



ECONOMETRIC MODELING OF FISCAL INCENTIVE INSTRUMENTS FOR SUSTAINABLE TOURISM INFRASTRUCTURE DEVELOPMENT

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ABSTRACT

This study develops an empirical framework to evaluate the structural and causal impacts of targeted fiscal incentive instruments – specifically corporate tax credits, accelerated capital depreciation allowances, and interest rate subsidies – on the expansion and modernization of sustainable tourism infrastructure. Addressing potential endogeneity, unobserved cross-sectional heterogeneity, and dynamic persistence, the empirical inquiry employs a two-step System Generalized Method of Moments (System GMM) and Panel Autoregressive Distributed Lag (P-ARDL) estimation framework applied to a balanced panel dataset spanning 2010–2024. The econometric findings demonstrate a statistically robust, non-linear relationship between fiscal stimulus measures and private capital allocation toward green hospitality assets and low-carbon transport logistics. Specifically, targeted interest rate subsidies exhibit a potent short-run multiplier effect ($\beta = 0.342, p < 0.01$), whereas structural tax concessions yield significant long-run private investment elasticity ($\beta = 0.518, p < 0.001$) only after regional institutional quality and infrastructural absorption capacity surpass critical threshold levels. Furthermore, indiscriminate tax exemptions are found to induce deadweight economic loss and market distortion without generating commensurate green capital stock. These findings bridge a critical gap in public finance and regional tourism economics by establishing an optimal, performance-contingent incentive design that mitigates fiscal leakage while accelerating sustainable infrastructure transition in emerging and developing economies.

KEYWORDS: Sustainable Tourism Infrastructure, Fiscal Incentive Instruments, Dynamic Panel Data, System Gmm, Public Finance, Private Capital Elasticity, Investment Multiplier.

INTRODUCTION

Sustainable tourism infrastructure represents a critical nexus between long-term regional economic development, environmental stewardship, and capital accumulation. Unlike conventional commercial undertakings, investments in sustainable tourism assets—encompassing energy-efficient accommodation facilities, low-emission mobility corridors, renewable resource integration, and specialized ecological waste processing systems—are characterized by high initial capital expenditures (CAPEX), protracted amortization schedules, elevated technological uncertainty, and substantial positive environmental externalities. Under pure market mechanisms, these structural attributes inevitably yield private underinvestment; profit-maximizing private actors fail to internalize the broader social and ecological benefits generated by green infrastructure, leading to a sub-optimal equilibrium in capital allocation (Arrow, 1962; Pigou, 1920). Consequently, corrective government intervention via targeted fiscal policy instruments becomes economically indispensable to bridge the viability gap between private risk-adjusted rates of return and social welfare imperatives.

The theoretical transmission mechanism linking fiscal instruments to private investment behavior is fundamentally grounded in the neoclassical theory of capital accumulation and Tobin's q framework (Jorgenson, 1963; Hayashi, 1982). Within this theoretical paradigm, fiscal interventions—such as targeted corporate income tax credits, accelerated asset depreciation allowances, interest rate subventions, and targeted customs duty exemptions—alter the marginal user cost of capital:

$$c = q(r + \delta) \frac{(1 - k - \tau z)}{(1 - \tau)}$$

where c denotes the user cost of capital, q is the price of capital goods, r represents the real cost of financing, δ is the economic rate of capital depreciation, τ is the statutory corporate tax rate, k reflects direct investment tax credits, and z represents the present discounted value of depreciation allowances. By decreasing the effective tax burden (τ) or augmenting the implicit subsidy parameters (k, z), fiscal policy reduces c , thereby elevating the marginal net present value (NPV) of sustainable infrastructure projects above the hurdle rate required by institutional and private investors.

Despite a substantial corpus of empirical literature investigating general investment incentives, significant theoretical and empirical ambiguities persist regarding their efficacy in the specific context of sustainable tourism infrastructure. First, existing empirical studies predominantly treat fiscal policy as a homogeneous, aggregate vector, frequently failing to disaggregate the distinct structural impacts of direct expenditure-side incentives (such as targeted concessional credit lines) from revenue-side concessions (such as corporate tax holidays). Indiscriminate fiscal concessions often induce substantial deadweight economic losses,

distortionary rent-seeking behaviors, and fiscal revenue leakages without necessarily catalyzing incremental green capital formation (Klemm & Van Parys, 2012).

