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Research on Digital Infrastructure Investments and Tourism Development in Cameroon with ARDL Approach

Gérard Tchouassi, Guylène Audrey Nguétchouo Domtchouang*

Faculty of Economics and Management, University of Yaounde II-Soa, BP. 18 Soa, Cameroon.

***Correspondence to:** Guylène Audrey Nguétchouo Domtchouang , Faculty of Economics and Management, University of Yaounde II-Soa, BP. 18 Soa, Cameroun; Email: guyleneaudrey17@gmail.com

Abstract: The advancement of digitalization, particularly through information systems, has significantly reshaped the tourism industry by altering both operational practices and structural organization, thereby establishing digital infrastructure as a pivotal component of the sector. This transformation has prompted economic stakeholders to increase investments in digital infrastructure to improve connectivity and facilitate access to digital services. The primary objective of this study is to evaluate the impact of digital infrastructure investment on tourism development in Cameroon. To this end, we employed the Autoregressive Distributed Lag (ARDL) model using annual data spanning the period from 2000 to 2021. Tourism development is proxied by international tourist arrivals, while digital infrastructure investment is captured through private sector investments in digital technologies. The empirical findings indicate that both private digital infrastructure investment and foreign direct investment (FDI) are statistically significant and positively associated with international tourist arrivals in Cameroon. However, the analysis also reveals a temporal asymmetry: in the short run, private digital investment exerts a significantly negative effect on tourist arrivals, whereas in the long run, the impact becomes positive and statistically significant. These results suggest that increased private investment in digital technologies eventually enhances access to digital tools among tourism stakeholders, thereby enabling more effective promotion of Cameroon's image at both national and international levels and facilitating the adaptation of tourism offerings to better meet the preferences and expectations of visitors.

Keywords: Tourism; Digital Infrastructures; Tourist Arrivals; ARDL; Cameroon

JEL codes: C22, O32, Z32

1. Introduction

Better access to improved digital infrastructure services is one of the components of a favorable investment climate for foreign investors and an important engine for sustainable growth. Nobel Prize-winning economist Robert Solow famously articulated what later became known as the "Solow Paradox," observing in 1987 that "you can see the computer age everywhere but in the productivity statistics" (Solow, 1987). This paradox was revisited by fellow Nobel laureate Paul Krugman during a presentation on Robert Gordon's 2016 work, noting

that "the truth is that, if we look at the new devices, it becomes clear that we have made less progress since 1970 and experienced far fewer changes in the fundamentals of our lives" (Ambialet & Lepetit, 2019). The paradox underscores a persistent disconnect between substantial investments in information and communication technologies (ICT) and the relatively limited gains in productivity observed over recent decades (Tchouassi, 2021). Despite this discrepancy, digital transformation continues to profoundly reshape the global economy, influencing virtually all sectors and dimensions of daily life. It is driving fundamental changes in how individuals learn, work, consume, interact socially, and access both public and private services. However, the pace and scope of digital transformation differ widely across countries and regions, reflecting disparities in infrastructure, policy, and digital literacy (Gaglio & Guillou, 2018). One of the most prominent manifestations of digitalization is the exponential growth in the generation and dissemination of knowledge, information, and data (Minghetti & Buhalis, 2010; Cuomo & al., 2020). In response, both governments and private-sector actors are increasingly leveraging digital technologies to provide essential services, such as passport and visa issuance, online payments, and other administrative functions aimed at improving efficiency and accessibility (Mahaldar & Bhadra, 2015).

The modern world has been profoundly transformed by the advent of the internet, ushering in an era that is now commonly described as connected, interactive, and digital (Scheid & al, 2012). This transformation has been supported by extensive public and private investment in digital infrastructure. Over the past two decades, digital technologies have become critical not only to business performance but also to the competitiveness and attractiveness of tourist destinations (Lemoine & Salvadore, 2018). In many developing countries, the expansion of digitalization presents an additional avenue for enhancing visitor experiences and promoting destinations in an increasingly competitive global tourism market. With ongoing technological advances, digital tools have become indispensable in the tourism sector. According to Gutierrez & al (2023), these tools are reshaping travel behaviors and altering the dynamics between supply and demand in the tourism industry. Tourism is among the sectors most significantly impacted by digitalization, as it has modernized tools, methods, and information systems to streamline operations for all stakeholders, enhance the development of tourism activities, and create greater opportunities for visitors. This transformation is evident through innovations such as digital distribution channels for tourism services, evolving roles among industry actors, and the reduction of physical and informational distances between providers and consumers (Safaa & al, 2021).

An increasing number of individuals are recognizing the advantages of digital infrastructure for planning leisure activities, as a growing range of companies and organizations gain seamless access to tourist information via web-based services (Tchamy & al, 2020). One of the key benefits of digital and social media in the tourism sector is the facilitation of information exchange (Gozgor & al, 2024), among tourism providers, intermediaries, and end consumers. However, digitalization also presents challenges commonly referred to as its "dark side." In response, many countries have implemented digital governance frameworks. In the tourism sector specifically, digital governance enhances the appeal of destinations by enabling the effective dissemination and amplification of destination-related information among current and prospective travelers (Xiang & al, 2017; Pencarelli, 2020). In the contemporary digital era, physical distance has become a diminishing barrier to interaction and exchange. Reflecting this shift, the World Bank Group's (2019), *Cameroon Digital Economy Assessment* identified five foundational pillars of the digital economy: digital infrastructure, digital platforms, digital financial services, digital entrepreneurship, and digital skills. This underscores the strategic importance of digital infrastructure, particularly in countries such as Cameroon.

Despite its considerable tourism potential, Cameroon's tourism industry remains underdeveloped. International tourist arrivals continue to fall short of 1.2 million annually, with only 570,054 visitors recorded over a 15-year period from 2006 to 2021. This modest growth stands in contrast to the country's vast tourism assets an estimated 921 tourist sites, including national parks, wildlife reserves, beaches, waterfalls, lakes, caves, monuments, chiefdoms, and rich cultural heritage, of which only two sites are

recognized as UNESCO World Heritage. Cameroon is also characterized by remarkable cultural diversity, encompassing numerous ethnic groups, languages, traditions, and festivals. However, the potential of digital infrastructure in promoting these attractions remains largely untapped. There is a notable absence of comprehensive online platforms or social media strategies that effectively showcase the country's tourism assets. Digital communication and advertising remain underdeveloped, limiting the visibility of the destination in global tourism markets. The transfer of certain administrative powers to decentralized local authorities by the Cameroonian government in 2021 presents an opportunity to implement more effective, digitally driven tourism marketing strategies at the local level.

