

Digitalisation and Economic Performance: The Impact of ICT on Tourism, Exports and Investments

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Dijitalleşme ve Ekonomik Performans: BİT'in Turizm, İhracat ve Yatırımlar Üzerindeki Etkisi

Abstract

This study examines the long- and short-term effects of Information and Communication Technology (ICT) investments on tourism, export, and foreign direct investment (FDI) in 12 developing economies during the period 1995-2020. To account for cross-sectional dependence, heterogeneity, and serial correlation in the panel data, the Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) estimator developed by Pesaran, Shin, and Smith (1999) was employed. Contrary to the existing literature, empirical findings indicate that ICT expenditures have statistically significant negative long-term relationships with all three economic variables: exports (coefficient = -1,62, $p = 0,04$), tourism (coefficient = -0,56, $p = 0,00$), and FDI (coefficient = -1,55, $p = 0,00$). Notably, while the error-correction terms for exports and tourism indicate stable convergence to equilibrium (-0,78 and -0,77, respectively), the FDI model yields an error-correction coefficient of -1,83, suggesting an oscillatory, potentially unstable adjustment process. The results suggest that ICT investments may negatively affect these key indicators in the long term in the context examined, and emphasise the importance of complementary policies to unlock their positive potential.

Keywords : Information and Communication Technologies, Tourism Revenues, Export, Foreign Direct Investment, PMG-ARDL Approach.

JEL Classification Codes : C33, F21, O33, Z32.

Öz

Bu çalışma, 1995-2020 döneminde 12 gelişmekte olan ekonomide Bilgi ve İletişim Teknolojileri (BİT) yatırımlarının turizm, ihracat ve doğrudan yabancı yatırımlar (DYY) üzerindeki uzun ve kısa vadeli etkilerini incelemektedir. Panel verilerindeki kesitsel bağımlılık, heterojenlik ve seri korelasyonu hesaba katmak için Pesaran, Shin ve Smith (1999) tarafından geliştirilen Havuzlanmış Ortalama Grup Otoregresif Dağıtılmış Gecikme (PMG-ARDL) tahmincisi kullanılmıştır. Mevcut literatürün aksine, ampirik bulgular, BİT harcamalarının üç ekonomik değişkenle de istatistiksel olarak anlamlı negatif uzun vadeli ilişkiler içinde olduğunu göstermektedir: ihracat (katsayı = -1,62, $p = 0,04$), turizm (katsayı = -0,56, $p = 0,00$) ve DYY (katsayı = -1,55, $p = 0,00$). Özellikle, ihracat ve turizm için hata düzeltme terimleri dengeye doğru istikrarlı bir yakınsamayı gösterirken (-0,78 ve -0,77, sırasıyla), doğrudan yabancı yatırım modeli -1,83'lük bir hata düzeltme katsayısı vermekte olup, bu da salınımlı ve potansiyel olarak istikrarsız bir uyum sürecine işaret etmektedir. Sonuçlar, ICT yatırımlarının incelenen bağlamda uzun vadede bu temel göstergeler üzerinde olumsuz bir etkiye sahip olabileceğini ve olumlu potansiyeli ortaya çıkarmak için tamamlayıcı politikaların önemini vurgulamaktadır.

Anahtar Sözcükler : Bilgi ve İletişim Teknolojileri, Turizm Gelirleri, İhracat, Doğrudan Yabancı Yatırım, PMG-ARDL Yaklaşımı.

1. Introduction

In recent years, the profound influence of digitalisation on national economies has become a central topic of scholarly inquiry. The digital shift has emerged as a transformative force, redefining economic systems and societal norms. Among the key facilitators of this shift are Information and Communication Technologies (ICT), which are now considered not merely tools of technological advancement but strategic enablers of economic progress. ICT investments, in particular, have increased the visibility and accessibility of the tourism industry (OECD, 2017), facilitated exporters' entry into international markets, and positioned digitally advanced nations as attractive hubs for foreign direct investment (World Bank, 2020). Within this framework, digitalisation is increasingly recognised as a catalyst redirecting global trade patterns and investment streams (Brynjolfsson & McAfee, 2014). Nonetheless, the pace and depth of this transformation differ significantly across countries, raising ongoing questions regarding its uneven effects. As a result, comparative cross-country and sector-specific investigations are necessary to fully grasp the implications of digitalisation on the global economic landscape (Gereffi, 2018).

