affects economic growth have utilized a neoclassical growth model. However, few studies have employed Kaldor's growth laws to investigate which sectors, other than manufacturing, including ICT, can be considered engines of growth in a particular country or group of countries. The advantage of adopting Kaldor's growth laws over the neoclassical model lies in its ability to test for the two channels through which ICT can impact economic growth, thus providing more guidance for formulating a sectoral development strategy to maximize its economic impact.

The empirical investigation concluded that, although the ICT sector in Egypt, proxied by the telecommunications subsector, has the potential to be an engine of growth, its effect comes primarily through value addition, with no discernible impact on TFP.

It is important to work on a dual path to realize the full potential of the ICT sector. The first path involves increasing the value addition of the ICT sector by embarking on higher value-added activities, with software development being a priority given the current dominance of the telecommunications sub-sector. The second path entails activating its role as an enabler of other sectors in the economy.

Key recommendations for achieving this include continuous investments in infrastructure to expand network coverage, particularly in rural and broader governorates, to reduce the digital divide at the regional level. It is equally important to address the shortcomings of the current institutional and legal frameworks to keep pace with rapid technological advancements and ensure the effective implementation of sectoral strategies. Furthermore, there is a need to design programs to provide incentives and support for small and medium enterprises to utilize ICT in business-related activities.

With respect to proposed further research, given the fact that the lack of comprehensive data has impeded efforts to calculate Kaldor's second law and evaluate the engine of growth hypothesis across all ICT subsectors, additional research will be necessary once such data become accessible to explore the potential of the ICT sector to serve as an engine for economic growth in Egypt.

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