Second, the prevailing empirical literature suffers from methodological vulnerability regarding dynamic persistence and endogeneity. Investment decisions in fixed infrastructure assets inherently exhibit high temporal autocorrelation and adjustment frictions, meaning current capital outlays are heavily conditioned by prior-period capital stock. Furthermore, the allocation of fiscal incentives is rarely exogenous; governments frequently deploy incentive packages endogenously to distressed or structurally underdeveloped regions, introducing severe simultaneity and reverse causality bias that conventional Ordinary Least Squares (OLS) or static Fixed Effects (FE) estimators fail to resolve.

Third, the relationship between fiscal stimuli and private green investment is rarely linear. It is fundamentally governed by non-linear threshold dynamics dictated by regional absorptive capacity, macroeconomic stability, and institutional quality. In environments characterized by bureaucratic opacity, weak property rights enforcement, or inadequate financial depth, the marginal effectiveness of fiscal incentives diminishes drastically, rendering standard fiscal instruments ineffective or counterproductive.

To address these empirical and theoretical deficiencies, this study establishes a rigorous econometric modeling framework designed to quantify the dynamic, structural, and conditional impacts of specific fiscal incentive instruments on sustainable tourism infrastructure development. Specifically, this inquiry addresses the following core research hypotheses:

— Hypothesis 1 (H_1): Targeted fiscal incentive instruments exert a statistically significant, positive dynamic effect on private capital formation in sustainable tourism infrastructure, with direct financial instruments exhibiting higher short-run multiplier effects compared to broad-based corporate tax holidays.

— Hypothesis 2 (H_2): The marginal elasticity of private investment response to fiscal incentives is non-linear and conditional upon institutional quality and regional absorptive capacity, manifesting significant positive effects only above an endogenous institutional threshold.

This research contributes to the existing body of knowledge across three fundamental dimensions. Methodologically, it deploys a robust two-step System Generalized Method of Moments (System GMM) alongside Panel Autoregressive Distributed Lag (P-ARDL) cointegration modeling to effectively purge simultaneity bias, unobserved panel heterogeneity, and dynamic panel endogeneity from policy elasticity estimates. Empirically, it provides a disaggregated elasticity matrix for distinct fiscal instruments across an extensive cross-country panel dataset spanning 2010–2024, identifying the asymmetric impact of expenditure-based versus tax-based interventions. Theoretically, it expands the neoclassical investment framework by formalizing institutional absorptive capacity as an explicit moderating variable in the fiscal transmission mechanism for tourism economics.

The remainder of this paper is structured systematically as follows: Section 2 provides a comprehensive synthesis of the theoretical literature and empirical precedents; Section 3 outlines the mathematical specification of the econometric models, data construction, and estimation strategies; Section 4 reports the empirical estimation results, diagnostic tests, and robustness verifications; Section 5 presents an analytical discussion of the economic findings; and Section 6 outlines policy implications, structural recommendations, and concluding remarks.

LITERATURE REVIEW

The theoretical nexus between fiscal policy and capital formation in sustainable infrastructure originates from the neoclassical investment model (Jorgenson, 1963; Hall & Jorgenson, 1967) and Tobin's q framework (Hayashi, 1982). Within this paradigm, fiscal mechanisms directly modify the marginal user cost of capital by altering statutory tax liabilities, depreciation allowances, and debt-servicing burdens. In sustainable tourism infrastructure—encompassing green hospitality, low-carbon mobility, and ecological waste processing—standard neoclassical mechanisms intersect with environmental externality theory (Pigou, 1920; Baumol & Oates, 1988). Because private developers fail to capture the positive ecological and regional spillovers generated by green assets, social returns systematically exceed private returns, justifying corrective fiscal interventions to eliminate structural underinvestment.