While a growing body of literature has explored the impacts of digitalization on tourism and the role of investment in tourism development globally, few studies have specifically examined how investment in

digital infrastructure influences tourism development. This study aims to fill that gap by analyzing the short- and long-term effects of private investment in digital infrastructure on international tourist arrivals in Cameroon. Furthermore, we investigate how key macroeconomic variables such as inflation, foreign direct investments and security interact with digitalization to influence the flow of international tourists into the country. This led us to two questions: what is the short- and long-run impact of private digital investment on international tourist arrivals in Cameroon? And how do macroeconomic variables such as inflation and security spending interact with digital investment in shaping tourism demand?

2. Literature Review

The advent of the internet in the 1990s marked a pivotal moment in technological evolution, following earlier waves of innovation brought about by first-generation communication technologies such as the telegraph, telephone, and radio broadcasting (Faucheux & al, 2010). In recent years, the rapid rise of digitalization has profoundly transformed the global economy, particularly in terms of how businesses operate. It has reshaped consumer behavior and individual habits, while also disrupting traditional marketing strategies, compelling firms to adapt to a rapidly changing environment. The speed of digital integration is a defining feature of this transformation. The swift adoption of the internet, the increasing dominance of smartphones as the primary means of online access, and the widespread use of social media platforms have collectively positioned the internet as a true technological revolution (Scheid & al, 2012).

Digitalization is characterized by its pace: the rapid dissemination of internet connectivity, the proliferation of advanced mobile devices enabling instant access, the emergence of new user behaviors and consumption patterns, and the dominance of social media as central platforms for interaction and information exchange. Internet usage has become a daily activity for many individuals, although generational and social disparities continue to influence access and usage patterns (Tronquoy, 2013). In today's interconnected world, social media have emerged as critical intermediaries within the tourism industry (Munar, 2012). These platforms are widely used by various stakeholders, especially tourists, at every stage of the travel experience before departure, during the trip, and after returning. Tourism enterprises can now enhance their performance and increase brand visibility by strategically directing online users to their websites, leveraging digital engagement to expand market reach and improve customer interaction.

Digital users increasingly represent prospective or potential customers. As such, digital marketing allows companies not only to build closer relationships with their clientele, fostering greater proximity and engagement, but also to increase their revenue streams. With the emergence of the web, the role of the customer has evolved: no longer merely a buyer, the customer also serves as a brand ambassador or spokesperson and, according to Gavard-Perret (2008), becomes a co-creator of value. Today's world is characterized by major developments in communication, largely driven by the widespread diffusion of information technologies through the internet (Alshurideh & al, 2019). Consumers have become more accessible, and interactions between brands and customers are now more immediate and personalized (Salloum & al, 2019). As visitors increasingly use mobile devices such as smartphones and tablets, destinations must, when possible, adapt their digital interfaces and services to accommodate various screen types. To offer a

personalized experience, tourism destinations need to provide tools and services aligned with visitors' preferences and expectations.

Technological advancements and the proliferation of social media have empowered tourists not only as consumers but also as co-marketers, co-designers, and co-producers of their travel experiences (Sigala & Haller, 2018). The accessibility and use of travel-related data by tourists are significantly influenced by the continuous evolution of information and communication technologies (Xiang & al, 2015). For tourists, the internet has transformed the way they search for, evaluate, select, consume, and experience tourism products and destinations (Sigala & Gretzel, 2018). Tankeu & Andzanga (2023), analyzed the impact of visa digitalization on the tourism sector and identified both positive and negative outcomes. On the positive side, a digital visa system can enhance the competitiveness, image, and visibility of Cameroon as a tourist destination, boost the national economy, reduce insecurity and illegal border crossings, and ultimately attract more international tourists. However, digitalizing the visa process also raises concerns, including the risks of cyberattacks, identity theft, and fraud. Moreover, the success of such innovations can be undermined by insufficient technological infrastructure, potentially excluding certain travelers from the visa process and creating system malfunctions that may prevent entry at the border.

In order to remain competitive, destinations are becoming increasingly dependent on digitalization (Pike & Page, 2014). Digital tools now lie at the heart of tourism activity (Centre International de Deauville, 2013), as the internet is widely recognized as a major driver in the development of new forms of communication and information exchange within the tourism ecosystem (Buhalis & Deimezi, 2004; Minghetti & Buhalis, 2010). Destination marketing refers to the set of activities aimed at attracting tourists to a particular location (Elbe, 2009). The emergence of digital marketing has facilitated the promotion of brands and products to consumers through a variety of digital media and touchpoints (Flores, 2016). In the tourism industry, digital marketing is centered around five core pillars: content, social media, multi-device compatibility, website personalization, and web design. Content must be concise, visually appealing, and adapted to digital consumption. It should encourage potential visitors to plan their trips and envision themselves in the destination. Moreover, content should go beyond showcasing landscapes it must depict tourists actively engaging in leisure and cultural activities. Through photos and videos, destination marketers should offer an immersive experience that allows prospective visitors to virtually explore and emotionally connect with the destination.

The following **Figure 1** summarizes the key elements discussed above.

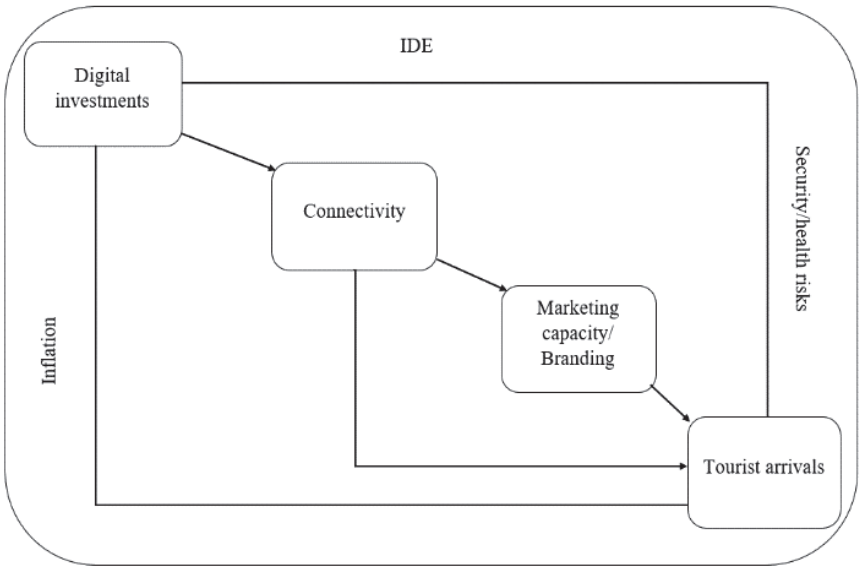

Figure 1. Conceptual diagram: relationship between digital investment and tourist arrivals.