The tourism sector, known for its significant contributions to economic growth, is also highly sensitive to technological innovations. In this context, investments in Information and Communication Technologies (ICT) are a cornerstone of the sector's digital transformation, as they enhance destinations' visibility in the digital sphere, strengthen customer engagement, and support business competitiveness (Buhalis & Law, 2008). Technological advances ranging from web-based reservation systems to targeted digital campaigns, mobile platforms, and immersive virtual experiences have fundamentally changed both tourists' decision-making processes and tourism businesses' operational activities. A robust digital infrastructure enables service providers to establish more efficient connections with potential visitors, while empowering consumers with tools such as real-time reservations, price comparisons, and user reviews, thereby enhancing trust and increasing reservation rates. Ultimately, these developments lead to increased tourist numbers and per capita spending, thereby boosting total tourism revenues (Gretzel et al., 2006). Thus, ICT has evolved from a mere technological component to a strategic instrument that shapes tourism revenue, commercial expansion, and foreign investment patterns. However, studies that comprehensively assess this multifaceted dynamic and provide cross-country comparative analyses remain limited in the literature.

The concept of Foreign Direct Investment (FDI) is defined by UNCTAD (2021) as the transfer of capital by a foreign investor to an enterprise in another country to provide long-term benefits. According to Seyidoğlu (2003), FDI is realised through an enterprise's establishment of new facilities or the acquisition of existing ones in another country. In this respect, FDI is the transfer of capital by international investors to engage in economic

activity in a country outside their own borders, and investment can be made individually or through partnerships with local firms. In recent years, ICT developments have had a significant impact on the direction, form and intensity of FDI. Countries with strong digital infrastructure have become more attractive to investors, both for operational efficiency and for the level of digitalisation. Therefore, ICT is no longer seen as merely a supporting element but also as a critical factor in investment decisions (Loungani & Razin, 2001). Multinational companies prefer countries with strong ICT infrastructure to manage global production processes more flexibly and in an integrated manner. Advanced digital infrastructure accelerates data flows, enhances remote management capabilities and facilitates supply chain integration (Brouwer et al., 2003). On the other hand, FDI also contributes to the development of the host country's digital infrastructure, creating positive externalities such as knowledge transfer, increased technical skills, and strengthened innovation capacity (Borensztein et al., 1998).

In terms of exports, ICT supports trade by enabling faster, more efficient, and more secure trade between countries. Digitalisation expands the boundaries of trade and facilitates firms' access to international markets (Mann & Eckert, 2000). For exporters, ICT not only transforms marketing and sales processes but also increases efficiency in key operational areas such as logistics, supply chain management and customer relations. Digital platforms and e-commerce sites enable small and medium-sized enterprises to compete in the global market and facilitate the integration of emerging economies into the international trade system (Almeida, 2007). In particular, e-commerce enables firms to conduct their export processes in a digital environment and reach consumers worldwide without being limited to local markets.

In today's globalised economic environment, Information and Communication Technologies (ICT) have become a central driver of both economic expansion and development strategies. Over the last two decades, as digital transformation has accelerated, the influence of ICT infrastructure on critical macroeconomic components, including tourism, international commerce, and foreign direct investment (FDI), has gained significant attention in both academic research and policy discussions.

As globalisation progresses, the growth of digital platforms and changing consumer behaviours has amplified the strategic relevance of ICT across these areas. However, a careful review of the existing body of work shows that although there is substantial research on ICT's effects within the tourism sector, studies that simultaneously evaluate its connections to broader economic variables such as export volumes and FDI, particularly using cross-country data, remain limited.

Addressing this research gap, the present study examines in depth the relationships among ICT expenditures, tourism income, export levels, and FDI flows. It draws on data from 12 developing countries over the 1995-2020 period. By adopting a multi-variable and comparative perspective, the study aims to make a distinctive academic contribution by embedding these interactions within a cohesive empirical model.