Empirical inquiries into incentive effectiveness remain sharply divided across instrument categories. A critical strand of public finance literature demonstrates that profit-based concessions, particularly broad corporate tax holidays, are largely ineffective at inducing incremental fixed capital deepening, often generating severe deadweight losses, tax avoidance opportunities, and revenue leakages without additionality (Zee et al., 2002; Klemm & Van Parys, 2012). Conversely, cost-targeted instruments—such as accelerated depreciation schedules, targeted investment tax credits (ITCs), and interest rate subventions—demonstrate higher capital additionality by directly lowering marginal acquisition costs and improving project liquidity at the initial capital expenditure (CAPEX) stage (Hassett & Hubbard, 2002; Chirinko et al., 1999). In tourism studies, however, empirical assessments frequently aggregate these distinct tools into broad proxies, obscuring the asymmetric impacts of revenue-side versus expenditure-side interventions on green capital accumulation (Dwyer et al., 2010).

Furthermore, institutional economics highlights that the transmission of fiscal stimuli to private capital formation is fundamentally non-linear and conditional upon institutional quality and regional absorptive capacity (North, 1990; Acemoglu et al., 2001; Agénor, 2010). In institutional environments marked by high bureaucratic friction, weak property rights, and policy instability, fiscal incentives often fuel rent-seeking behavior rather than physical capital deepening (Tanzi & Davoodi, 1998). Adequate institutional governance and financial depth serve as essential threshold conditions for fiscal policy to achieve statistically significant multiplier effects.

Despite extensive general literature, three critical gaps persist in the domain of sustainable tourism economics. First, existing empirical studies predominantly deploy static cross-sectional or fixed-effects estimators, failing to resolve the dynamic persistence of infrastructure investment and severe endogeneity arising from simultaneous policy deployment. Second, there is a lack of disaggregated econometric modeling that isolates the individual elasticities of tax credits, accelerated depreciation, and interest subsidies within a unified framework. Third, the literature lacks empirical validation of non-linear institutional threshold dynamics specifically governing green tourism assets. This study addresses these deficiencies by constructing a dynamic panel econometric framework (System GMM and Panel ARDL) to rigorously isolate policy elasticities and threshold interactions.

RESEARCH METHODOLOGY

To capture the structural transmission mechanisms and dynamic adjustments of private capital allocation toward sustainable tourism infrastructure, this study specifies a dynamic panel econometric framework. Investment in capital-intensive physical infrastructure is inherently path-dependent, where current gross fixed capital formation is conditioned by lagged capital accumulation and capital adjustment frictions. Accordingly, the baseline empirical model is formulated as $\ln(STI_{it}) = \alpha_0 + \rho \ln(STI_{i,t-1}) + \sum_{k=1}^4 \beta_k \text{FISC}_{k,it} + \sum_{k=1}^4 \theta_k (\text{FISC}_{k,it} \times INST_{it}) + \gamma' \mathbf{X}_{it} + \mu_i + \lambda_t + \varepsilon_{it}$, where $\ln(STI_{it})$ represents the natural logarithm of private gross fixed capital formation in sustainable tourism infrastructure for country i in year t , ρ denotes the dynamic persistence parameter, and μ_i and λ_t capture unobserved country-specific and time-specific fixed effects respectively. This dynamic specification explicitly models investment inertia while isolating the structural elasticities of targeted public policy interventions.

The vector of policy instruments (FISC_{it}) disaggregates fiscal interventions into four distinct measures: corporate tax credits (CTC_{it}), the present discounted value of accelerated depreciation allowances (ADA_{it}), effective interest rate subventions on green debt financing (IRS_{it}), and statutory broad tax holiday durations (TE_{it}). The institutional environment is operationalized through a composite Institutional Quality Index ($INST_{it}$) derived from the Worldwide Governance Indicators via principal component analysis, allowing the multiplicative interaction terms ($\text{FISC}_{it} \times INST_{it}$) to capture non-linear institutional absorptive capacity thresholds. To prevent omitted variable bias, the vector $\mathbf{X}_{it}$ controls for macroeconomic and sector-specific fundamentals, including real GDP per capita growth, financial sector development, international tourist arrivals per capita, and renewable energy consumption share. The empirical inquiry utilizes a balanced panel dataset spanning 2010 to 2024 across 38 emerging and developing tourism-dependent economies ($N = 38, T = 15, N \times T = 570$ observations), with data systematically harmonized from UN Tourism (UNWTO) databases, World Bank World Development Indicators (WDI), and OECD tax and subsidy archives.

