



The Dynamics of ICT and Economic Growth in Morocco: A Quantitative Approach

Echaoui Mohamed¹, Mohamed Karim¹, Mouti Omayma¹, Touzani Ahmed^{2*}

¹Macroeconomics and Public Policy Research Team, Faculty of Law, Economics and Social Sciences of Salé, Mohammed V University, Rabat, Morocco, ²Research Team in Finance, Audit, and Organizational Management, Moulay Ismail University-EST, Meknès, Morocco. *Email: a.touzani@uiz.ac.ma

Received: 05 December 2025

Accepted: 24 March 2026

DOI: <https://doi.org/10.32479/ijefi.23191>

ABSTRACT

This research empirically examines the effect of Information and Communication Technologies (ICT) on Morocco's economic growth over the period 1998-2022. It is based on an extended Solow growth model that incorporates ICT as a production factor complementing capital and labor. A composite ICT index is constructed using data from the International Telecommunication Union (ITU), encompassing dimensions of access, usage, and skills. The econometric approach adopted is the Auto Regressive Distributed Lag (ARDL) model, which captures both short- and long-term dynamics. The results reveal a cointegration relationship between ICT and economic growth, validated by the Bounds testing approach of Pesaran et al. (2001). In the short run, ICT has a positive and significant impact on growth, while inflation and the labor force have a negative effect. In the long run, ICT, foreign direct investment (FDI), labor force, and gross fixed capital formation contribute positively to economic growth. The study confirms the pivotal role of ICT as a driver of economic transformation and emphasizes the importance of sustained investment in technology and education. It recommends strengthening digital infrastructure, improving workforce skills, and attracting more foreign investment to foster inclusive and sustainable growth.

Keywords: Information and Communication Technologies, Economic Growth, ARDL Model, Morocco

JEL Classifications: O47, O33, F43, C22

1. INTRODUCTION

In a global context marked by digital transformation, Information and Communication Technologies (ICTs) have become a fundamental driver of economic growth, both in advanced economies and in developing countries. Far from being mere tools of modernization, ICTs now play a structuring role in production dynamics, innovation, competitiveness, and knowledge dissemination. Their ability to enhance the efficiency of economic processes, facilitate access to information, and strengthen exchange networks makes them an essential engine of contemporary economic development (Brynjolfsson and McAfee, 2014; Jorgenson and Vu, 2005).

In Morocco, the rise of ICTs since the 1990s—intensified by liberalization reforms and public digital strategies such as

“Maroc Numeric 2013”—has gradually placed ICTs at the heart of growth policies. This dynamic has led to a significant increase in investments in digital infrastructure, rapid expansion of connectivity, and growing digitalization of public and private services. The global health crisis linked to COVID-19 has further heightened the urgency of this digital transformation, revealing its vital role in economic resilience and continuity of activities.

However, beyond political discourse and strategic ambitions, it is crucial to empirically verify the actual impact of ICTs on national economic growth. This study adopts an analytical approach aimed at quantifying, through robust econometric methods, the contribution of ICTs to economic growth in Morocco over the period 1998-2022. By incorporating ICTs as a production factor in an extended Cobb-Douglas function, this work employs an ARDL

(Autoregressive Distributed Lag) model to assess the short- and long-term effects of technological investment on the country's economic performance.

The main objective of this analysis is twofold: On the one hand, to highlight the structuring role of ICTs in the growth process, and on the other, to provide empirical insights to public decision-makers on the most effective levers to activate in order to fully harness the digital potential. The study uses data from reliable sources (World Bank, HCP, ANRT) and builds a composite ICT index based on recommendations from the International Telecommunication Union (ITU), covering access, usage, and digital skills. This rigorous analytical framework will allow for the examination of the existence of a cointegration relationship between ICTs and growth, while controlling for other key economic variables such as investment, trade openness, FDI, inflation, and the labor force.

2. LITERATURE REVIEW

The contribution of technological progress to economic growth was initially theorized within the framework of neoclassical models, notably by Solow (1956). He demonstrated that the accumulation of physical capital alone could not explain the observed differences in long-term growth trajectories between countries. He thus introduced the concept of the “Solow residual,” attributing the unexplained portion of growth to technological progress, although considered as an exogenous factor in the model. Solow's model remains a fundamental reference in the analysis of the determinants of economic growth. Its structure is based on a Cobb-Douglas production function: $Y = A \times L^\beta \times K^\alpha$

Where Y represents total output, A overall technological efficiency (technological progress), L the labor factor, K physical capital, and α and β the respective elasticities of capital and labor, under the constraint $\alpha + \beta = 1$.

