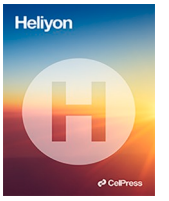
Heliyon 9 (2023) e13505

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon



Research article

Re-examining the tourism-led growth nexus and the role of information and communication technology in East Asia and the Pacific

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ARTICLE INFO

JEL classification:
L8
L81
L83

Keywords:
ICT usage
Tourism
Economic growth
Quantile regressions
Moderation modelling
EAP

ABSTRACT

This study revisits the tourism-led growth discourse and differs from the existing literature to examine if information and communications technology (ICT) moderates the relationship between tourism and economic growth in East Asia and the Pacific. Using data on 33 selected countries, the study deploys the Driscoll and Kraay (1998) [1] panel spatial correlation consistent (PSCC) approach, Machado and Santos Silva (2019) [2] method of moments quantile regression (MMQR) and Arellano and Bond (1991) [3] generalized method of moments (GMM) technique. Using a composite ICT index on four indicators ((mobile phones, fixed telephones, fixed broadband, and secured internet servers) derived from the Principal Component Analysis (PCA), the results which are mostly consistent across the three estimation methods reveal, among others, that (1) ICT moderates the tourism-growth path and the effect is positive and statistically significant; (2) the moderation effect is consistently positive across all quantiles of $Q_{0.25}$, $Q_{0.50}$ and $Q_{0.75}$; (3) the results are sustained when omitted variables (growth enablers) – institutions, R&D, and human capital – are accounted for. Policy recommendations are discussed.

1. Introduction

This study takes a new position and revisits the tourism-led growth discourse to highlight whether ICT moderates the tourism-growth path. It fills a gap in the literature to examine the interaction effect of ICT and tourism on economic growth. Existing studies have independently established a positive relationship between tourism and economic growth. That is, tourism is an enabler of growth [4–10]. Similarly, the growth-enhancing impact of ICT is well documented [11–16]. However, the moderation[1] effect of ICT and tourism on economic growth is sparsely explored which drives the motivation for this study.

The study motivation is premised on the assumption that an ICT-driven tourism sector stimulates growth in East Asia and the Pacific which is a known choice-tourist destination and adds a new shade to the tourism-growth argument for the region. That is, given the convenience that ICT usage brings, the conjecture is that tourists will be able to make adequate travel plans and arrangements without difficulties. The conceptual framework supporting how ICT influences the impact of tourism on economic growth is depicted in Fig. 1. It is clear from the schema that ICT can stimulate the nexus between tourism and economic growth. This is essentially because ICT tools can be deployed by individuals and corporate organisations to make travel plans from the comforts of their homes and offices reducing cost and turnaround time. It is expected that an ICT-enabled tourism sector will create the incentives for individuals and

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[1] Moderation and interaction are synonymous and therefore, used interchangeably.

https://doi.org/10.1016/j.heliyon.2023.e13505
Received 21 December 2022; Received in revised form 26 January 2023; Accepted 1 February 2023
Available online 8 February 2023

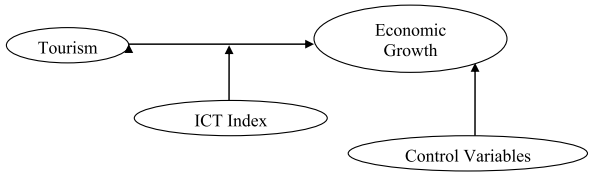

Fig. 1. Schema on the role of ICT in the tourism-led growth nexus.

corporate organisations to set tourism adventures which boost economic activities for the home and destination countries.

This paper contributes to the sparse literature on the ICT-tourism interaction on economic growth in East Asia and the Pacific using sample of selected 33 countries from 2010 to 2020. The variables used are real per capita gross domestic product (a measure of economic growth), tourism receipts, and a composite index of four ICT indicators (mobile phone usage per 100 people, fixed telephone users per 100 people, fixed broadband users per 100 people and secured Internet servers). The index is derived from the Principal Component Analysis. To situate the study within the extant literature, this study infuses the models of Tang and Tan [17], and Song and Wu [18] to make novel contributions to the literature which is to (1) examine whether the moderation effect of ICT and tourism is significant on economic growth, and (2) determine if the results are sustained when omitted variables are accounted for. Deploying the PSCC, MMQR, and GMM techniques, for the most part the results are consistent across all estimators and reveal that (1) the moderation effect is positive and statistically significant from the mean and quantile regressions; and (2) the results are sustained when growth enablers (institutions, R&D, and human capital) are included in the models. The rest of the paper is structured as follows: review of literature in Section 2; data and model in Section 3; analysis and results interpretations in Section 4; and conclusion with policy recommendations in Section 5.