*Source: by authors

Figure 1 illustrates the impact of investments in digital infrastructure on tourist arrivals at a destination. It appears that increased investment in this area enables tourism stakeholders to benefit from higher-quality connectivity, which is essential for implementing effective digital marketing strategies. These strategies aim to enhance the destination's assets its attractions, products, and tourism services thus improving its visibility and overall appeal. Moreover, connectivity plays a direct role in tourists' decision-making. Travelers increasingly seek to share their experiences in real time via social media platforms. The lack of adequate digital infrastructure, which limits access to stable internet connections and digital platforms, can act as a deterrent to potential visitors. Other contextual factors also influence tourist arrivals. High inflation, by reducing visitors' purchasing power, may hinder tourism demand and discourage investment in the sector. Conversely, a secure environment supported by targeted investments creates a climate of trust for both tourists and local residents, thereby promoting tourism. Finally, foreign direct investment (FDI) also contributes to a destination's attractiveness. The presence of well-known multinational companies can positively influence tourists' choices, as they often associate such companies with reliability and trust.

Similar to security concerns, health risks are a critical factor that can negatively affect both investment and tourist arrivals. Health is a fundamental concern for individuals, and the perception of an epidemic or pandemic risk in a destination tends to significantly deter international tourist flows. A destination facing a health crisis loses its attractiveness, thereby reducing its ability to attract foreign visitors. This decline in attractiveness undermines the expected profitability of investments, prompting both public and private actors to scale back their financial commitments in the tourism sector. The COVID-19 pandemic serves as a particularly striking illustration of this dynamic. This global health crisis led to an unprecedented contraction of international tourism, with arrivals declining by more than 50%. The resulting disruption to tourism value chains caused widespread bankruptcies among tourism-related businesses worldwide.

3. Methodology

3.1 Data and Variables

The following section outlines the variables utilized in the analysis, identifies their sources, and describes the model framework applied.

This study uses data exclusively from Cameroon, covering a 22-year period from 2000 to 2021, to analyze the impact of digital infrastructure investments on international tourist arrivals, as presented in **Table 1**. empirical evidence on the impact of digital infrastructure on tourism in Sub-Saharan Africa, and Cameroon specifically, is scarce, especially using time-series econometrics. This time frame was selected because it marks the beginning of significant investments in optical fiber infrastructure in Cameroon. Additionally, during the early 2000s, the telecommunications sector in the country was considered a contestable market (Baumol & al, 1982). According to this theory, "if a firm in a contestable market raises its prices much beyond the average price level of the market and thus begins to earn excess profits, potential rivals will enter the market, hoping to exploit the price level for easy profit" (Tchouassi, 2012). At that time, Camtel was the sole operator in the market, with MTN and Orange entering around 2002.

Table 1. Summary of variables used in the model and data source.

Measure	Variable	Data Source
Tourism arrivals	AT	World development indicators (WDI); Report on economic, social, and financial situation and prospects of the nation of Cameroon (2021 and 2022)
Private investment in digital infrastructures	ITPr	Statistical directory of the ministry of posts and telecommunications (2017); 2020 annual observatory of the electronic communications market
Public investment in digital infrastructures	ITPu	Cameroon finance laws (2000–2021)
People using the internet as a percentage of the population	IUI	World development indicators (WDI)
Public investment in security	IS	Cameroon finance laws (2000–2021)
Inflation	inf	World development indicators (WDI)
Foreign direct investment	IDE	World development indicators (WDI)

Source: by authors.

One of the main limitations of studying the impact of digital infrastructure investment on tourism development in Cameroon is the lack of comprehensive and accessible data. Local stakeholders are only beginning to recognize the importance of consistent data collection and availability. As a result, this study relies on the most relevant available variables namely, private and public investments in digital infrastructure to approximate the effects of digitalization on tourism. The use of digitalization in economic growth models is not new. Notably, Solow (1956), and Romer (1986), integrated technology into their respective frameworks, treating it as exogenous in the former and endogenous in the latter. Building on this theoretical foundation, we propose the following hypothesis to capture the relationship between digital infrastructure investment and tourism development. After that, we will execute some tests for cointegration, lag length selection criteria (AIC/BIC), and diagnostic checks such as heteroskedasticity and stability tests.

First hypothesis: private investment in digital boosts tourist arrival.

$$AT = f\ (itpr) \tag{3.1}$$

Second hypothesis: In addition to private investment in digital infrastructure, other factors such as economic and political variables may also contribute to the increase in tourist arrivals. These factors are represented by the vector *Z*.

$$AT = f\ (Z) \tag{3.2}$$

Where $Z = (itpu, ind, is, inf, ide)$

Now we have

$$AT = f\ (itpr, Z) \tag{3.3}$$

By combining the hypothesis above, we get the following equation:

$$AT_t = \beta_0 + \beta_1 itpr_t + \beta_2 itpu_t + \beta_3 ind_t + \beta_4 is_t + \beta_5 inf_t + \beta_6 ide_t + u \tag{3.4}$$

The function f is a linear function; we can write:

$$logAT_t = \beta_0 + \beta_1 logitpr_t + \beta_2 logitpu_t + \beta_3 logind_t + \beta_4 logis_t + \beta_5 loginf_t + \beta_6 logide_t + u_t \tag{3.5}$$

In this study, international tourist arrivals (Gozgor & al, 2023) are used as a proxy for tourism demand, consistent with numerous previous studies (Seetanah & al, 2011; Nguyen, 2021).

Investment is commonly included in tourism analyses either as public investment (Barro, 1990; Tchouassi & Ngwen, 2014), or as investment specifically targeting tourism infrastructure (Nguyen, 2021). To assess the impact of the independent variables on the dependent variable, we employ a log-log regression model. This specification is frequently used to estimate elasticities, as it allows for the interpretation of coefficients as percentage changes, thus providing insight into the relative impact of explanatory variables (Song & al, 2008). Foreign direct investment (FDI) is expected to contribute positively to the tourism sector by enabling the development of a skilled workforce, fostering innovation, and enhancing competitiveness and resilience through the adoption of digital technologies (UNWTO, 2023).