The impact of Information and Communication Technology (ICT) investments on economic outcomes has been examined within the framework of the New Growth Theory and the Endogenous Technology Approach. According to these theories, technological investments contribute to economic growth by enhancing productivity (Romer, 1990; Aghion & Howitt, 1992). However, since our study's findings indicate a negative relationship contrary to general expectations in the literature, our analysis also discusses potential negative externalities, including inefficient use of ICT investments, infrastructure deficiencies, a lack of skilled human capital, and inadequate policy and institutional alignment. In this context, the study is linked to the ICT Paradox (Solow, 1988) literature, emphasising the importance of complementary reforms and institutional capacity for technological investments to generate positive effects.

2. Literature

Information and communication technologies (ICT) are at the heart of the structural transformation of the global economy, driving innovation in tourism, exports, and foreign direct investment (FDI). In tourism, ICT infrastructure contributes to the growth of sectoral revenues by optimising access to destinations, while in exports, digital tools enable SMEs to integrate into global markets by minimising geographical constraints. In the context of FDI, economies with high ICT maturity are attractive to foreign investors thanks to their infrastructure that reduces communication costs and increases productivity. However, the existing literature lacks an integrated perspective on the interrelationships among these three areas and the multiple impacts of ICT. In this study, academic findings on ICT-tourism revenues, ICT-exports and ICT-FDI relations will be detailed under separate headings, and literature will be presented.

2.1. Relationship between ICT and Tourism Revenues

Tourism has emerged as one of the earliest adopters of digital transformation, leading the way by moving services such as flight and hotel bookings online. With the rapid spread of information and communication technologies (ICT) across the globe, the sector has been at the forefront of technological developments by rapidly adopting new tools and digital innovations (unwto.org, 2025). ICT has fundamentally transformed the functioning and dynamics of the tourism industry. While travellers used to rely on printed guides or travel agencies for information, they now have instant access to destination information through search engines, websites and social media. This change has accelerated travel decision-making processes, reduced the need for intermediaries and made tourists more independent and informed. For example, international research shows that countries with high internet usage rates, secure servers and a high number of mobile subscribers experience significant increases in the number of tourists and tourism revenues. These findings suggest that destinations with strong digital infrastructure and active online presence are likely to attract more demand (Lee et al., 2021).

The economic impact of ICT on tourism is a topic frequently examined in the academic literature. However, studies examining ICT, tourism revenues, foreign direct investment and export variables together are quite limited. The general opinion is that investments in ICTs increase countries' tourism performance and revenues. However, the magnitude and form of this effect may differ depending on the level of development and tourism infrastructure of countries. Some important findings from studies conducted on different country groups in the last decade are as follows:

Tourism Demand and Internet Access: A large-scale empirical investigation utilising World Bank data has revealed that key ICT indicators, including growth in mobile phone usage, expansion of secure internet servers, and broadband access, exert a significant positive influence on international tourist inflows. Enhancements in ICT infrastructure, particularly in digital connectivity, have been found to correlate with higher volumes of international visitors.

For instance, Lee et al. (2021) demonstrated, in a panel analysis covering 189 countries between 2000 and 2018, that growth in mobile phone subscriptions significantly boosts tourist arrivals. In a similar vein, Rajan et al. (2016) noted that the proliferation of secure internet servers contributes to increased international tourism flows.

Tourism Revenues and ICT Use: A growing body of empirical evidence indicates a strong, positive association between ICT variables and tourism income. For instance, Choudhary et al. (2020), through a panel data study covering 28 nations, emphasised the significant contribution of ICT utilisation to the rise in tourism earnings. Specifically, factors such as internet penetration, mobile connectivity, and widespread access to digital platforms were associated with statistically significant, long-term increases in tourism-related inflows.

According to Kumar & Kumar (2012), the Granger causality test revealed a one-way causal relationship from capital accumulation to ICT development, and subsequently from ICT improvements to tourism income. Al-Mulali et al. (2020) also demonstrated through regression analysis that digital transformation positively influences actual tourism income across various regional clusters, excluding high-income nations. Similarly, Tsaurai & Chimbo (2019) argue that ICT development fosters tourism revenues over both the short and long term.