This theoretical framework can be expanded to incorporate the impact of Information and Communication Technologies (ICT), which have become major drivers of innovation and economic transformation.

The limitations of the neoclassical approach led to the emergence of endogenous growth models, particularly those proposed by Romer (1990) and Lucas (1988). These authors introduced internal factors within the economic system—such as human capital, research and development, and innovation—as key drivers of growth. Romer, in particular, emphasized that investment in knowledge—including ICT—can generate increasing returns and positive externalities, thereby highlighting the central role of public policy and institutions in fostering innovation.

In a complementary perspective, Schumpeter (1934), through his theory of “creative destruction,” viewed innovation as a dynamic process that continuously renews productive structures by replacing old technologies with more efficient solutions. ICTs

perfectly embody this logic, deeply transforming value chains, production methods, and traditional economic models.

The diffusion process of innovations has also been analyzed from a sociological perspective by Rogers (1962), who identified successive phases of technological adoption within society. His model highlights the role of social norms, influence networks, and infrastructure in the adoption of ICT, emphasizing that their diffusion is not only functional but also cultural and institutional.

Empirically, numerous studies confirm the positive effect of ICT on economic growth, provided that adequate structural conditions are in place. Niebel (2018), in an analysis covering 59 countries with varying levels of development, shows that ICT investments have a significant and growing impact on GDP, regardless of initial wealth levels, as long as supportive policies for diffusion are implemented. Focusing on ASEAN economies, points out that the impact of ICT on productivity strongly depends on the availability of skilled human capital capable of absorbing technological innovations.

In the African context, Balamoune-Lutz and Mavrotas (2022) emphasize the importance of institutional quality and governance in maximizing the positive effects of ICT. These findings align with those of Brynjolfsson and Hitt (2000), who demonstrated that productivity gains at the firm level only materialize when technological investments are accompanied by internal process reorganization. Autor et al. (2003) also stressed that ICT facilitates the automation of repetitive tasks, allowing human activity to shift toward higher value-added cognitive tasks.

More recently, Frey and Osborne (2017) estimated that nearly 47% of jobs in the United States are at risk of being automated in the coming decades. While this prospect presents significant challenges in terms of workforce retraining, it also opens opportunities for upskilling and labor market reconfiguration, which are conducive to economic growth.

In Morocco, the analysis of ICT impact on growth is still developing, but several studies provide noteworthy contributions. Bourhaba and Zerouali (2019), using an ARDL model, highlight a long-term relationship between ICT investment and GDP, particularly through productivity gains in the service sector. Hajji and El Khadiri (2021), based on panel data from MENA countries, point out that the positive effects of ICT are contingent on the existence of an inclusive and well-regulated institutional environment.

El Wardaoui (2023) analyzes the outcomes of the “Morocco Digital 2020” strategy, highlighting significant progress in e-government, digital banking, and logistics. However, he notes persistent obstacles, notably the digital divide between regions and the shortage of qualified digital skills.

Reports by the High Commission for Planning (HCP) (2023) and the World Bank (2022) converge on this point, identifying ICT as

a lever for territorial development, provided that rural connectivity is improved, digital training is generalized, and technology is integrated into key sectors such as agriculture, industry, and education.

3. RESEARCH METHODOLOGY

Before proceeding with the model estimation, we first calculate the Information and Communication Technology (ICT) Development Index. This statistical tool, developed by the International Telecommunication Union (ITU), aims to measure the level of ICT development across different countries. The index is based on the assessment of various indicators, which are classified into three main categories: a sub-index related to access (linked to infrastructure), a sub-index related to use, and a sub-index related to skills.

With regard to the calculation of the composite ICT index, it results from the addition of the scores of the three sub-indices. Thus, the Composite ICT Index is equal to the sum of the Access Sub-index, the Use Sub-index, and the Skills Sub-index.

Each sub-index (access, use, and skills) is assigned an equal weight of 1/3, ensuring that the total sum of weights equals 1. Moreover, the three sub-indices differ in terms of the number of components: The access sub-index includes 5 components, while the use and skills sub-indices each include 3 components. The weight assigned to each component within its respective sub-index is also equal, being 1/5 for the components of access, and 1/3 for those of use and skills.