2. Literature review

2.1. Theoretical review

The theoretical discourse on the tourism-led growth relation is summarised in this section. Balaguer and Cantavella-jordá [19], and Brida, Cortés-Jiménez [20] hypothesise the connexions between inbound tourism and economic growth which is drawn on the conjecture that growth is export-driven. This hypothesis is supported by the "new export-growth" theory of Balassa [21]. Other protagonists of the export theory are Krueger [22], Grossman and Helpman [23], and Ghirmay, Grabowski [24]. The commonness among these studies is that exports stimulate economic growth via increase in investment which in turn causes internal and external competitiveness, creation of positive spill overs and technological diffusion. This connection is due to several factors which includes the easing of foreign exchange restrictions to boost exports [25]. In essence, the ability of tourism to generate revenues and boost economic growth classifies it as a non-traditional type of export good. Equivalently, tourism stimulates economic growth [5,17, 26–30].

2.2. Empirical review

The literature on the tourism-led growth [17,18,31] and ICT-growth relationships is well documented [32–39]. Both tourism activities and ICT development are growth enhancers and several studies have drawn the connections and this section undertakes a review of some of these. Contingent on the variables, study scope, and estimation techniques used the empirical findings are diverse regarding the nature of relationships. The lack of a consensus on the exact nature of associations gives the suggestion that the research area involving these three phenomena needs more scientific examinations.

On the tourism-growth empirical relation, Min, Roh [40] conclude development in telecom and transportation sectors increases the revenue-generating effect of tourism on economic growth. Nepal, Indra al Irsyad [41] show that economic growth boosts expansion in in tourist arrivals [4]. Similar to Antonakakis, Dragouni [42], Brida, Matesanz Gómez [43] find evidence to support of the tourism-led-growth hypothesis. Also, Scarlett [5] finds that tourism has a significant positive impact on growth and it is one of the enablers of economic recovery [44]. Chen, Cui [26] reveal that for Belt Road Initiative (BRI) countries, economic growth is an important input to tourism development. Also, Croes, Ridderstaat [6] show that tourism exerts a short-run impact on economic growth and a negative and indirect link to human development in Poland. Analysing the link between tourism and economic vulnerability index (EVI), Canh and Thanh [45] explain that tourism expenditures have significant negative effect on EVI particularly for low- and lower-middle-income countries. On growth resilience and resurgence in Europe, Romao [8] finds that a positive tourism-growth relation exists more so when combined with agriculture. Castilho, Fuinhas [7] find that tourism arrivals reduce eco-efficiency in the short- and long-run for 22 Latin America and the Caribbean countries while eco-efficiency improves in the long-run from tourism capital investment. In China, Tu and Zhang [27] find a nonlinear tourism-growth relationship and on a panel of 96 countries, Lv [46] reveals similar non-linear U-shaped tourism relation with the informal sector.

Examining the ICT-tourism and growth nexus, Gössling [47] showed that global tourism has been transformed by ICT such that modern medium of communication has positively impacted society and business structures with multiplier effects on economic growth. Similarly, Anser, Adeleye [32] revealed that ICT has a significant positive effect on tourism and the ICT-services trade

interaction boosts tourism growth [48]. According to Tan, Lee [49], ICT provides the enabling platform for tourism to thrive as it allows tourists the convenience of making payments to cater for logistics [50]. In the same vein, Law, Chan [51] show that digital telecom is an indispensable means for tourists to book reservations, meet locals, get information about weather, foods and historical tourists sites [33,52,53]. Kumar and Kumar [38] show that ICT increase tourist arrivals by 0.04% and 0.11%, respectively. Similarly, Kotiloglu, Lappas [54] reveal that ICT enable tourist find tourist guides, locate tourist sites and create the ability to interact with locals [55]. Likewise, Adeola and Evans [36] conclude that a positive ICT-tourism relationship exists [56,57]. For the most part, there seem to be a consensus that both ICT and tourism are enablers of economic growth, but none showed if a moderation effect exists to influence or dampen economic growth which is a clear distinction between the current study and those reviewed. Thus, this study uses the theoretical and empirical expositions to test a conditional hypothesis that ICT moderates the effect of tourism on economic growth.

3. Scope, data and model

The scope is 33 selected countries[2] East Asia and the Pacific region from 2010 to 2020. Eleven variables obtained from World Bank [58] World Development Indicators are used in addition to six institutional indicators from World Bank [59] World Governance Indicators. The inclusion of a country in the sample is subject to such having sufficient data points on the main variables of interest – real per capita GDP, tourism receipts, and ICT indicators (mobile phone usage per 100 people, fixed telephone users per 100 people, fixed broadband users per 100 people and secured Internet servers). That is, the selection of countries and coverage years is driven by data availability constraints at the time of the study. Precisely, most countries show significant loss in these variables pre-2010 years (see Appendix Table 1A).