Differences between Developed and Developing Countries: The influence of ICT on tourism revenues can vary significantly across countries, depending on their level of digital development and overall economic context. A comprehensive international study explored the role of ICT in promoting inclusive growth within the tourism industry and highlighted regional disparities in ICT effectiveness. As outlined by Nchofoung et al. (2022), while ICT-related investments tend to boost tourism development in regions such as Europe and Asia-Pacific, where digital infrastructure and skilled labour are more abundant, they may yield more modest outcomes in regions such as Africa and Latin America, where digital competencies are generally lower.

Nevertheless, a panel data analysis covering African nations from 1996 to 2016 by Adeola & Evans (2020) found a statistically significant long-term increase in tourist arrivals and tourism revenues, driven by enhancements in telecommunications and internet accessibility. Thus, despite structural limitations, ICT investments are increasingly emerging as a catalyst for tourism development, even in less developed economies.

According to the Tourism Competitiveness Index, based on the 2021/2024 Travel and Tourism Development Index (TTDI) published by the World Economic Forum, a well-established ICT infrastructure is a fundamental determinant of a country's competitiveness in the tourism sector. The 2024 version of the report emphasises that, in the post-pandemic era, ICT readiness scores have increased by 7.2% across many economies, primarily due to the accelerated digitalisation of travel and tourism services. The report further underlines that a significant portion of the top 30 countries with the highest tourism competitiveness are advanced economies characterised by sophisticated digital infrastructure. Countries such as the United States, Spain, Japan, France, Germany, and the United Kingdom exemplify this trend, benefiting from the effective integration of their transport systems, tourism assets, and digital technologies. The fact that these countries collectively generated over 75% of global tourism GDP in 2022 is a clear indicator of the strong positive association between digital infrastructure quality and tourism revenue performance (Travel & Tourism Development Index, 2024).

In sum, academic literature and international indices show that investments in ICT and technological development generally have a positive impact on tourism revenues. Factors such as a good communication infrastructure, high internet and mobile penetration, and the prevalence of online services can both attract more tourists and increase per capita spending. There is also evidence that large-scale digital transformation projects, such as the "smart city" concept, significantly increase the attractiveness of destinations and tourism yields (e.g., the China smart city example, a +24% increase in tourism revenue) (Ji et al., 2024). In light of these findings, it is clear that both the public and private sectors should continue to invest in tourism technology.

2.2. Relationship between ICT and Export

Recent progress in information and communication technologies (ICT) has emerged as a key driver enhancing national export performance and global competitiveness. From a theoretical standpoint, well-developed communication systems and broad internet accessibility help streamline information flow and establish market connections, ultimately reducing the barriers for firms entering international trade arenas. Numerous scholarly works support a positive linkage between ICT-related metrics and foreign trade outcomes. For instance, Akhvlediani (2021) found that in Asian countries, a 10% rise in telephone subscriptions, both in exporting and importing nations, can lead to a 2.2% to 2.6% increase in bilateral trade volumes.

With the worldwide acceleration of digitalisation over the last decade. The role of ICT in export performance has become more prominent. In particular, the proliferation of e-commerce platforms and digital payment systems makes it easier for even SMEs to find international customers, increasing the number of exporting firms. Increased internet access in developing countries has facilitated their participation in global supply chains. India, for example, has become one of the world's leading exporters of software and IT services thanks to its strong telecom infrastructure and skilled human resources. By 2023, India's software and IT services exports reached approximately \$193 billion annually (Statista, 2024). In sum, countries with strong ICT infrastructure and effective use of digital technologies have gained a competitive advantage in exports in recent years. Thanks to ICT, the decline in communication and computing costs has reduced the importance of geographical barriers; access to distant markets has become possible, and the distances between producers and consumers have shortened "digitally" (Gholami et al., 2005).

2.3. Relationship between ICT and Foreign Direct Investment

The strength of a country's information and communication technology (ICT) infrastructure is a fundamental factor that directly influences its potential to attract foreign direct investment (FDI). International investors seek an advanced digital environment that reduces communication costs, improves supply chain efficiency, and enables modern, data-driven production techniques before making investments in a country. Supporting this expectation, studies have revealed a strong, positive relationship between FDI flows and digitalisation indicators, such as a country's internet usage rate, number of mobile subscribers, and telecommunications quality (Wang & Rukh, 2021; Addison & Heshmati, 2003).