3.1. Measurement and Estimation of the ICT Index in Morocco

The measurement and estimation of the ICT index for Morocco is presented in Table 1.

3.2. Specification and Estimation of the Empirical Model

Our objective is to assess the impact of Information and Communication Technologies (ICT) on economic growth, identifying ICT (the variable of interest) as the primary factor influencing economic development (GDP: Dependent variable). This analysis takes into account a set of complementary essential

variables, whose roles are widely acknowledged to refine and enrich the interpretation of the results. These additional variables, which are frequently included in studies examining the link between ICT and economic growth, include gross fixed capital formation (GFCF), trade openness (TO), foreign direct investment (FDI), the active population (POPA), and infrastructure (INF).

Our study considers the application of an Autoregressive Distributed Lag (ARDL) model to analyze the linear relationship envisaged between these variables:

$Y = f(\text{ICT}, \text{GFCF}, \text{POPA}, \text{INF}, \text{TO}, \text{FDI})$; To understand both the short-term impacts and the long-term consequences of the aforementioned determinants on economic development, it is preferable to adopt an ARDL (AutoRegressive Distributed Lag) approach to the specified function. This method allows for examining how the influence of variables unfolds over different time horizons. The functional form of the model will be as follows:

$$\Delta \text{GR}_t = \partial_0 + \sum_{i=1}^p \partial_{1i} \Delta \text{GR}_{t-i} + \sum_{i=0}^q \partial_{2i} \Delta \text{ICT}_{t-i} + \sum_{i=0}^q \partial_{3i} \Delta \text{GFCF}_{t-i} + \sum_{i=0}^q \partial_{4i} \Delta \text{POPA}_{t-i} + \sum_{i=0}^q \partial_{5i} \Delta \text{INF}_{t-i} + \sum_{i=0}^q \partial_{6i} \Delta \text{TO}_{t-i} + \sum_{i=0}^q \partial_{7i} \Delta \text{FDI}_{t-i} + \beta_1 \text{GR}_{t-i} + \beta_2 \text{ICT}_{t-i} + \beta_3 \text{GFCF}_{t-i} + \beta_4 \text{POPA}_{t-i} + \beta_5 \text{INF}_{t-i} + \beta_6 \text{TO}_{t-i} + \beta_7 \text{FDI}_{t-i} + \varepsilon_t$$

With Δ : first difference operator; ∂_0 : constant term; p represents the number of lags of the dependent variable, and q represents the number of lags of the explanatory variables; $\partial_{1i} \dots \partial_{8i}$: short-term effects; $\beta_1 \dots \beta_8$: long-term dynamics of the model; ε_t : error term (white noise).

This equation represents the unrestricted error correction model (ECM), also referred to as the “conditional ECM” as mentioned by Pesaran et al. (2001). It enables the simultaneous modeling of short-term dynamics (represented by the first-differenced variables) and long-term relationships (represented by the variables in levels).

Table 1: Components and weights of the ICT index

Sub-index	Components of each sub-index	Explanation of the components	Weight of each component
Access sub-index (infrastructure)	1. AbonTelF	1. Fixed telephone subscriptions/100 inhabitants	1/5
	2. AbonTelM	2. Mobile telephone subscriptions/100 inhabitants	1/5
	3. NLigneTel	3. Number of telephone lines/100 inhabitants	1/5
	4. NbrOrdinateur	4. Number of computers and tablets/household as a % of total households	1/5
	5. CouvertReseau	5. Number of Internet subscribers in millions	1/5
Usage sub-index	1. AbonInternet	1. Fixed broadband Internet subscriptions/100 people	1/3
	2. Utilisateur	2. Individuals using the Internet as a % of the population	1/3
	3. TrafficInternet	3. Secure Internet servers/1 million people	1/3
Skills sub-index	1. (NMA) Scolarisation	1. Average number of years of schooling	1/3
	2. ScolarisationSecondaire	2. Gross secondary school enrollment rate (%)	1/3
	3. ScolarisationSupérieur	3. Gross tertiary school enrollment rate (%)	1/3