Security plays a crucial role in economic development, particularly in African contexts, where insecurity leads to the destruction of human, social, and physical capital including essential equipment and infrastructure that rely on institutional stability and relational networks (Hugon, 2001). In Cameroon, successive editions of the national tourism statistical directory have shown that regions affected by insecurity consistently experience a decline in tourist arrivals. Consequently, public investment aimed at restoring and maintaining security is likely to support the recovery and growth of tourism flows. Moreover, income is widely recognized as a key determinant of tourism demand (Bouzahzah & El Menyari, 2012). Tourists tend to favor destinations where they can maximize the value of their income while minimizing travel-related costs. Therefore, destinations with lower inflation rates are generally more attractive to international tourists, as they offer a more affordable travel experience.

3.2 Model

To test our proposed relationship, we employ the Autoregressive Distributed Lag (ARDL) model. The ARDL model combines autoregressive components where past values of the dependent variable are included as explanatory variables and distributed lag components, which incorporate current and lagged values of the independent variables (Benyacoub & Es-Salmani, 2021). This model is particularly well-suited for testing cointegration and estimating both short- and long-term relationships between variables integrated of different orders. For instance, Iaich & Bouroune (2020), used the ARDL approach to analyze the impact of public investment on economic growth in Morocco, incorporating private investment as an additional explanatory variable. They found that public investment

had a negligible and inconsistent short-term effect on growth and was statistically insignificant in the long run, concluding that public investment did not explain economic growth in Morocco. The ARDL estimation technique is advantageous for small sample sizes (Pesaran & al, 2001), as it requires estimating a single reduced-form equation rather than a system of equations (Pesaran & Shin, 1995). Moreover, by including lagged variables as regressors, the model helps address potential endogeneity issues (Wooldridge, 2006). Our model specification follows the demonstration by Ayoub (Ayoub, 2020), based on the framework developed by Pesaran & al (2001), which we adapt to our context.

Thus, our ARDL model is expressed as follows:

$$l\text{nat}_t = c_0 + \sum_{i=1}^{n} c_1 \Delta l\text{nat}_{t-i} + \sum_{i=0}^{m} c_2 \Delta l\text{nitpr}_{t-i} + \sum_{i=0}^{m} c_3 \Delta l\text{nitpu}_{t-i} + \sum_{i=0}^{m} c_4 \Delta l\text{nind}_{t-i} + \sum_{i=0}^{m} c_5 \Delta l\text{nis}_{t-i} + \sum_{i=0}^{m} c_6 \Delta l\text{ninf}_{t-i} + \sum_{i=0}^{m} c_7 \Delta l\text{nide}_{t-i} + d_1 l\text{nat}_{t-i} + d_2 l\text{nitpu}_{t-i} + d_3 l\text{nitpr}_{t-i} + d_4 l\text{nind}_{t-i} + d_5 l\text{nis}_{t-i} + d_6 l\text{ninf}_{t-i} + d_7 l\text{nide}_{t-i} + s_t \quad (3.6)$$

With c_0 as constant; c_1 to c_7 as short-run coefficients; d_1 to d_7 as long-run dynamic coefficients; Δ as the first difference operator.

Subsequently, **Table 2** displays the correlation matrix of the model variables:

Table 2. Matrix of correlation.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) lnat	1.000						
(2) lnitpr	0.653	1.000					
(3) lnitpu	0.682	0.674	1.000				
(4) lnis	0.315	0.443	0.680	1.000			
(5) lninf	−0.064	0.177	−0.051	0.100	1.000		
(6) lnide	0.287	−0.024	0.374	0.258	−0.111	1.000	
(7) lnind	0.648	0.725	0.897	0.658	0.146	0.226	1.000

Source: by authors.

Table 2 reveals a moderate correlation between investments in digital infrastructure and international tourist arrivals in Cameroon. This suggests that additional factors, not captured in our current model, may also influence tourist arrivals. An increase in digital investment is associated with a rise in international tourism inflows. Conversely, for variables such as inflation, an increase appears to correspond with a decline in tourist arrivals. This table highlights the influence of macroeconomic variables on both international tourist arrivals and investments in digital infrastructure. It appears that an increase in foreign direct investment (FDI) and spending on security is associated with a rise in tourist arrivals, whereas high inflation has a deterrent effect. Indeed, elevated inflation levels tend to discourage tourism flows. Furthermore, inflation and security investments seem to encourage private investment in digital infrastructure, while an increase in FDI appears to have the opposite effect. Finally, among these three indicators, inflation is the one that most negatively affects public investment in digital infrastructure.

We will now examine the descriptive statistics presented in **Table 3** below:

Table 3. Descriptive Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
AT	22	634,411.55	265,153.24	240,000	1,081,000
ITPr	22	1.402×10^{11}	8.537×10^{10}	2.7×10^{10}	3.208×10^{11}
ITPu	22	1.437×10^{10}	1.736×10^{10}	5×10^{8}	4.794×10^{10}
IS	22	5.687×10^{9}	6.285×10^{9}	1.02×10^{9}	2.84×10^{10}
Inflation	22	2.23	1.397	0.234	5.338
IDE	22	1.687	0.962	−0.107	4.069
IUI	22	12.661	14.874	0.252	45.602

Source: by authors.

Over the 22-year period covered by this study, the average number of international tourist arrivals in Cameroon was 634,441.55. The relatively low standard deviation indicates that the data are concentrated around the mean, suggesting that most of the observed values are close to this average. In contrast, both public and private investments in digital infrastructure exhibit standard deviations that exceed their respective means, reflecting greater variability and dispersion in these variables over the study period.

4. Results and Discussion

In this section, we begin by conducting preliminary tests, including the multicollinearity test, the Augmented Dickey-Fuller (ADF) unit root test, and the Phillips-Perron test, as well as determining the optimal lag length to be used in the ARDL model. Second, we estimate the ARDL model, having first applied Ordinary Least Squares (OLS). Finally, we perform post-estimation diagnostic tests, such as the cointegration test, the heteroskedasticity test, and the stability test.

4.1 Preliminary Tests

In this section, we conduct the multicollinearity test, the Augmented Dickey-Fuller (ADF) and Phillips-Perron unit root tests, and determine the optimal number of lags to be included in the model specification.

The results presented in **Table 4** indicate a positive relationship between investments in digital infrastructure whether private or public, and international tourist arrivals. Specifically, a 1% increase in private investment in digital infrastructure is associated with a 0.294% increase in international tourist arrivals. Similarly, a 1% increase in public investment in digital infrastructure corresponds to a 0.073% increase in tourist arrivals in Cameroon. The model yields an R^2 value of 0.605, indicating that 60.5% of the variation in international tourist arrivals is explained by the variables included in the model, while the remaining 39.5% is attributable to factors not captured by the model. Despite the positive estimated effects, the coefficients for both types of investment are not statistically significant, as their p-values exceed the 0.05 threshold. This lack of significance may be explained by multicollinearity i.e., a high correlation between explanatory variables which can inflate standard errors and weaken the reliability of coefficient estimates.