The role of ICT is not limited to making a country attractive to investors by reducing costs; it also acts as a catalyst that enhances the contribution of incoming investment to economic growth. Recent studies indicate that in countries with strong ICT infrastructure and high levels of digital literacy, the positive effects of FDI on inclusive growth increase exponentially. In other words, technology and foreign capital are two complementary strategic forces that accelerate economic development (Ofori & Asongu, 2021).

In the existing literature, the effects of ICT on tourism, exports, or investments have mostly been examined separately. However, comprehensive approaches that analyse these three key macroeconomic components together using recent panel data are quite limited. Moreover, studies focusing on the digital transformation process in developing economies are notably insufficient. In this regard, our study offers a unique contribution to the literature by adopting a holistic approach to examine the multidimensional impact of ICT on economic performance.

3. Methodology and Analysis

To examine the long-term dynamic effects of ICT expenditures on tourism, exports, and FDI in developing economies, the Pooled Mean Group Autoregressive Distributed Lags (PMG-ARDL) model was used, which addresses the cross-sectional dependence, heterogeneity, and serial correlation issues commonly observed in panel data. Traditional fixed-effect/random-effect models distort parameter estimates in such data structures, leading to misleading standard errors and, consequently, erroneous conclusions. This is because traditional fixed- and random-effects models assume that the coefficients are the same across countries (slope homogeneity). If the coefficients are actually heterogeneous (which is often the case), this assumption is violated, and the parameter estimates and standard errors produced by traditional models become inconsistent and biased. This leads to completely incorrect results and policy recommendations (Pesaran et al., 1999).

To solve these problems, they developed their proposed PMG (ARDL) method. The formulation information is given below:

$$\Phi(L, p)y_t = \sum_{i=1}^k \beta_i (L, q_i)X_{it} + \delta w_t + u_t \quad (1)$$

L is a lag operator, and w_t is a $s \times 1$ vector of deterministic variables such as the intercept term, time trends, seasonal dummies, or delay lengths are predetermined deterministic/external components. $P = 0, 1, 2, \dots, m$, $q = 0, 1, 2, \dots, m$, $I = 1, 2, \dots, k$: namely a total of $(m + 1)^{k+1}$ different ARDL models. The maximum lag order, m , is determined by the researcher (Nkoro & Uko, 2016).

In this research, expenditures on Information and Communication Technologies (ICT) are used as the primary independent variable, while tourism income, export earnings, and foreign direct investment (FDI) are the dependent variables. Gross Domestic Product (GDP) serves as a control variable to account for general economic size. The empirical analysis utilises yearly data spanning 1995 to 2020, sourced from the World Bank database. Due to gaps in annual ICT expenditure records across several countries, the final sample consists of 12 developing countries with consistent data availability. All computations and statistical procedures were performed using Stata 14 software.

Table: 1
Cross-Sectional Dependence Test Result

Test Statistic	Probability Value
34.21	0.00*

Note: ***, **, * denote 1%, 5% and 10% significance levels.

Pesaran's (2004) CD test is highly effective at detecting cross-sectional dependence in panel data sets where the time dimension exceeds the cross-sectional dimension ($T > N$). According to the results presented in Table 1, the Pesaran (2004) test indicates the presence of cross-sectional dependence, as evidenced by a p-value of 0,001. Adopting this

methodology enables more robust and reliable inferences by accounting for interdependencies among cross-sectional units within the panel data structure.

Table: 2
CIPS Unit Root Test Result

Variables		Test Statistic-Fixed	Test Statistic-Fixed and Trend
ICT		-0,82	-1,61
Tourism		-1,47	-1,72
Export		-1,90	-1,66
FDI		-3,49*	-4,24*
GDP		-1,28	-1,73
CADF Critical Values	%10	-2,14	-2,66
	%5	-2,25	-2,76
	%1	-2,45	-2,96

Note: ***, **, * denote 1%, 5% and 10% significance levels.

The results of the Pesaran CIPS (2007) unit root test, as shown in Table 2, suggest that the time series is stationary when the test statistic exceeds the critical values in absolute magnitude. Among the variables examined, only FDI satisfies this condition at a level.

Therefore, for variables that do not initially exhibit stationarity, their first differences will be used in the analysis to achieve stationarity. This transformation helps ensure the robustness and statistical validity of the econometric model.