Indeed, thanks to the procedure developed by Pesaran et al. (2001), the error correction model can help confirm the existence or absence of cointegration among the variables. This model is presented in the following form:

$$\begin{aligned} \Delta GR_t = & \alpha U_{t-i} + \hat{\delta}_0 + \sum_{i=1}^p \hat{\delta}_{1i} \Delta GR_{t-i} + \sum_{i=0}^q \hat{\delta}_{2i} \Delta ICT_{t-i} \\ & + \sum_{i=0}^q \hat{\delta}_{3i} \Delta GFCF_{t-i} + \sum_{i=0}^q \hat{\delta}_{4i} \Delta POPA_{t-i} + \sum_{i=0}^q \hat{\delta}_{5i} \Delta INF_{t-i} \\ & + \sum_{i=0}^q \hat{\delta}_{6i} \Delta TO_{t-i} + \sum_{i=0}^q \hat{\delta}_{7i} \Delta FDI_{t-i} + \varepsilon_t \end{aligned}$$

3.3. Nature and Source of Data

The study is based on annual data collected from publications by the World Bank, the High Commission for Planning (HCP), and the National Telecommunications Regulatory Agency (ANRT). These data cover the period from 1998 to 2022. The following table provides details on the variables considered in the analysis (Table 2).

4. ANALYSIS AND DISCUSSION OF RESULTS

4.1. Correlation Analysis Between Variables

The analysis of the correlation table highlights significant statistical relationships between several key variables, reflecting the structural dynamics of the Moroccan economy (Table 3). A strong positive correlation (0.729) between trade openness and ICT suggests that integration into global trade facilitates technological adoption, in line with the analyses of Grossman and Helpman (1991) and Melitz (2003). This relationship illustrates the spillover effect of globalization on the diffusion of digital innovations.

Table 2: Variables of the econometric models

Variables	Description	Expected effects
Dependent variable		
GR	Annual GDP growth rate (%)	
Variable of interest		
ICT	Estimated ICT index	Positive/negative effect
Control variables		
GFCF	Gross fixed capital formation (% of GDP)	Positive effect
FDI	Foreign direct investment	Positive effect
POPA	Active population	Positive effect
TO	Trade openness	Positive effect
INF	Inflation rate	Negative effect

Table 3: Correlation matrix results

Variable	TO	ICT	GR	POPA	INF	FDI	GFCF
TO	1.000000						
ICT	0.729587	1.000000					
GR	-0.263580	-0.021901	1.000000				
POPA	-0.731798	-0.917858	0.135572	1.000000			
INF	0.394582	0.161537	-0.093283	-0.012400	1.000000		
FDI	-0.038813	-0.235163	0.274552	0.178430	-0.161747	1.000000	
GFCF	0.739112	0.295599	0.666101	-0.411647	0.062593	0.003455	1.000000

Conversely, trade openness is negatively correlated with the labor force (-0.731), as is ICT (-0.918), which may indicate job displacement effects linked to automation, particularly in low-skilled sectors. These findings are consistent with the observations of Brynjolfsson and McAfee (2014) regarding the transformation of the labor market in the digital age.

A significant positive correlation (0.739) between trade openness and gross fixed capital formation (GFCF) indicates that openness stimulates productive investment by facilitating access to markets and equipment. Moreover, the positive relationship between GFCF and growth (0.666) confirms the importance of physical capital accumulation in strengthening productive potential, in line with the approaches of Solow (1956) and Barro (1991).

These results reveal complex interactions between openness, capital, technology, and employment. They underscore the need for integrated policies to support economic transformation, strengthen human capital, and promote inclusive growth in a context of digital transition.

4.2. Analysis of Stationarity

The non-stationarity of a time series, often indicated by changes in its mean or variance over time, can lead to spurious regressions if not addressed properly. To detect its presence, various tests can be employed, notably the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test, both widely used in econometrics (Table 4). The ADF test is suitable for correcting autocorrelation in residuals, while the PP test is more robust in the presence of heteroskedasticity. In this study, both tests are applied to assess the stationarity of the considered series.

It is observed that the series related to Information and Communication Technologies (ICT), Gross Fixed Capital Formation (GFCF), and the trade openness rate (TO) require first differencing to achieve stationarity, whereas the growth rate (GR), the active population (POPA), the inflation rate (INF), and foreign direct investment (FDI) are stationary at level, without the need for differencing. Given this disparity in the order of integration of the series, conventional cointegration methods such as those of Engle and Granger in the multivariate framework, or Johansen's approach, are not suitable. In contrast, the bounds testing approach to cointegration developed by Pesaran in 2001 proves to be a relevant method in this context.