3.1. Variables and expectations

The dependent variable and proxy for economic growth is real per capita GDP (*RPC*) which controls for inflation and population size. The main independent variable is tourism receipts (*TRCP*) used to measure revenue outcomes. The second independent variable which is the moderating variable is a composite index of ICT indicators derived using the Principal Component Analysis (PCA) given the strong correlation among them. In line with the extant literature [11,16,60–65], the ICT variables are: mobile phone subscription per 100 people (*MOB*), fixed telephone subscription per 100 people (*FTEL*), fixed broadband subscription per 100 people (*FXB*), and secure Internet servers per million people (*SEV*). In line with the growth literature, the following control variables are included: individuals using the Internet (*NET*), gross fixed capital formation (GFCF), and labour force participation (*LAB*), an index of institutional quality (INST), research and development (R&D), and human capital (HC) proxied by tertiary school enrolment. Lastly, to satisfy the main objective of this study, we add the interaction of tourism receipts with the composite ICT index *(TRCP *ICT)* to determine if the moderation effect is significant on growth. See Table 1 for variables details.

On *a priori* expectations, tourists' activities generate tourism revenues which boost economic growth [42,43,66]. As documented in the literature, ICT usage and penetration is expected to ease the way and manner individuals socialise and engage in both domestic and international transactions which is expected to have a positive impact on the economy [32,67,68]. Internet usage is controlled for because at the minimum, it is expected to increase turnaround time with improved productivity. This is due to the ability to access emails, news and data files across several communication channels including the world wide web [69,70]. Also, gross fixed capital formation is the proxy for investment which represents factor inputs needed to spur economic growth [71]. Labour is another factor of production required to work the machineries and boost average productivity [72–74]. Institutional quality is a growth enabler as social infrastructure contributes to capital accumulation [75–77]. R&D births innovation with direct impact on economic growth [78]. From Mankiw, Romer [79] human capital is essential for growth [80–82].

3.2. Empirical model

According to Coe and Helpman [78], the determinants of economic growth are inexhaustive. Thus, this study builds its empirical model from three sources. First is the neoclassical model of Mankiw, Romer [79], where technology (which includes ICT) is considered a growth enabler in addition to labour and capital, that is:

$$Y_{i,t} = K_{i,t}^{\alpha}\left[A_{i,t}L_{i,t}\right]^{1-\alpha}, 0 < \alpha < 1 \tag{1}$$

Where, Y = economic growth, K = capital, L = labour, A = is the technological parameter affecting productivity; α = factor contribution to output, i,t = cross-sectional and time dimensions of the data.

Next, are the adaptation of Tang and Tan [17] and Song and Wu [18] that define economic growth as a function of labour, capital, tourism and other control variables as indicated in Equation [2]:

$$Y_{i,t} = f\left(K_{i,t}, L_{i,t}, T_{i,t}, \boldsymbol{Z}\right) \tag{2}$$

Where, T = tourism, $\boldsymbol{Z}$ = vector of control variables

[2] Countries and classifications are listed in Appendix Table 1B.

Table 1
Variables description, expectation and source.

Variables	Expectation	Source
GDP per capita (constant 2015 US$)	N/A	WDI
International tourism, receipts (% of total exports)	+	-do-
Gross fixed capital formation (constant 2015 US$)	+	-do-
Labor force participation rate, total (% of total population ages 15–64) (modeled ILO estimate)	+	-do-
Individuals using the Internet (% of population)	+	-do-
ICT Composite Index	+	Author from WDI
Institutions Composite Index	+	Author from WGI
Research and development expenditure (% of GDP)	+	WDI
School enrollment, tertiary (% gross)	+	-do-

Note: Principal Component Analysis (PCA) used to obtain composite index for indicators of ICT (mobile phones, fixed telephones, fixed broadband, and secured Internet servers) and Institutions (control of corruption, rule of law, regulatory quality, government effectiveness, political stability, and voice and accountability).
Source: Author's Compilations.

With the variables defined in Section 3.1, this study draws from Equations (1) and (2) to express economic growth as a function of capital formation, labour force, internet users, tourism, and technology. Given the contribution of this paper, the model specification is improved with the inclusion of an interaction term, *TRCP*ICT* to capture the moderation effect such that the equation is specified as:

$$\ln PC_{it} = \eta_0 + \eta_1 \ln GFCF_{it} + \eta_2 \ln LAB_{it} + \eta_3 \ln NET_{it} + \eta_4 \ln TRCP_{it} + \eta_5 ICT_{it} + \eta_6 (\ln TRCP * ICT)_{it} + (\alpha_i + e_{it}) \quad (3)$$

where, ln = natural logarithm; *PC* = real per capita GDP; *GFCF* = capital formation; *LAB* = labour; *TRCP* = tourism receipts; *ICT* = proxy for technology obtained from constructing a composite index of four ICT indicators; η_i = parameters to be estimated; α_i = time-invariant unobserved heterogeneous region-specific fixed effects; and = error term. Equation (3) is the baseline model designed to test the conditional hypothesis of the moderation effect of ICT and tourism on economic growth [14,83,84].