Table: 3
CIPS Unit Root Test Result (First Difference)

Variables		Test Statistic-Fixed	Test Statistic-Fixed and Trend
ICT		-3,50	-4,20
Tourism		-3,73	-3,74
Export		-3,89	-4,01
GDP		-3,68	-3,75
CADF Critical Values	%10	-2,14	-2,66
	%5	-2,25	-2,76
	%1	-2,45	-2,96

Given the panel structure with $T > N$, this study utilises the second-generation CIPS test developed by Pesaran (2007). In contrast to first-generation unit root tests, which assume cross-sectional independence, the CIPS test explicitly accounts for cross-sectional dependence, making it better suited to the dataset's characteristics. According to Pesaran's CIPS test (2007), the level values of the ICT, Tourism, Exports, and GDP variables exhibit unit roots and are therefore not stationary. However, the first differences of these variables were taken. It was concluded that they are stationary at a 1% statistical significance level.

Table 4
Variable Variance Test Result

Test Statistic	Probability Value
0,63	0,53

According to the Breusch-Pagan (1979) and Cook & Weisberg (1983) heteroskedasticity tests, the null of constant error variance cannot be rejected, as indicated

by p-values greater than 0,05. This outcome supports the assumption of homoscedasticity and, by extension, the model's statistical validity.

Furthermore, since the computed test statistic remains below the critical threshold, there is no evidence of significant heteroskedasticity within the dataset, reinforcing the robustness of the regression estimates.

Table: 5
Autocorrelation Test Result (Wooldridge Test)

Test Statistic	Probability Value
5,14	0,04

As shown in Table 5, the Wooldridge (2010) test yields a p-value below the 0,05 significance level, providing statistical evidence of autocorrelation in the model's error terms. This outcome indicates that serial correlation is present; hence, adjustments are required to address it and ensure the reliability and validity of the regression results.

Table: 6
A Model Selection (Breusch-Pagan Lagrangean Test and Hausman Test)

Tests	Test Statistic	Probability Value
Breusch-Pagan Test	116,42	0,00
Hausman Test	0,19	0,90

Table 6 presents the outcomes of the Breusch-Pagan Lagrangean Test (1979) and the Hausman specification test (1978), both conducted to determine the most suitable econometric model for the analysis. The first test produced a p-value of 0,00, indicating strong statistical support for choosing the random effects model over the pooled OLS alternative, as the result falls well below the conventional 5% significance level.

In the second test, the Hausman test yielded a p-value of 0,90, well above the 0,05 critical threshold, confirming that there is no significant difference between the random- and fixed-effects estimators. This outcome supports the selection of the random effects model as a valid specification for the panel data structure in question.

Table: 7
Pesaran, Yamagata Test Result

Delta	Probability Value
2,952	0,00
Adj. 3,38	0,01

As shown in Table 7, the Pesaran and Yamagata (2008) tests indicated heterogeneity when the p-values were less than 5%. This evidence confirms that the PMG-ARDL framework is capable of modelling heterogeneous short-term dynamics while predicting homogeneous long-term relationships, in a manner consistent with the data's structural properties.

Table: 8
PMG-ARDL Test Result

Dependent Variable	Long-Term ICT Coeff.	p-value (ICT)	Cointegration Coeff. (ec_term)	p-ec_term	Interpretation
Export	-1,62	0,04	-0,78	0,00	In the long term, ICT exports are declining but rapidly returning to equilibrium.
Tourism	-0,5593	0,00	-0,77	0,01	ICT spending is reducing tourism, but the balance is quickly being restored.
FDI	-1,5498	0,00	-1,83	0,00	ICT significantly reduces FDI; the adjustment is unstable and oscillatory.

Given detected cross-sectional dependence, heterogeneity, and serial correlation, the PMG-ARDL was adopted. It accommodates heterogeneous short-run dynamics while assuming homogeneous long-run relationships appropriate for the analysed variables. The effects of ICT on tourism, exports, and FDI were tested within this framework.

According to Table 8, ICT has a significant negative effect on export revenues (coefficient = -1,62, $p = 0,04$) and a strong return to equilibrium (cointegration coefficient = -0,78, $p = 0,00$). This indicates that ICT investments reduce exports in the long term, but the economy quickly returns to equilibrium. Tourism revenues are statistically significantly negatively affected by ICT (coefficient = -0,5593, $p = 0,00$). The speed of convergence to equilibrium is also significant (cointegration coefficient = -0,77, $p = 0,01$). ICT has the strongest negative effect on FDI (coefficient = -1,5498, $p = 0,00$).