4.3. Cointegration Test of Pesaran et al. (2001)

The bounds testing approach to cointegration developed by Pesaran et al. (2001) proves particularly suitable for our time series analysis due to its ability to handle variables integrated of

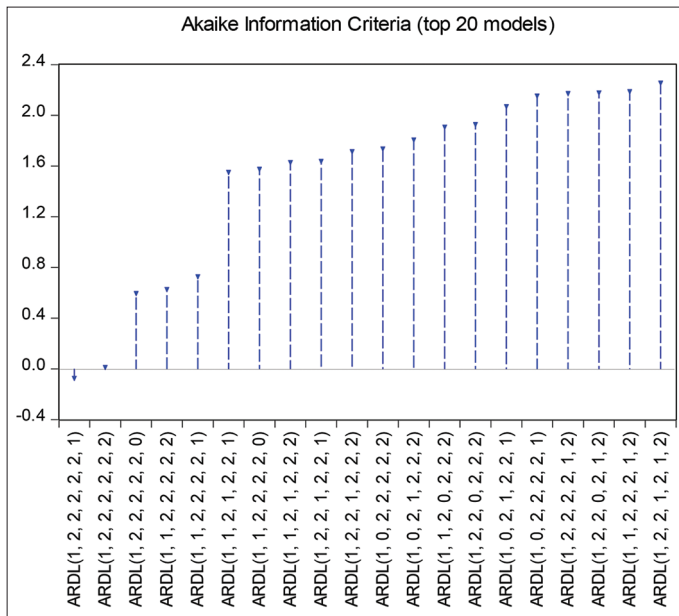
different orders. Its application follows a two-step procedure: First, selecting the optimal lag length using information criteria such as AIC and SIC, and second, assessing the cointegration relationship using the Fisher F-statistic.

4.3.1. Selection of the optimal lag length and estimation of the ARDL model

To determine the most appropriate ARDL model, we rely on the Schwarz Information Criterion (SIC), which helps select the specification that offers statistical significance while minimizing the number of parameters. The following are the estimation results of the ARDL model identified as the most suitable (Figure 1):

It is clear that among the twenty models examined, the ARDL (1, 2, 2, 2, 2, 2, 1) model stands out as the most effective, due to its lower value in the Schwarz Information Criterion (SIC). Furthermore, a diagnostic assessment of the selected ARDL model reveals satisfactory results: there is no evidence of residual autocorrelation, the tests rule out the presence of heteroscedasticity,

Figure 1: Result of selecting the most appropriate ARDL model



the error distribution appears normal, and the model specification is adequate.

4.3.2. Validity test of the selected model

The results of the diagnostic tests applied to the ARDL (1, 2, 2, 2, 2, 2, 1) model confirm its statistical robustness and proper specification (Table 5). The Jarque-Bera test confirms the normality of the residuals, while the Breusch-Godfrey test detects no autocorrelation, and the Breusch-Pagan-Godfrey and ARCH tests validate the assumption of both conditional and unconditional homoscedasticity. Altogether, these results suggest that the classical conditions for the validity of the estimators are satisfied. The model thus demonstrates strong explanatory power, capturing nearly 98% of the variation in economic growth over the 1998-2022 period, thereby reinforcing the reliability of the empirical relationships identified.

4.3.3. Bounds cointegration test

To carry out the cointegration test proposed by Pesaran and his collaborators in 2001, it is first necessary to estimate the ARDL model. Then, a test statistic—the Fisher F-value—is calculated and evaluated by comparing it to established critical bounds.

The results obtained from the Bounds cointegration test clearly indicate a long-term relationship among the variables under study (Table 6). The F-statistic, which stands at 26.95576, significantly exceeds the upper bound critical values (I [1]) at the 10%, 5%, 2.5%, and 1% significance levels (with critical values of 3.59, 4.00, 4.38, and 4.90, respectively). This confirms the validity of assessing the long-term impacts of the variables ICT, GFCF, FDI, INF, POPA, and TO on economic growth.