Table 4. Linear regression.

lnat	Coef.	St.Err.	t-value	*p*-value	[95% Conf	Interval]	Sig
lnitpr	0.294	0.175	1.68	0.115	−0.081	0.669	
lnitpu	0.073	0.115	0.63	0.538	−0.174	0.319	
lnis	−0.126	0.116	−1.09	0.296	−0.375	0.123	
lninf	−0.061	0.108	−0.56	0.581	−0.292	0.17	
lnide	0.091	0.093	0.97	0.348	−0.11	0.291	
lnind	0.051	0.119	0.42	0.677	−0.205	0.306	
Constant	6.886	4.909	1.40	0.183	−3.643	17.414	
Mean dependent var		13.296		SD dependent var		0.425	
R-squared		0.605		Number of obs		21	
F-test		3.577		Prob > F		0.023	
Akaike crit. (AIC)		17.165		Bayesian crit. (BIC)		24.477	

Source: by authors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

As shown in **Table 4**, no variables appear to be statistically significant, which could be attributed to potential multicollinearity. Therefore, we proceed to test for multicollinearity in **Table 5** below.

Table 5. Variance inflation factor.

	VIF	1/VIF
lnitpu	8.338	0.12
lnind	7.068	0.141
lnitpr	2.493	0.401
lnis	1.96	0.51

Continuation Table:

	VIF	1/VIF
lnide	1.422	0.703
lninf	1.299	0.77
Mean VIF	3.763	.

Source: by authors.

The Variance Inflation Factor (VIF) is commonly used to test for multicollinearity among the explanatory variables in a model. Depending on the VIF value, four scenarios may arise: severe multicollinearity, high multicollinearity, moderate multicollinearity, or no multicollinearity. Specifically, a VIF value greater than 10 indicates severe multicollinearity; a value between 5 and 10 indicates high multicollinearity; values between 1 and 5 suggest moderate multicollinearity; and a VIF of 1 implies no multicollinearity.

In our analysis, two variables exhibit high levels of multicollinearity, with VIF values of 8.338 and 7.068. These correspond to public investment in digital infrastructure and the proportion of individuals using the internet in Cameroon, respectively. Consequently, these two variables are excluded from the final model. It is important to note that their exclusion does not imply that they have no effect on international tourist arrivals in Cameroon; rather, they are removed to avoid multicollinearity, which could lead to unstable or biased estimations. Private investment in digital infrastructure remains our primary variable of interest.

Table 6 shows that, whether it is the Augmented Dickey-Fuller test (1981) or the Phillips-Perron test (1988), all the variables are stationary.

Table 6. Stationarity tests: Philipps-Perron and Augmented Dickey Fuller (ADF).

Variables	ADF Test		Phillips-Perron Test		Lags
	Test Statistic	*p*-value	Test Statistic	*p*-value	
lnat	−3.650	0.0049	−7.721	0.0000	4
lnitpr	−2.878	0.0479	−4.437	0.0003	1
lnis	−5.912	0.0000	−5.912	0.0000	0
lninf	−5.420	0.0000	−5.420	0.0000	0
lnide	−2.920	0.0431	−8.476	0.0000	2

Source: by authors.

To determine the optimal lag length, we use the Akaike Information Criterion (AIC). According to **Table 7**, the optimal number of lags for our analysis is 4.

Table 7. Determination of the Optimal Lag Length.

	Selection-Order Criteria							
	Sample: 2006–2021				Number of obs = 16			
lag	**LL**	**LR**	**df**	**p**	**FPE**	**AIC**	**HQIC**	**SBIC**
0	−61.8693				0.002938	8.35866	8.37103	8.6001
1	−18.7611	86.216	25	0.0000	0.00037	6.09514	6.09514	7.54375
2	50.4253	138.37	25	0.0000	5.8×10^{-6}*	0.571836	0.707833	3.22761
3	2325.8	4550.7	25	0.0000	.	−280.724	−280.527	−276.862
4	2501.7	351.81*	25	0.0000	.	−302.713*	−302.515*	−298.85*

Source: by authors

4.2 Model Estimation

In this section, we present the results of the Ordinary Least Squares (OLS) estimation and the ARDL analysis.

In the second regression presented in the **Table 8**, the relationship between private investment in digital infrastructure and international tourist arrivals is both positive and statistically significant. Specifically, a 1%

increase in private digital investment leads to a 0.472% increase in international tourist arrivals. With a *p*-value of 0.002, this relationship is significant at the 1% level. By contrast, a 1% increase in security-related public investment and inflation is associated with a decrease in tourist arrivals by 0.033% and 0.085%, respectively though these effects are not statistically significant. In addition, a 1% increase in foreign direct investment (FDI) results in a statistically significant increase in international tourist arrivals. Based on these findings, we conclude that while FDI and private digital infrastructure investment have a measurable impact on tourism inflows, public investment in security and inflation levels do not significantly explain variations in international tourist arrivals in Cameroon.

Table 8. Linear regression.

lnat	Coef.	St.Err.	*t*-value	*p*-value	[95% Conf	Interval]	Sig
lnitpr	0.472	0.127	3.72	0.002	0.203	0.741	***
lnis	−0.033	0.098	−0.33	0.742	−0.24	0.174	
lninf	−0.085	0.097	−0.87	0.396	−0.291	0.122	
lnide	0.142	0.083	1.71	0.106	−0.034	0.319	
Constant	1.965	2.96	0.66	0.516	−4.309	8.239	
Mean dependent var		13.296		SD dependent var		0.425	
R-squared		0.544		Number of obs		21	
F-test		4.770		Prob > F		0.010	
Akaike crit. (AIC)		16.195		Bayesian crit. (BIC)		21.418	

Source: by authors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.

Table 9 presents both the short-term and long-term dynamics between private investment in digital infrastructure and international tourism in Cameroon. In the long term, private digital infrastructure investment and foreign direct investment (FDI) both have a statistically significant impact on international tourist arrivals at the 1% significance level. Specifically, a 1% increase in private digital investment and FDI leads to a 0.264% and 0.161% increase in international tourist arrivals, respectively. Public investment in security also shows a positive effect on international arrivals, although this effect is not statistically significant. Conversely, inflation has a negative yet also statistically insignificant impact. A 1% rise in inflation results in a 0.053% decrease in tourist arrival.

Table 9. ARDL analysis.