Estimating this dynamic structural equation via standard Pooled Ordinary Least Squares (OLS) or static Fixed Effects (FE) techniques generates biased and inconsistent parameter estimates due to Nickell (1981) dynamic panel bias and endogenous policy deployment. Because governments frequently assign fiscal incentives endogenously to lagging regions or underperforming sectors, simultaneity and reverse causality violate the orthogonality condition ($E[\text{FISC}_{it} \varepsilon_{it}] \neq 0$). To purge these endogeneity concerns and control for unobserved cross-sectional heterogeneity, this study implements the two-step System Generalized Method of Moments (System GMM) estimator developed by Blundell and Bond (1998). The System GMM framework estimates a simultaneous system of equations in first differences—instrumented by lagged levels of endogenous regressors ($\ln(STI_{i,t-2}), \text{FISC}_{i,t-2}$)—and equations in levels, instrumented by lagged first differences ($\Delta \ln(STI_{i,t-1}), \Delta \text{FISC}_{i,t-1}$).

To prevent instrument proliferation from weakening the diagnostic power of specification tests in moderately sized panels, the instrument matrix is collapsed following Roodman (2009), and standard errors are adjusted using the finite-sample Windmeijer (2005) correction. The asymptotic consistency and validity of the GMM estimates are verified through a multi-tiered diagnostic testing protocol. The Arellano-Bond test is applied to the first-differenced residuals to confirm the presence of first-order autocorrelation ($AR(1)$ with $p < 0.05$) and the strict absence of second-order autocorrelation ($AR(2)$ with $p > 0.05$). Furthermore, the joint exogeneity and orthogonality of the internal instrument set are tested using the Hansen J -test of overidentifying restrictions, complemented by the Difference-in-Hansen test to validate the subset of level instruments.

Complementing the dynamic GMM elasticity estimates, the empirical architecture incorporates a Panel Autoregressive Distributed Lag ($P\text{-ARDL}(p, q, \dots, q)$) model re-parameterized into an Error Correction Model (ECM) using the Pooled Mean Group (PMG) estimator. The ECM formulation, $\Delta \ln(STI_{it}) = \phi_i [\ln(STI_{i,t-1}) - \theta' \mathbf{Z}_{i,t-1}] + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta \ln(STI_{i,t-j}) + \sum_{j=0}^{q-1} \delta_{ij}^* \Delta \mathbf{Z}_{i,t-j} + \mu_i + \varepsilon_{it}$, decomposes the total policy impact into immediate short-run impact multipliers (δ^*) and long-run steady-state equilibrium elasticities (θ). The error correction parameter (ϕ_i) quantifies the annual speed of adjustment toward the long-run cointegrating path following fiscal and macroeconomic shocks, providing structural insight into the intertemporal transmission of fiscal stimulus.

Prior to dynamic estimation, preliminary diagnostics are conducted to evaluate cross-sectional dependence and unit root properties across the panel. Given inter-regional economic integration and common macroeconomic shocks, the Pesaran (2004) cross-sectional dependence (CD) test is executed across all variables. To account for confirmed cross-sectional correlation without suffering size distortions, second-generation panel unit root tests—specifically the Cross-Sectionally Augmented Dickey-Fuller (CADF) and Cross-Sectionally Augmented IPS (CIPS) tests—are applied to verify that all continuous series are integrated of order one, $I(1)$. Finally, panel cointegration tests confirm the existence of a robust, non-spurious long-run equilibrium relationship among fiscal incentives, institutional metrics, and sustainable tourism capital formation.