4.4. The Short-Term Impact of ICT on Economic Growth

According to the Table 7, the adjustment coefficient, or the error correction term indicating the force of return to equilibrium, is statistically significant at the 5% level. The CointEq (-1) term is equal to -1.395998, which indicates the presence of an error correction mechanism and thus the existence of a long-term relationship (cointegration) between the variables. In other words, this coefficient—representing the degree to which the growth rate

Table 4: Stationarity test results of the series

Variables	Lag	Level		First difference		Conclusion
		t-Stat.ADF (Prob)	t-Stat.PP (Prob)	t-Stat.ADF (Prob)	t-Stat.PP (Prob)	
GR	1	-4.226794 (0.0155)	-8.494689 (0.00)	-	-	I (0)
ICT	7	-0.630196 (0.9673)	-0.630196 (0.9673)	-4.792698 (0.0066)	-5.575505 (0.0008)	I (1)
GFCF	2	-1.809432 (0.6684)	-1.851813 (0.6475)	-4.155467 (0.0179)	-4.207666 (0.0155)	I (1)
FDI	1	-5.342264 (0.0015)	-6.755557 (0.0001)	-	-	I (0)
INF	0	-3.640123 (0.0125)	-3.640123 (0.0125)	-	-	I (0)
POPA	6	-4.668399 (0.0077)	-3.049165 (0.0039)	-	-	I (0)
TO	1	-0.710839 (0.8256)	-0.710839 (0.8256)	-3.826322 (0.0088)	-2.398016 (0.0189)	I (1)

(GR) is pulled back toward its long-run equilibrium—is estimated at -1.395998 in our ARDL model, indicating a relatively rapid adjustment process.

Moreover, the negative sign of the error correction term confirms the expected convergence process in the long-term dynamics. This estimated value implies that 139.59% of the disequilibrium observed in period (t-1) is corrected in period (t), suggesting a strong adjustment speed in the relationship process following a shock in the previous year.

The analysis of the short-term coefficients derived from the ARDL model highlights several significant dynamics regarding the determinants of economic growth in Morocco over the period 1998-2022. First, investments in Information and Communication Technologies (ICT) have a positive and statistically significant short-term effect, confirming their structural role in boosting productivity and enhancing economic efficiency. This result reinforces the idea that digitalization is an immediate driver of growth, particularly in economies undergoing technological acceleration.

Conversely, inflation shows a negative short-term impact on growth, suggesting that increases in the general price level

hinder economic activity, likely due to the erosion of purchasing power and the uncertainty they generate. This finding aligns with the economic literature that emphasizes the adverse effects of uncontrolled inflation on investment and consumption decisions.

In addition, trade openness exhibits both an immediate and lagged positive effect on growth, reflecting the short-term benefits of global economic integration—especially through specialization, access to foreign markets, and technology transfer. These results support international trade theories by highlighting the dynamic gains associated with trade liberalization.

Regarding the labor force, the results paradoxically indicate a negative short-term impact on economic growth. This may be explained by a mismatch between labor supply and market needs, or by the underutilization of available skills, reflecting labor market rigidities or deficiencies in professional integration.

Furthermore, Foreign Direct Investment (FDI) exerts a strongly positive effect on short-term growth, both in the current and subsequent periods. Their contribution goes beyond capital inflows, as they promote technology transfer, skills enhancement, and integration into global value chains. These findings support the relevance of FDI attraction policies to strengthen growth dynamics.

The results highlight the importance of supporting ICT development, maintaining controlled inflation, enhancing trade openness, better utilizing available labor, and fostering an attractive investment climate, with the aim of sustainably stimulating the country's economic growth.

Table 5: Results of diagnostic tests of the estimated ARDL model

Test hypothesis	Test	Value (probability)
Normality test	Jaque-Bera	0.712 (prob.=0.2111)
Autocorrelation test	Breusch-Godfrey	17.78 (prob.=0.168)
Heteroscedasticity test	Breusch-Pagan-Godfrey	0.174505 (prob.=0.9943)
	ARCH test	0.099242 (prob.=0.7560)

Table 6: Results of the Pesaran cointegration test

Test statistic	F-bounds test			
	Value	Signif. (%)	I (0)	I (1)
F-statistic	26.95576	10	2.53	3.59
k	6	5	2.87	4
		2.5	3.19	4.38
		1	3.6	4.9