	ARDL regression				**Number of obs = 18**	
	Sample: 2004–2021				**R-squared = 0.9766**	
					Adj R-squared = 0.9338	
	Log likelihood = 21.20114				**Root MSE = 0.1291**	
D.lnat	**Coef.**	**Std.Err.**	**t**	***P* > t**	**[95%Conf.**	**Interval]**
ADJ						
lnat						
L1.	−2.033***	0.237	−8.570	0.000	−2.613	−1.452
LR						
lnitpr	0.264***	0.044	5.970	0.001	0.156	0.372
lnis	0.035	0.025	1.430	0.203	−0.025	0.096
lninf	−0.053	0.026	−2.050	0.086	−0.115	0.010
lnide	0.161***	0.030	5.320	0.002	0.087	0.236
SR						
lnat						

Continuation Table:

LD.	0.193	0.182	1.060	0.332	−0.253	0.638
L2D.	2.854***	0.581	4.910	0.003	1.432	4.276
L3D.	0.665	0.670	0.990	0.359	−0.974	2.305
lnitpr						
D1.	−1.076***	0.146	−7.360	0.000	−1.433	−0.718
lnide						
D1.	−0.393***	0.079	−4.990	0.002	−0.585	−0.200
LD.	−0.157***	0.045	−3.510	0.013	−0.267	−0.048
cons	11.609***	2.634	4.410	0.005	5.163	18.054

Source: by authors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In the short term, private investment in digital infrastructure exhibits a statistically significant negative effect on international tourist arrivals. A 1% increase in private digital investment corresponds to a 1.076% decline in arrivals. Similarly, foreign direct investment both in its first and second lags shows a statistically significant negative short-term impact. A 1% increase in FDI is associated with a 0.393% decrease in tourist arrivals.

These findings are consistent with those of Nguyen (2021), who demonstrated that, globally, investment in tourism infrastructure components has a positive and significant effect on attracting international tourist arrivals. However, his study also highlights that this effect may differ between the short and long term. In the case of Cameroon, this result can be explained by the fact that the telecommunications and internet service market is largely dominated by the private sector. These private investments have played a key role in expanding connectivity across the country and promoting the adoption of digital technologies aimed at enhancing the performance of tourism stakeholders, particularly businesses. Digital investments facilitate the widespread use of digital tools and applications including the internet, websites, social media platforms (Benbba & al, 2024), and artificial intelligence thus enabling the development and execution of more effective tourism marketing strategies.

These results suggest that the more the private sector invests in digital infrastructure, the greater the access tourism stakeholders will have to reliable connectivity. This, in turn, enables them to showcase and market both their products and services, as well as promote the image of Cameroon as a tourist destination both nationally and internationally. Access to digital platforms allows Cameroonian tourism providers, in particular, to better understand the needs and preferences of tourists, enabling them to tailor their offerings accordingly. This increased responsiveness not only enhances the visibility and attractiveness of the destination but also contributes to boosting international tourist arrivals. Cameroonian tourism companies can now easily personalize their offers and meet customer expectations. This shows that, there are several actors 378 involved in the development of the tourism industry as identified by Tchouassi & Nguétchouo Domtchouang (2024).

In this context, digitalization enables tourism businesses in general and hospitality businesses in particular to adopt digital tools as a strategic resource (Shah & al, 2012), enhancing their visibility, productivity, and competitiveness in the international market (Bethapudi, 2013). A destination with strong international digital visibility allows potential tourists to explore it virtually through online platforms, virtual reality experiences, or travel applications. Digitalization facilitates the dissemination of destination-related information and promotes interaction with a diverse global audience (Morrison, 2013). It is therefore a critical component in the promotion and marketing of tourist destinations. Digital platforms are reshaping traditional tourism models and contributing significantly to global economic growth (Presenza & al, 2021). They are altering the role of the tourism sector in areas such as product development, governance, market access, tourist attractions, and data collection (World Bank Group, 2018). For the tourism industry, these platforms offer numerous opportunities not only for consumers but also for entrepreneurs and small and medium-sized enterprises by fostering innovation

and increasing access to the global tourism market (Mendieta-Aragón & al, 2025).

The greater relevance of private investment compared to public investment can be explained in terms of volume. In Cameroon, private investments in digital infrastructure are significantly larger than public investments. This disparity may be attributed to constraints on the national budget, which often prioritizes recurrent expenditures over capital investments (Fanmoe, 2011).

This trend is illustrated in the following **Figure 3**, which shows the evolution of private and public investments in digital infrastructure in Cameroon.

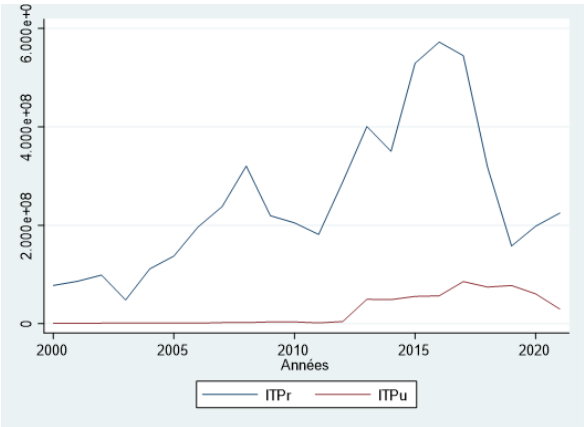

Figure 3. Evolution of Public and Private Investments in Digital Infrastructure in Cameroon.

Source: by authors

The figure illustrates the evolution of public and private investments in digital infrastructure in Cameroon over the study period, from 2000 to 2021. It clearly shows that private investment in digital infrastructure has consistently been higher than public investment. Public investments remained relatively stable until 2012, after which they began to increase. In contrast, private investment levels fluctuated over time but generally exhibited an upward trend. The highest level of private investment was recorded in 2016, while the lowest occurred in 2003.

Investments in digital infrastructures appear to be a strategic lever to boost international tourist arrivals in Cameroon. Although the overall trend is upward, this growth remains relatively modest. Between 2000 and 2021, over a 21-year period, the country recorded a cumulative increase of only 664,054 international tourists. To date, despite the stated ambition to reach 3,500,000 international tourists by 2030, the annual threshold of 1,200,000 arrivals has yet to be achieved. The evolution of international tourist arrivals in Cameroon can be seen below (**Figure 4**):

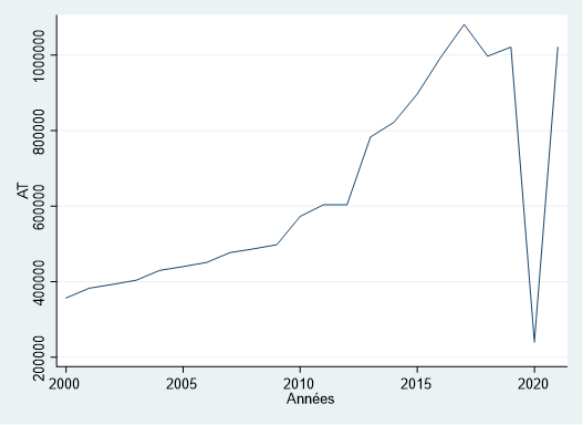

Figure 4. Evolution of international tourist arrivals in Cameroon.