Note, on the expectations that $\eta_4 > 0$ and $\eta_5 > 0$, η_6 which is the coefficient of the interaction term measures if the interaction of ICT and tourism exerts a significant effect on economic growth. If $\eta_6 = 0$ it implies that the interaction of ICT and tourism has no effect on economic growth. However, a positive (negative) interaction coefficient shows that ICT improves (distorts) the performance of tourism on growth. Hence, ICT *moderates* the effect of tourism on growth as shown in Equation (4):

$$\frac{\partial \ln PC}{\partial \ln TRCP} = \eta_4 + \eta_6 ICT \quad (4)$$

For robustness checks, Equation [3] is included to account for growth enablers (*INST*, *R&D*, and *HC*) initially omitted from the model specification in a bid to ascertain the consistency of the parameter of the interaction term, η_6.

3.3. Estimation techniques

Additional novelty of this study is the deployment of static and dynamic techniques which serve as robustness checks to ascertain the consistency of the coefficient of the main parameter of interest, η_6. Firstly, given the presence of cross-sectional dependence, the panel spatial correlation consistent (PSCC) developed by Driscoll and Kraay [1] is augmented with the infusion of the least squares dummy variables (LSDV) in a bid to control for fixed effects. The *PSCC-LSDV* recognises the inherent heterogeneities of the countries. It assumes that the cross-sections have similar characteristics (for instance, countries located within the same region, belong to the same economic community, etc.) and independent errors. From Torres-Reyna [85] and Baum [86], the LSDV approach permits the effect of *TRCP* be mediated by the differences across cross-sectional units in the panel using dummy variables. By including region[3] dummies, the pure effect of *TRCP* is estimated having controlled for unobserved heterogeneity. Essentially, each dummy absorbs the effects particular to each sub-region.[4] Among others, the PSCC approach controls for heteroscedasticity and serial correlation [87]. One-period lag is included in the underlying procedure to address the problem of causality and endogeneity.

Given that the PSCC-LSDV approach is concerned with just the conditional mean regression of *PC*, this study controls for distributional heterogeneity using novel method of moments quantile regression (MMQR) developed by Machado and Santos [88].[5] The approach which is gaining traction in the empirical literature [32,89,90] is robust for handling fixed effects in panel quantile models and allows for the estimation of other aspects of the conditional distribution (25th, 50th, and 75th quantiles) of the dependent variable. Finally, given that GDP per capita is highly dependent on its past requires a dynamic specification of the relationship. Therefore Equation ([3) is re-specified with the inclusion of the lagged *PC* as a regressor to measure the degree of persistence. The augmented

[3] Additional robustness check is done using income group dummies. We provide these results upon request.
[4] Two region dummies rather than 33 country dummies are used as the latter will significantly weaken the efficiency of the estimator. The dummy for East Asia is the base region dummy variable.
[5] Interested reader is referred to 2. Machado, J.A.F. and J.M.C. Santos Silva, *Quantiles* via *moments*. Journal of Econometrics, 2019. **213**(1): p. 145–173. for detailed econometric specification of the model.

model is estimated using Arellano and Bond [3] system generalized method of moments (sys-GMM) designed for short panel analysis. Two specification tests put forward by Arellano and Bond (1991) to examine the validity of the instruments used in the underlying algorithm. The first is the Hansen statistic and second-order serial correlation *AR* (2). Not rejecting the null hypotheses of *over--identifying* restrictions, and no second-order serial correlation gives credibility to the results.

4. Results and discussion

4.1. Summary statistics and pairwise correlation

Table 2 shows the historical properties (upper panel) among the variables using their raw forms. With emphasis on the indicators of interest, the average per capita income is US$14′830.49. The standard deviation of 19908.30 shows wide deviation from the sample average. US$22.95 billion is the mean tourism receipts with a standard deviation of 26.57 billion indicating that the countries are widely dispersed from the sample mean. The ICT index has a zero mean with a standard deviation of 1.543. The lower panel of Table 2 informs about the pairwise correlation between each pair of variables and all reveal positive and statistically significant association with PC. A cursory look at the relationships shows that the correlation coefficient between ICT/INST and ICT/HC are 0.779 and 0.782, respectively. Likewise, the coefficient between INST/HC is 0.757. The study controls for multicollinearity by using INST and HC in separate models. More so, the variance inflation statistics for the models are between 3.72 and 8.45 (see lowest panel of Tables 3 and 4 for diagnostics) which indicates that multicollinearity is not a concern. Also, the evidence of cross-sectional dependence from the Pesaran [91] which supports the use of the PSCC approach is shown in the lowest panel of Tables 3 and 4