The FDI model's error correction coefficient of -1.83 indicates an unstable, oscillatory adjustment process. While statistically significant, this coefficient suggests the system overshoots its long-run equilibrium rather than converging smoothly. In conclusion, ICT expenditures have a statistically significant inhibitory effect on all variables. While the Export and Tourism models demonstrate stable and rapid convergence to equilibrium (ec_term = -0.78 and -0.77, respectively), the FDI model exhibits an oscillatory adjustment dynamic, suggesting greater instability in foreign capital flows in response to ICT shocks.

4. Conclusion and Recommendations

Information and communication technologies (ICT) expenditures refer to the total monetary value of digital products/services, such as information technology services (software development, telecommunications infrastructure), consultancy activities, data processing solutions, and similar digital products/services, that a country provides abroad. In this context, ICT expenditures are considered a critical indicator of a country's competitive capacity and technological maturity in the global digital economy.

Using the PMG-ARDL approach, the long- and short-term dynamics between ICT expenditures and key economic indicators, including tourism revenues, export revenues, and foreign direct investment (FDI) inflows, were analysed using panel data from 12 developing countries spanning 1995-2020. The PMG-ARDL approach, which is robust to cross-sectional dependence, heterogeneity, and serial correlation, revealed a consistent and statistically significant negative long-term relationship between ICT investments and the

three dependent variables. Specifically, ICT expenditures were found to have a significant negative impact on export revenues (coefficient = -1.62, $p = 0.04$), tourism revenues (coefficient = -0.5593, $p = 0.00$), and FDI inflows (coefficient = -1.5498, $p = 0.00$). These results contradict the majority of the existing literature, which generally suggests a positive link between ICT and economic performance (e.g., Kumar & Kumar, 2012; Tsaurai & Chimbo, 2019; Adeola & Evans, 2020; Choudhary et al., 2020).

The most important finding of the analysis is that the error correction mechanism ECT is significant in all models. This proves that there is a long-term equilibrium relationship between the variables. The transition to this equilibrium is quite robust in the Export and Tourism models. The coefficients are -0.78 and -0.77, respectively. These values are theoretically within the ideal range. This can be interpreted as follows: 78% of the imbalance from the previous year is corrected in exports and 77% in tourism in the following year. In short, these two sectors stably return to equilibrium after shocks. The FDI model, however, presents a very different picture. The error correction coefficient is -1.83. A coefficient below -1 does not mean a faster correction. On the contrary, it indicates an unstable, oscillatory adjustment process. The system overshoots its target and overreacts as it tries to return to equilibrium.

If interpretation is required for the observed negative long-term effects, this situation may reflect that, for Exports and FDI, the adoption of ICT in the developing economies examined during this period may have high upfront costs, skill mismatches, or disruptive effects that outweigh productivity gains. The negative impact on Tourism may indicate insufficient integration of digital infrastructure in the sector (e.g., delays in adopting dynamic pricing, data analytics, or seamless online experiences), the potential substitution effects of virtual alternatives, or increased competition eroding revenues despite the growth of digital marketing. Deviations from studies reporting positive effects highlight the context-dependent nature of ICT's impact, which can be influenced by the stage of development, sectoral structure, complementary investments, or policy frameworks in emerging example countries.

In conclusion, although ICT is widely regarded as a driving force for growth, this PMG-ARDL analysis reveals a significant negative long-term relationship between ICT expenditures and tourism, exports, and foreign direct investment in the developing economies examined. While the Export and Tourism models demonstrate stable convergence to equilibrium, the oscillatory adjustment in the FDI model highlights the fragility of foreign capital flows in developing economies, collectively necessitating a strategic reassessment of ICT investment policies. It is crucial to emphasise complementary investments, targeted sectoral support, and a robust enabling environment to unlock ICT's positive potential and mitigate the negative effects identified in this study. Future research could develop integrated metrics that assess not only economic outcomes but also the impact of ICT-driven structural changes on social welfare and environmental sustainability.

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