Source: by authors

In recent years, Cameroon has experienced sustained growth in the number of international tourists. However, this positive trend was abruptly interrupted by the outbreak of the COVID-19 pandemic in 2020. Tourist arrivals dropped from 1,021,000 in 2019 to just 240,000 in 2020, representing a decline of over 75%. This sharp decrease is primarily due to the inherent dependence of the tourism sector on human mobility. Health measures such as lockdowns and travel restrictions significantly limited both regional and international movement, leading to a drastic reduction in tourist flows (Hao & al, 2021). In this context, a new trend emerged, characterized by a rise in local travel and a shift toward more responsible tourism practices. A significant recovery was nonetheless observed in 2021. This improvement is primarily attributed to Cameroon's hosting of the Africa Cup of Nations, a major event that attracted a substantial number of international tourists.

Security, whether related to political conflicts, wars, or terrorism, is a major determinant of a destination's tourism attractiveness. The case of Cameroon clearly illustrates this effect: the regions of the Far North, North-West, and South-West, which have been particularly affected by insecurity, have experienced a drastic decline in tourist arrivals, dropping from several hundred thousand to just a few thousand. Due to their nationality and the frequent targeting of tourist hotspots by terrorist groups, foreign tourists are often more

vulnerable to acts of terrorism than local residents. As Mamontoff (2019), notes, *"tourist destinations become inaccessible in the absence of territorial security"*, which poses a major barrier to tourism development. In this context, digitalization plays a crucial role, as it enables tourists to stay informed about specific risks, including health, climate, and security conditions, which may deter them from visiting certain destinations. Investments in security help enhance the perceived stability of a destination, thereby increasing the confidence of potential visitors. Moreover, a secure environment also reduces risks associated with cybercrime and information leaks, while ensuring more efficient use of digital services. This, in turn, fosters innovation and provides better protection for stakeholders on both the supply and demand sides of the tourism sector.

Inflation has a negative impact on tourist arrivals, primarily due to rising prices that reduce visitors' purchasing power. In some cases, potential tourists may forgo travel to destinations perceived as too expensive; in others, they may shorten the duration of their stay or limit on-site activities to stay within budget. This behavior leads to decreased visitation of tourist attractions and may prompt travelers to opt for alternative destinations with lower inflation rates. A destination perceived as costly thus becomes less competitive, resulting in a decline in tourist numbers and, consequently, reduced revenues for businesses in the sector. Moreover, inflation also hampers access to digital equipment, as tourism stakeholders face diminished purchasing power. This limitation hinders their ability to adopt digital tools essential for promoting and distributing their offerings, thereby reducing their visibility on the international stage. In response, some firms may choose to increase their investments in digital technologies to maintain competitiveness, while others constrained by budget pressures, may reduce their workforce to offset rising costs.

The pricing system in the Cameroonian tourism sector is characterized by significant variability. This fluctuation is primarily driven by the pronounced seasonality of tourism activity. Prices tend to rise during peak periods, notably during holidays, major sporting events (such as the Africa Cup of Nations), and cultural festivals, and decrease during low seasons. Furthermore, pricing, especially in the hotel industry, also depends on the timing of the reservation. A tourist who books accommodation a few days in advance generally benefits from a lower rate compared to a last-minute booking. Therefore, early online reservations help optimize the visitor's budget.

The presence of foreign direct investment (FDI) in a host country is likely to have a direct impact on productivity in both the short and long term, through significant externalities that contribute to development, particularly in countries of the Global South (Hymer, 1960; Caves, 1974). The tourism sector offers numerous investment opportunities in projects that enhance the attractiveness of FDI (El Kadiri & al, 2023). According to UNWTO (2023), FDI enables access to a skilled workforce capable of generating exponential growth, serving as a driver of innovation, and, through the adoption of digital technologies, improving both the competitiveness and resilience of the tourism sector. Foreign direct investment (FDI) in the Cameroonian tourism sector is primarily concentrated in the hotel industry. Major international players include the American group Hilton (owner of the five-star Hilton Hotel), the French group Accor (three-star Ibis Hotel), the Moroccan group Onomo (three-star Onomo Hotel), the American group Best Western Hotels and Resorts (four-star Best Western Plus Soaho Hotel), and the American group Marriott (four-star Le Méridien Hotel, managed locally by Albert Kouinche). However, the presence of these international investors is also associated with profit repatriation, which may limit the positive impact of FDI on national tourism revenues.

4.3 Post-Estimation Diagnostics Tests

To validate the robustness and reliability of the model, we conducted several post-estimation tests, including checks for cointegration, heteroskedasticity, and stability.

Table 10 indicates the presence of at least one long-term relationship between the dependent variable and the independent variables. This finding allows us to reject the null hypothesis, which posits the absence of a level relationship. The cointegration test developed by Pesaran & al (2001), known as the bounds testing approach is particularly well-suited for small sample sizes. It assesses whether one or more cointegration relationships exist within the ARDL framework. According to these authors, ensuring parameter stability requires verifying the constancy of the long-run multipliers.

Table 10. Cointegration test.

Pesaran/Shin/Smith (2001) ARDL Bounds Test				
H0: no levels relationship F = 21.794				
t = −8.569				
Critical Values (0.1–0.01), F-statistic, Case 3				
	10%	5%	2.5 %	1%
	[I_0] [I_1]	[I_0] [I_1]	[I_0] [I_1]	[I_0] [I_1]
k_4	2.45 3.52	2.86 4.01	3.25 4.49	3.74 5.06
accept if F < critical value for I(0) regressors				
reject if F > critical value for I(1) regressors				
Critical Values (0.1–0.01), t-statistic, Case 3				
	10%	5%	2.5 %	1%
	[I_0] [I_1]	[I_0] [I_1]	[I_0] [I_1]	[I_0] [I_1]
k_4	−2.57 −3.66	−2.86 −3.53	−3.13 −4.26	−3.43 −4.60
accept if t > critical value for I(0) regressors				
reject if t < critical value for I(1) regressors				
k: # of non-deterministic regressors in long-run relationship				

Source: by authors.