4.2. Empirical results and discussions

Table 3 displays the composite results from the PSCC-LSDV and MMQR techniques. Starting with the control variables, the coefficient of capital formation is negative and statistically significant at the 1% level. It implies a percentage increase in capital formation is associated with a 0.09% decline in economic growth, on average, *ceteris paribus*. This finding supports Adeleye and Eboagu [15] and Santiago, Koengkan [92] but contradicts Mankiw, Romer [79]. Like previous studies [12,93–95], Internet usage show a statistically significant positive effect on growth. The relationship implies that a percentage change increases growth by 0.49%, on average, *ceteris paribus*. With the inclusion of interaction term, $\ln TRCP * ICT$ in the model, the constitute terms cannot be interpreted independently. Hence, only the coefficient of the interaction term is relevant [96]. Similar to Hussain, Batool [97] who derived a composite ICT index, the results show that ICT positively moderates the effect of tourism on economic growth by. This finding is consistent across the quantiles, and it improves the conjecture in the tourism-led growth literature [17,18,98]. The positive interaction coefficient indicates that ICT is a growth-enabler and provides a springboard to launch developmental progress [99]. Lastly, the coefficient of the PACIFIC dummy variable which captures the differential intercept indicates that oceanic countries exhibit high growths than East Asian counties by 0.155. The constant term represents the intercept for the base region (East Asia).

Controlling for omitted variables, Equation (3) is modified to include an indicator of institutions, R&D, and human capital to observe if the positive and significant moderating effect of ICT and tourism on economic growth is sustained. The composite results are displayed in Table 4 and columns 1 to 3 relate to the PSCC-LSDV analysis while columns 5 to 12 are from the MMQR technique. From column 1, the coefficient of INST (0.355) is positive and statistically significant at the 1% level confirming previous studies that assert the importance of institutional quality to nation building [75,76,100]. From MMQR, the coefficient is positive and significant across all quantiles. From column 2, the coefficient of R&D (0.472) is positive and statistically significant at the 1% level supporting the literature that R&D is a precursor for innovation with positive outcomes on growth [78]. Except at the 0.25 quantile, evidence of a significant positive effect of R&D is shown at the 0.50 and 0.75 quantiles. Column 3 provides evidence on the positive effect of HC on growth with a positive and significant coefficient of 0.0075 which aligns with the literature [79,101,102]. Across the quantiles, the positive and significant relationship is evident. Having controlled for omitted variables, the positive and significant moderation effect of ICT and tourism on economic growth is evident across all the model specifications. On the region dummies, the positive differential intercept of countries in the PACIFIC region relative to countries in East Asia is evident in the R&D and HC models at 0.636 and 0.193, respectively.

Finally, we examine the ICT-tourism-growth relationship using the dynamic GMM approach to ascertain if the positive moderation effect is sustained when the persistency of economic growth is accounted for. The results displayed in Table 5 showed analyses for the baseline model specified in Equation (3) and the expanded models containing three omitted variables (INST, R&D, and HC) that are growth enablers. Starting with the diagnostics, all four models passed the Hansen instruments identification and second-order serial correlation tests with p-values above 0.05. However, only two (baseline and INST) of the four models met the "Group/Instruments" criteria.[6] From columns 1 and 2, economic growth is persistent with positive and statistically significant coefficient at the 1% level. This outcome supports the conjecture that past realisation of growth drives the current realisation. While the control variables (LAB and NET) are significant albeit with negative coefficients, the coefficient of INST is positive and significant at the 1% level. Most importantly, the results show that the ICT-tourism moderation effect is positive and significant at the 1% level across both models. Overall, within the ambit of the scope, variables, techniques of estimation and accounting for omitted variables, this study provides

[6] Due to extensive missing observations for R&D and HC variables, the number of instruments exceed the number of Groups. Hence, to avoid misleading readers, the results are displayed in Appendix Table 1C.

Table 2
Summary statistics and pairwise correlation analysis.

Variables	PC	TRCP	ICT Index	GFCF	LAB	NET	INST	R&D	HC
Observations	353	286	298	248	260	299	348	124	175
Mean	14830.498	22.952	0	1.38 E+11	70.349	45.931	0	1.394	52.057
Std. Dev.	19908.303	26.566	1.543	3.75 E+11	10.007	29.944	2.026	1.283	30.162
Minimum	888.913	0.019	−1.969	17872504	46.42	0.25	−4.972	0.032	11.763
Maximum	98751.816	101.26	5.28	4.66 E+12	87.98	96.505	4.398	4.814	143.93
Pairwise Correlation									
(1) lnPC	1.000								
(2) lnTRCP	−0.058	1.000							
(3) ICT Index	0.890***	−0.114*	1.000						
(4) lnGFCF	0.559***	−0.539***	0.643***	1.000					
(5) lnLAB	0.188***	0.067	0.311***	0.301***	1.000				
(6) lnNET	0.758***	0.011	0.727***	0.625***	0.200***	1.000			
(7) INST Index	0.864***	−0.003	0.779***	0.404***	0.100	0.706***	1.000		
(8) R&D	0.426***	−0.424***	0.452***	0.729***	0.145	0.559***	0.412***	1.000	
(9) HC	0.744***	−0.012	0.782***	0.434***	0.075	0.582***	0.757***	0.454***	1.000

Note: ***p < 0.01, **p < 0.05, *p < 0.1; ln = Natural logarithm, GFCF = Gross fixed capital formation; LAB = Labour force participation rate; NET = Individuals using the Internet; TRCP = Tourism receipts; ICT Index = Composite index of ICT variables; INST = Composite index of institutions variables; R&D = Research & Development; HC = Human capital.
Source: Author's Computations.