Table 7: Estimation results of short-term coefficients

Variable	ARDL error correction regression			
	Coefficient	Std. error	t-Statistic	Prob
C	-43.80501	1.042472	-42.02032	0.0000
@TREND	0.429586	0.015671	27.41247	0.0001
D (ICT)	0.074534	0.004945	15.07155	0.0006
D (ICT [-1])	0.028036	0.004904	-5.717386	0.0106
D (INF)	-0.292515	0.047401	-6.171033	0.0086
D (INF [-1])	-1.607792	0.052679	-30.52065	0.0001
D (TO)	0.058748	0.014649	4.010394	0.0278
D (TO [-1])	0.141832	0.009337	15.19080	0.0006
D (POPA)	-0.391040	0.079579	-4.913854	0.0161
D (POPA [-1])	-3.751728	0.097502	-38.47835	0.0000
D (FDI)	1.779662	0.033710	52.79284	0.0000
D (FDI [-1])	-0.584590	0.032351	-18.07041	0.0004
D (GFCF)	-0.675121	0.054609	-12.36271	0.0011
CointEq (-1)*	-1.395998	0.032668	-42.73255	0.0000
R-squared	0.999011	Adjusted R-squared	0.997582	

4.5. The Long-Term Impact of ICT on Economic Growth

The analysis of long-term elasticities derived from the ARDL model estimation highlights a positive structural relationship between several economic determinants and GDP growth in Morocco (Table 8). Information and Communication Technologies (ICT) emerge as a significant growth driver, with an estimated coefficient of 0.119 and strong statistical significance ($P < 0.001$), reflecting the structural impact of digital investment on productivity and innovation, consistent with the findings of Jorgenson and Vu (2005). Similarly, Foreign Direct Investment (FDI) exerts a substantial impact (coefficient of 2.459; $P < 0.01$), confirming its role in technology transfer, the creation of skilled jobs, and the country's integration into global value chains.

The labor force, with an elasticity of 1.192 ($P < 0.001$), represents another fundamental pillar of growth, underscoring

Table 8: Estimation results of long-term coefficients

Variable	Coefficient	Std. error	t-statistic	Prob
ICT	0.119353	0.007368	16.19897	0.0005
INF	0.312381	0.201520	1.550128	0.0218
TO	0.031088	0.055929	0.555843	0.0617
POPA	1.192097	0.061137	19.49870	0.0003
FDI	2.458673	0.226340	10.86273	0.0017
GFCF	0.724003	0.165362	-4.378279	0.0221

EC=GR-(0.1194*ICT+0.3124*INF+0.0311*TO+1.1921*POPA+2.4587*FDI-0.7240*GFCF)

the importance of the labor factor in an emerging economy with a high demographic dynamic. Gross Fixed Capital Formation (GFCF) also contributes positively to growth (coefficient of 0.724; $P < 0.05$), highlighting the multiplier effect of infrastructure investments on productive capacity.

Furthermore, the inflation rate (INF) shows a moderately positive effect (coefficient of 0.312; $P \approx 0.02$), suggesting that controlled inflation may accompany demand dynamics and support growth, in line with certain post-Keynesian theories. Finally, trade openness (TO) presents a positive but marginally significant influence (coefficient of 0.031; $P \approx 0.06$), indicating that the benefits of trade integration remain contingent on other structural factors.

The analysis highlights that ICT, FDI, physical investment, and labor are key contributors to Morocco's long-term economic growth, while external openness and price stability have more nuanced effects. These results underscore the need for targeted public policies focused on enhancing human capital, promoting technological innovation, and strengthening economic attractiveness.

5. CONCLUSION

This study has shed light on the complexity of interactions between Information and Communication Technologies (ICT), Foreign Direct Investment (FDI), inflation, trade openness, the active population, and gross fixed capital formation (GFCF) in the process of economic growth in Morocco. By applying the ARDL (Autoregressive Distributed Lag) approach, in line with the methodology of Pesaran et al. (2001), we identified long-term cointegration relationships between these variables and the gross domestic product, while also detecting significant short-term adjustment dynamics.

The results confirm the structural role of ICT in enhancing overall productivity by facilitating innovation diffusion, optimizing economic processes, and transforming productive structures, as highlighted by Jorgenson and Vu (2005). This finding is particularly relevant for emerging economies, where digitalization serves as a strategic lever for integration into the global economy.

Furthermore, FDI emerges as a key driver of economic growth by providing financial resources, technology transfers, and managerial expertise, as demonstrated by Borensztein, et al. (1998). Their long-term positive impact underscores the need for a stable and attractive institutional framework to encourage foreign investment flows.

The analysis also reveals contrasting effects of inflation: While its short-term impacts are negative, moderate inflation appears to exert a slightly positive influence on long-term growth, in line with the findings of Bruno and Easterly (1998). This highlights the importance of prudent monetary policies to support sustainable economic development.