As shown in the **Table 11**, the p-value is less than 0.05, indicating the presence of autocorrelation in the residuals. To address this issue, we apply the Generalized Least Squares (GLS) method, which is an appropriate approach for correcting autocorrelation in the model.

Table 11. Autocorrelation test.

Breusch-Godfrey LM test			
lags(p)	chi2	df	Prob > chi2
1	0.007	1	0.9355

Source: by authors.

Table 11 revealed the presence of autocorrelation in the initial model. However, the results presented in **Table 12** indicate a positive and statistically significant effect of private investments in digital infrastructure on international tourist arrivals. Specifically, a 1% increase in private investment leads to a 0.489% increase in arrivals. Similarly, foreign direct investment (FDI) has a positive and significant impact, with a 1% increase in FDI resulting in a 0.181% increase in arrivals. Moreover, the model highlights the significant effect of inflation, where a 1% rise in inflation reduces tourist arrivals by 0.134%. The transformed Durbin-Watson statistic is close to 2, suggesting the absence of autocorrelation in the final model.

Table 12. The Generalized Least Squares model.

Prais-Winsten AR (1) regression							
lnat	Coef.	St.Err.	t-value	*p*-value	[95% Conf	Interval]	Sig
lnitpr	0.489	0.074	6.57	0	0.329	0.648	***
lnis	−0.043	0.068	−0.63	0.537	−0.188	0.102	
lninf	−0.134	0.065	−2.07	0.058	−0.273	0.005	*
lnide	0.181	0.058	3.12	0.008	0.056	0.306	***
Constant	1.789	1.776	1.01	0.331	−2.021	5.598	
Mean dependent var		13.344		SD dependent var		0.418	
R-squared		0.840		Number of obs		19	
F-test		18.403		Prob > F		0.000	
Akaike crit. (AIC)		7.033		Bayesian crit. (BIC)		11.755	
Durbin-Watson statistic (original) 2.921440							
Durbin-Watson statistic (transformed) 2.320206							

Source: authors, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We will now test the Heteroskedasticity in our model in **Table 13** below:

Table 13. Heteroskedasticity test.

Breusch-Pagan/cook-weisberg test
Ho: constant variance
variables:fitted values of D.lnat
chi2(1) = 0.16
prob > chi2 = 0.6875

Source: by authors.

As shown in our **Table 13**, the p-value is greater than 0.05, allowing us to conclude that there is no evidence of heteroskedasticity. We will now test the stability of our model in **Table 1**4 below:

Table 14. Stability test.

Cumulative sum test for parameter stability				
Sample: 2004–2021		**Number of obs = 18**		
Ho: No structural break				
Statistic	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
recursive	0.5434	1.1430	0.9479	0.850

Source: by authors.

This is illustrated in **Figure 2** below:

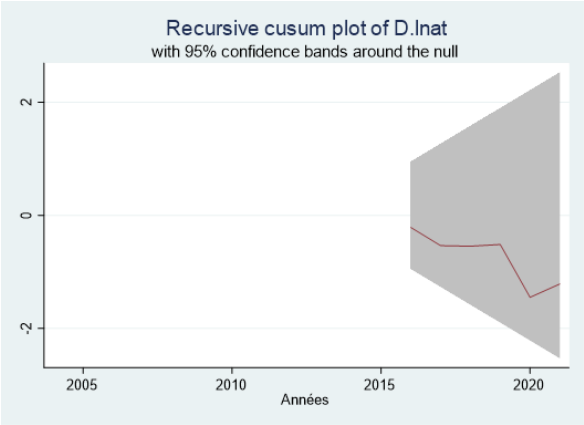

Figure 2. Cusum stability test.

Source: by authors.

The residual plot remains within the confidence bands, indicating that the model coefficients are stable over time.

5. Conclusion and Recommendations

5.1 Conclusion

To attract tourists and establish an effective pricing strategy, investing in digital infrastructure to enhance the competitiveness and attractiveness of a destination is crucial. This study aimed to analyze the impact of investments in digital infrastructure on tourism development in Cameroon. Utilizing the Autoregressive Distributed Lag (ARDL) model, we examined data spanning 22 years, from 2000 to 2021. Our findings indicate that private investment in digitalization has a significant positive effect on international tourist arrivals in the long term. Conversely, in the short term, this effect is negative yet remains statistically significant. The results suggest that digital investments by private stakeholders in Cameroon contribute positively to tourism growth primarily over the long run.

This implies that increased private sector investment in digitalization enhances access to digital tools among tourism actors, enabling them to better promote Cameroon's image both nationally and internationally, and to tailor their offerings to the preferences and needs of visitors. Furthermore, digitalization improves service quality, enriches tourists' experiences, and reshapes the roles of actors within the tourism ecosystem by allowing tourists greater autonomy in planning their trips without physical travel constraints. Investments in digital infrastructure also foster the development and use of the internet and artificial intelligence technologies. However, connectivity in Cameroon remains limited and costly, restricting access to digital platforms and social media to a relatively small segment of the population. A key limitation of this study is the scarcity of comprehensive data on digitalization.

5.2 Recommendations

For sustained tourism growth, stakeholders particularly in the private sector, must integrate digital strategies into their marketing efforts to offer products that meet tourists' expectations and provide optimal value. Digital marketing strategies also enhance the experiences of visitors engaged in creative tourism activities. To support this, the Cameroonian government should implement policies such as tax incentives to encourage greater private investment in digital technologies. Improving the overall visitor experience through such investments will likely increase Cameroon's attractiveness as a tourist destination. This goal necessitates continued expansion and modernization of digital infrastructure and equipment. The establishment of public-private partnerships is essential to enhance public investment in digital infrastructure and effectively compete with foreign direct investment.

Cameroon has over 900 tourist sites distributed across its ten regions; however, to date, only a few benefits from significant online visibility. Improving internet coverage, particularly in rural areas, would facilitate the promotion and digitalization of all these sites. It is necessary that internet accessibility also involves reducing the cost of data plans, which remain high for the majority of Cameroonians. Furthermore, it is necessary to strengthen the training of tourism sector stakeholders in digital marketing techniques to enhance their online presence and competitiveness.

This analysis could be extended to a panel study covering different regions of Africa or specific monetary zones. It could also focus on digital inclusion or the adoption of digital indicators. At the macroeconomic level, a targeted investigation of tourism enterprises investing in digitalization would be relevant to better understand their impact on sectoral development.

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