Table 3
Main results from PSCC-LSDV and MMQR analysis.

Variables	PSCC-LSDV	MM-QR		
	Mean	$Q_{0.25}$	$Q_{0.50}$	$Q_{0.75}$
lnGFCF	−0.0868***	−0.126	−0.104*	−0.085***
	(-5.418)	(0.119)	(0.056)	(0.016)
lnLAB	−0.265	−0.992	−0.554	−0.172
	(-0.695)	(1.743)	(0.818)	(0.244)
lnNET	0.491***	0.355	0.365*	0.374***
	(5.460)	(0.400)	(0.187)	(0.054)
lnTRCP	−0.114**	−0.247	−0.158	−0.080**
	(-2.746)	(0.234)	(0.110)	(0.034)
ICT	0.414***	0.012	0.098	0.172***
	(8.715)	(0.401)	(0.188)	(0.056)
lnTRCP*ICT	0.110***	0.183*	0.133***	0.090***
	(8.629)	(0.107)	(0.050)	(0.016)
PACIFIC	0.155***			
	(2.942)			
Constant	10.47***	15.271*	12.917***	10.869***
	(6.258)	(7.813)	(3.671)	(1.110)
Observations	186	186	186	186
R-squared	0.871			
CSD/VIF	10.528***/3.72			
Countries	24			
F-Statistic	2511			

Note: ***p < 0.01, **p < 0.05, *p < 0.1; *t*-statistics in parentheses for PSCC-LSDV analysis; standard errors in parentheses for MM-QR analysis; ln = Natural logarithm, GFCF = Gross fixed capital formation; LAB = Labour force participation rate; NET = Individuals using the Internet; TRCP = Tourism receipts; ICT Index = Composite index of ICT variables; PSCC = Panel spatial correlation consistent; LSDV = Least squares dummy variables; MMQR = Method of moments quantile regression; CSD = Cross-sectional dependence; VIF = Variance inflation factor.
Source: Author's Computations.

sufficient evidence and makes an innovative contribution to the tourism-growth literature that ICT improves the effect of tourism on economic growth. That is, subjecting the tourism-led growth hypothesis to various empirical techniques (*PSCC*, *MMQR*, and *GMM*) provides some compelling evidence that ICT is a critical determinant of growth [103–105] and a new incursion to the ICT-tourism-growth literature.

5. Conclusion and policy recommendations

This study expands the ICT-tourism-growth literature to examine the relevance of ICT on the tourism-led growth nexus. The set of variables comprise real per capita GDP, tourism receipts and ICT index derived from four ICT indicators (mobile phones, fixed telephones, fixed broadband, and secured servers) using Principal Component Analysis (PCA). The data is an unbalanced panel data of 33

Table 4
Robustness checks (omitted variables of growth enablers).