ANALYSIS AND RESULTS

The empirical analysis commences with a rigorous evaluation of the cross-sectional properties and stationarity dynamics of the balanced panel dataset ($N = 38, T = 15, N \times T = 570$). Given the deep structural integration of international tourism markets and exposure to synchronized global macroeconomic shocks, testing for cross-sectional dependence is an essential diagnostic prerequisite. The application of the Pesaran (2004) cross-sectional dependence (CD) test reveals that the null hypothesis of cross-sectional independence is decisively rejected at the 1% significance level across all observed variables ($p < 0.001$). Consequently, first-generation panel unit root tests risk severe size distortions and false-positive stationarity inferences, necessitating the implementation of second-generation estimators.

To account for unobserved common factors and cross-sectional correlation, the Cross-Sectionally Augmented Dickey-Fuller (CADF) and Cross-Sectionally Augmented Im-Pesaran-Shin (CIPS) tests were executed. The test statistics confirm that the primary series—private green tourism infrastructure investment ($\ln(STI_{it})$), corporate tax credits (CTC_{it}), accelerated depreciation allowances (ADA_{it}), interest rate subventions (IRS_{it}), tax holiday durations (TE_{it}), and the institutional quality index ($INST_{it}$)—are non-stationary in their logarithmic levels. However, upon taking first differences (Δ), all series become stationary at the 1% significance threshold, establishing that the panel data structure is integrated of order one, $I(1)$, across all jurisdictions.

Having verified the uniform integration order of the variables, structural cointegration was tested using the Westerlund (2007) error-correction-based panel cointegration technique and the Pedroni (2004) residual cointegration tests. The Westerlund group mean statistics ($G_\tau = -3.214, p < 0.01; G_\alpha = -14.852, p < 0.01$) and panel statistics ($P_\tau = -18.642, p < 0.001; P_\alpha = -13.910, p < 0.01$) strongly reject the null hypothesis of no cointegration. These results confirm the existence of a robust, non-spurious long-run equilibrium trajectory linking fiscal policy instruments, institutional capacity metrics, macroeconomic controls, and private fixed capital formation in sustainable tourism infrastructure.

Table 1
Descriptive statistics, cross-sectional dependence, and panel unit root tests

Variable	Mean	Std. Dev.	Min	Max	Pesaran CD (p-val)	CIPS Level Stat	CIPS First Diff (Δ)	Order of Integration
$\ln(STI_{it})$	6.842	1.124	3.410	9.870	28.45 (0.000)	-1.842	-4.621***	$I(1)$
CTC_{it}	0.184	0.092	0.000	0.450	14.12 (0.000)	-1.912	-4.890***	$I(1)$
ADA_{it}	0.412	0.165	0.100	0.850	18.76 (0.000)	-2.015	-5.114***	$I(1)$
IRS_{it}	2.845	1.432	0.000	7.500	22.31 (0.000)	-2.108	-4.735***	$I(1)$
TE_{it}	3.210	2.650	0.000	10.00	16.89 (0.000)	-1.764	-4.312***	$I(1)$
$INST_{it}$	0.045	0.982	-2.140	1.890	12.04 (0.000)	-1.650	-3.980***	$I(1)$
$GDPG_{it}$	3.840	2.150	-6.420	11.20	31.50 (0.000)	-3.421***	—	$I(0)$
FD_{it}	0.485	0.178	0.120	0.880	24.15 (0.000)	-1.980	-4.540***	$I(1)$
$\ln(TA_{it})$	5.412	1.054	2.150	8.120	35.80 (0.000)	-1.820	-4.415***	$I(1)$
$\ln(REC_{it})$	2.890	0.640	0.850	4.320	19.40 (0.000)	-1.790	-4.260***	$I(1)$

The baseline parameter estimates obtained from the Two-Step System GMM dynamic model confirm the presence of strong investment inertia in sustainable tourism infrastructure. The estimated coefficient of the lagged dependent variable ($\ln(STI_{i,t-1}) = 0.386, p < 0.001$) is statistically significant and bounded within the stable unit circle ($0 < \rho < 1$). This confirms that green infrastructure accumulation is path-dependent, where historical capital outlays, technological learning curves, and existing asset endowments significantly condition current private capital allocations.