Trade openness, although moderately significant, positively influences growth by fostering innovation, productive

specialization, and market access, consistent with the theoretical contributions of Grossman and Helpman (1991). This factor plays a complementary role in consolidating long-term productivity gains.

As for the active population, the results emphasize that its contribution to growth largely depends on its level of qualification and effective integration into the economic fabric. This supports Romer's (1990) assertion of the central role of human capital in endogenous growth dynamics and calls for the implementation of active training and professional inclusion policies.

Finally, gross fixed capital formation remains a traditional pillar of growth by strengthening productive capacities and stimulating structural investment, as underscored by Solow (1956) and Barro (1991).

In conclusion, the implementation of an integrated development strategy—based on the complementarity between technological investment, foreign capital attractiveness, human capital enhancement, macroeconomic stability, and controlled trade openness—emerges as a key lever to reinforce the resilience and competitiveness of the Moroccan economy in a constantly evolving international context.

REFERENCES

- Autor, D.H., Levy, F., Murnane, R.J. (2003), The skill content of recent technological change: An empirical exploration. *The Quarterly Journal of Economics*, 118(4), 1279-1333.
- Baliamoune-Lutz, M., Mavrotas, G. (2002), ICT, governance, and inclusive growth in Africa: A panel data analysis. *African Development Review*, 34(1), 70-84.
- Barro, R.J. (1991), Economic growth in a cross section of countries. *Quarterly Journal of Economics*, 106(2), 407-443.
- Borensztein, E., De Gregorio, J., Lee, J.W. (1998), How does foreign direct investment affect economic growth? *Journal of International Economics*, 45(1), 115-135.
- Bourhaba, O., Zerouali, A. (2019), Technologies de l'information et croissance économique au Maroc: Une approche ARDL. *Revue Marocaine d'Économie*, 15, 88-106.
- Bruno, M., Easterly, W. (1998), Inflation crises and long-run growth. *Journal of Monetary Economics*, 41(1), 3-26.
- Brynjolfsson, E., Hitt, L.M. (2000), Beyond computation: Information technology, organizational transformation and business performance. *Journal of Economic Perspectives*, 14(4), 23-48.
- Brynjolfsson, E., McAfee, A. (2014), *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York: W. W. Norton and Company.
- El Wardaoui, A. (2023), Politiques publiques et transformation digitale au Maroc: Bilan et perspectives de la stratégie Maroc Digital 2020. *Revue Économie and Développement*, 27(3), 105-128.
- El Wardaoui, N. (2023), Digitalisation et croissance sectorielle au Maroc: Une approche empirique. *Revue Africaine des Politiques de Développement*, 9(1), 123-141.
- Frey, C.B., Osborne, M.A. (2017), The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, 114, 254-280.
- Grossman, G.M., Helpman, E. (1991), *Innovation and Growth in the Global Economy*. Cambridge, MA: MIT Press.
- Hajji, A., El Khadiri, A. (2021), L'impact des TIC sur la croissance dans

- les pays de la région MENA: Une analyse en données de panel. *Revue Tunisienne d'Économie et de Gestion*, 37, 45-68.
- Haut-Commissariat au Plan (HCP). (2023), *Rapport Sur Les Indicateurs de Développement Numérique au MAROC*. Rabat, Maroc: HCP.
- Jorgenson, D.W., Vu, K. (2005), Information technology and the world economy. *The Scandinavian Journal of Economics*, 107(4), 631-650.
- Lucas, R.E. Jr. (1988), On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3-42.
- Melitz, M.J. (2003), The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6), 1695-1725.
- Niebel, T. (2018), ICT and economic growth - Comparing developing, emerging and developed countries. *World Development*, 104, 197-211.
- Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326.
- Rogers, E.M. (1962), *Diffusion of Innovations*. 1st ed. Glencoe: Free Press of Glencoe.
- Romer, P.M. (1990), Endogenous technological change. *Journal of Political Economy*, 98(5), S71-S102.
- Schumpeter, J.A. (1934), *The Theory of Economic Development*. Cambridge: Harvard University Press.
- Solow, R.M. (1956), A contribution to the theory of economic growth. *The Quarterly Journal of Economics*, 70(1), 65-94.
- World Bank. (2022), *World Development Report 2022: Finance for an Equitable Recovery*. Washington, DC: World Bank. Available from: <https://www.worldbank.org>