Variables	INST	R&D	HUM. CAP.	INSTITUTIONS			R & D			HUMAN CAPITAL		
	PSCC-LSDV Mean Regressions			$Q_{0.25}$	$Q_{0.50}$	$Q_{0.75}$	$Q_{0.25}$	$Q_{0.50}$	$Q_{0.75}$	$Q_{0.25}$	$Q_{0.50}$	$Q_{0.75}$
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
lnGFCF	−0.0248**	−0.137***	−0.0912***	−0.040***	−0.048***	−0.054***	−0.195***	−0.177***	−0.154***	−0.142***	−0.127***	−0.100***
	(-2.324)	(-4.327)	(-5.050)	(0.014)	(0.012)	(0.012)	(0.073)	(0.052)	(0.045)	(0.023)	(0.021)	(0.023)
lnLAB	−0.169	−0.0383	−0.275	−0.680***	−0.480***	−0.327*	−0.373	−0.453	−0.547	−0.354	−0.188	0.106
	(-1.176)	(-0.0794)	(-1.425)	(0.206)	(0.175)	(0.180)	(1.249)	(0.894)	(0.768)	(0.419)	(0.380)	(0.407)
lnNET	0.177***	0.282**	0.482***	0.131***	0.161***	0.184***	0.338*	0.326***	0.312***	0.399***	0.401***	0.404***
	(3.307)	(2.629)	(4.895)	(0.040)	(0.034)	(0.035)	(0.173)	(0.123)	(0.106)	(0.062)	(0.056)	(0.060)
lnTRCP	−0.0843**	−0.194**	−0.130**	−0.152***	−0.113***	−0.083***	−0.456***	−0.427***	−0.393***	−0.179***	−0.135***	−0.058
	(-2.695)	(-2.512)	(-2.236)	(0.029)	(0.025)	(0.025)	(0.164)	(0.117)	(0.101)	(0.044)	(0.042)	(0.043)
ICT Index	−0.0450**	0.0142	0.221***	−0.151***	−0.163***	−0.173***	−0.182	−0.275**	−0.387***	0.060	0.060	0.062
	(-2.299)	(0.181)	(3.536)	(0.048)	(0.040)	(0.042)	(0.167)	(0.122)	(0.105)	(0.057)	(0.051)	(0.055)
lnTRCP*ICT	0.150***	0.247***	0.141***	0.150***	0.157***	0.161***	0.264***	0.291***	0.323***	0.147***	0.138***	0.121***
	(25.81)	(5.784)	(5.469)	(0.017)	(0.014)	(0.015)	(0.082)	(0.059)	(0.050)	(0.022)	(0.020)	(0.021)
INST Index	0.355***			0.266***	0.277***	0.285***						
	(24.85)			(0.024)	(0.020)	(0.021)						
R&D		0.472***					0.188	0.282***	0.394***			
		(7.761)					(0.141)	(0.103)	(0.089)			
HC			0.00747***							0.005**	0.004**	0.003*
			(3.967)							(0.002)	(0.002)	(0.002)
PACIFIC	−0.0477	0.636***	0.193***									
	(-0.990)	(21.69)	(2.926)									
Constant	9.811***	10.89***	10.26***	12.503***	11.848***	11.349***	14.894***	14.900***	14.906***	12.464***	11.485***	9.760***
	(16.46)	(8.484)	(7.995)	(0.932)	(0.788)	(0.816)	(4.752)	(3.397)	(2.918)	(1.669)	(1.525)	(1.623)
Observations	185	100	128	185	185	185	100	100	100	128	128	128
R-squared	0.946	0.880	0.895									
CSD/VIF	6.687***/4.35	2.895***/8.45	0.193/3.81									
Countries	23	15	18									
F-Statistic	52567	4716	945.3									

Note: ***p < 0.01, **p < 0.05, *p < 0.1; *t*-statistics in parentheses; ln = Natural logarithm, GFCF = Gross fixed capital formation; LAB = Labour force participation rate; NET = Individuals using the Internet; TRCP = Tourism receipts; ICT Index = Composite index of ICT variables; INST Index = Composite index of institutions variables; R&D: Research & Development; CSD = Cross-sectional dependence; VIF = Variance inflation factor.
Source: Author's Computations.

Table 5
Results from GMM analysis.

Variables	[1]	[2]
lnPC, lag	0.992***	0.837***
	(125.609)	(20.981)
lnGFCF	−0.005	0.011
	(-1.131)	(1.065)
lnLAB	−0.267***	−0.404**
	(-3.114)	(-2.446)
lnNET	−0.004	−0.040*
	(-0.250)	(-2.015)
lnTRCP	−0.049***	0.016
	(-4.086)	(0.950)
ICT Index	−0.035**	−0.018
	(-2.384)	(-0.749)
lnTRCP*ICT	0.017***	0.031***
	(3.339)	(4.136)
INST Index		0.064***
		(3.700)
Constant	1.487***	3.054***
	(4.415)	(3.590)
Observations	114	168
Groups/Instruments	17/17	23/16
AR (2) p-value	0.319	0.316
Hansen p-value	0.118	0.422
F-Statistic	3.09 E+08	353450.2

Note: ***p < 0.01, **p < 0.05, *p < 0.1; *t*-statistics in parentheses; ln = Natural logarithm, GFCF = Gross fixed capital formation; LAB = Labour force participation rate; NET = Individuals using the Internet; TRCP = Tourism receipts; ICT Index = Composite Index of ICT variables; INST Index = Composite index of institutions variables; GMM = Generalized method of moments.
Source: Author's Computations.

East Asia and the Pacific countries from 2010 to 2020. A battery of econometric techniques which includes PSCC-LSDV, MMQR and GMM are applied to explain the intrinsic relationship. For the most part, the consensus is that the interaction effect is positive and statistically significant at the 1% across all the techniques. The finding is sustained when omitted variable that are growth enablers are accounted for. Given these submissions, we recommend that the government and stakeholders in these countries embrace the following policy directives.

1) Make the tourism sector more attractive to drive more tourism arrivals and revenues.
2) Take advantage of the leapfrog potentials of ICT on economic growth most especially for mobile phones subscription and usage.
3) Partner with the private sector to develop the tourism-enhancing attributes of ICT.
4) Subsidise the cost of owning a mobile phone and importantly reduce the cost of Internet connectivity without which the growth-enhancing effect of ICT is substantially reduced.
5) Promote an *e*-tourism platform such that the gains from tourism will have far-reaching multiplier effects on economic growth.

For further research, foreign direct investment (FDI) is crucial to the tourism sector and economic growth. Hence, subject to data availability the role of FDI in influencing the tourism-growth nexus in Asia may be taken up. Also, comparative analysis of countries with high ICT index and low ICT index may be considered for a larger sample of countries extending beyond EAP countries.

Declarations

Author contribution statement

Bosede Ngozi ADELEYE, PhD: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare no conflict of interest.

Appendix A

Table 1A
Variables and Percentage of Missing Values

Variables/Scope	2000–2020	2000–2009	2010–2020
Total Observations	**693**	**330**	**363**
GDP per capita (constant 2015 US$)	3.75	4.85	2.75
International tourism, receipts (% of exports)	24.68	28.48	21.21
Mobile cellular subscriptions (per 100 people)	7.79	7.58	7.99
Fixed broadband subscriptions (per 100 people)	20.92	29.7	12.95
Fixed telephone subscriptions (per 100 people)	6.78	4.55	8.82
Secure Internet servers (per 1 million people)	49.35	100	3.31
Individuals using the Internet (% of population)	14.46	10.91	17.63
Labour force participation rate, total (% of total population ages 15–64)	24.96	21.21	28.37
Gross fixed capital formation (constant 2015 US$)	37.09	43.03	31.68
Institutions Composite Index	Not Applicable		
Research and development expenditure (% of GDP)	65.37	64.85	65.84
School enrolment, tertiary (% gross), proxy for Human Capital	53.68	55.76	51.79

Source: Author's Computations from World Bank (2022) World Development Indicators.

Table 1B
Countries and Classification

S/No.	Country	Region	Income Group
1	American Samoa	Pacific	Upper middle income
2	Australia	Pacific	High income
3	Brunei Darussalam	Pacific	High income
4	Cambodia	Pacific	Lower middle income
5	China	East Asia	Upper middle income
6	Fiji	Pacific	Upper middle income
7	Hong Kong SAR, China	Pacific	High income
8	Indonesia	Pacific	Upper middle income
9	Japan	East Asia	High income
10	Kiribati	Pacific	Lower middle income
11	Lao PDR	Pacific	Lower middle income
12	Macao SAR, China	Pacific	High income
13	Malaysia	Pacific	Upper middle income
14	Marshall Islands	Pacific	Upper middle income
15	Micronesia, Fed. Sts.	Pacific	Lower middle income
16	Mongolia	East Asia	Lower middle income
17	Myanmar	Pacific	Lower middle income
18	Nauru	Pacific	High income
19	New Caledonia	Pacific	High income
20	New Zealand	Pacific	High income
21	Palau	Pacific	High income
22	Papua New Guinea	Pacific	Lower middle income
23	Philippines	Pacific	Lower middle income
24	Samoa	Pacific	Upper middle income
25	Singapore	Pacific	High income
26	Solomon Islands	Pacific	Lower middle income
27	South Korea	East Asia	High income
28	Thailand	Pacific	High income
29	Timor-Leste	Pacific	Upper middle income
30	Tonga	Pacific	Lower middle income
31	Tuvalu	Pacific	Upper middle income
32	Vanuatu	Pacific	Upper middle income
33	Vietnam	Pacific	Lower middle income

Source: Author's Compilations.

Table 1C
Results from GMM Analysis (Omitted Variables)

Variables	[1]	[2]

(*continued on next page*)

Table 1C (*continued*)

Variables	[1]	[2]
lnPC, lag	1.012***	0.955***
	(33.538)	(47.827)
lnGFCF	0.014	−0.018*
	(1.176)	(-2.002)
lnLAB	0.139	−0.140
	(0.505)	(-0.988)
lnNET	−0.104***	0.005
	(-3.527)	(0.200)
lnTRCP	0.025	−0.029*
	(0.919)	(-1.843)
ICT	0.089**	0.055**
	(2.341)	(2.676)
lnTRCP*ICT	−0.026**	−0.008
	(-2.552)	(-1.157)
R&D	−0.043*	
	(-1.773)	
HC		0.000
		(0.656)
Constant	−0.650	1.488*
	(-0.441)	(2.004)
Observations	91	114
Groups/Instruments	15/18	17/18
AR (2) p-value	0.301	0.324
Hansen p-value	0.932	0.944
F-Statistic	2.94 E+06	1.13 E+07

Note: ***p < 0.01, **p < 0.05, *p < 0.1; *t*-statistics in parentheses; ln = Natural logarithm, GFCF = Gross fixed capital formation; LAB = Labour force participation rate; NET = Individuals using the Internet; TRCP = Tourism receipts; ICT = Composite index of ICT variables; R&D: Research & Development; GMM = Generalized method of moments.
Source: Author's Computations.

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