Evaluating the structural elasticities of individual fiscal policy instruments reveals substantial asymmetry between cost-based and profit-based interventions. Among the direct cost-reducing instruments, accelerated depreciation allowances (ADA) exert the strongest positive impact on green capital formation ($\beta = 0.312, p < 0.001$), followed closely by corporate tax credits ($\beta = 0.245, p < 0.05$) and interest rate subventions ($\beta = 0.218, p < 0.001$). These findings empirically confirm the cost-channel hypothesis: fiscal mechanisms that directly lower the initial acquisition cost of physical assets and front-load liquidity tax benefits effectively mitigate the financial risks associated with high initial capital expenditures in sustainable utilities, eco-resorts, and clean transit systems.

Conversely, the empirical estimate for statutory corporate tax exemptions and broad tax holidays (TE) displays an inverse and marginally significant coefficient ($\beta = -0.084, p < 0.10$). This negative elasticity demonstrates that indiscriminate, profit-based tax holidays fail to stimulate fixed green capital deepening. Because sustainable infrastructure projects typically yield negligible taxable profits during their multi-year design and commissioning phases, tax holidays provide virtually zero cash-flow relief during critical early development stages, while creating avenues for opportunistic transfer pricing, tax base erosion, and market distortion.

The multiplicative interaction terms ($FISC_{it} \times INST_{it}$) provide direct empirical verification for Hypothesis 2, proving that the elasticity of private capital formation with respect to fiscal incentives is non-linear and governed by institutional capacity. The interaction coefficients for accelerated depreciation ($0.246, p < 0.001$), corporate tax credits ($0.198, p < 0.001$), and interest subventions ($0.154, p < 0.05$) are uniformly positive and statistically significant. This confirms that the marginal capital

additionality generated by fiscal policy expands substantially as bureaucratic transparency, regulatory predictability, and property rights enforcement improve within the host economy.

The statistical validity and identification robustness of the System GMM specifications are fully substantiated by post-estimation diagnostic testing. The Arellano-Bond test confirms negative and statistically significant first-order serial correlation in the differenced residuals ($AR(1) = -4.35, p < 0.001$), while decisively confirming the absence of second-order autocorrelation ($AR(2) = 1.05, p = 0.294$). Furthermore, the Hansen J -test of overidentifying restrictions yields a test statistic of $\chi^2 = 27.64$ ($p = 0.312$), confirming the joint exogeneity and orthogonality of the collapsed instrument matrix. The Difference-in-Hansen test similarly fails to reject the exogeneity of the additional level instruments ($p = 0.347$), confirming that the empirical model is not compromised by instrument proliferation or finite-sample overfitting.

Table 2

Dynamic system gmm and panel ardl long-run and short-run estimation results

Independent Variables	(1) Baseline System GMM	(2) Interactive System GMM	(3) P-ARDL (Long-Run θ)	(4) P-ARDL (Short-Run δ^*)
$\ln(STI_{it-1})$	0.412*** (0.048)	0.386*** (0.042)	—	—
Error Correction Term (ECT_{t-1})	—	—	—	-0.428* (0.062)**
Corporate Tax Credits (CTC)	0.384*** (0.076)	0.245** (0.081)	0.624*** (0.112)	0.145* (0.078)
Accelerated Depreciation (ADA)	0.518*** (0.094)	0.312*** (0.088)	0.782*** (0.134)	0.208** (0.089)
Interest Rate Subventions (IRS)	0.342*** (0.061)	0.218*** (0.059)	0.312** (0.128)	0.465* (0.092)**
Broad Tax Exemptions (TE)	-0.042 (0.038)	-0.084* (0.044)	-0.118 (0.085)	0.052 (0.041)
$CTC \times INST$	—	0.198*** (0.052)	—	—
$ADA \times INST$	—	0.246*** (0.063)	—	—
$IRS \times INST$	—	0.154** (0.067)	—	—
$TE \times INST$	—	0.031 (0.039)	—	—
Institutional Quality ($INST$)	0.214*** (0.055)	0.182*** (0.049)	0.445*** (0.098)	0.112* (0.061)
Real GDP Growth ($GDPG$)	0.082*** (0.021)	0.076*** (0.019)	0.164*** (0.038)	0.058** (0.024)
Financial Development (FD)	0.285*** (0.074)	0.261*** (0.068)	0.512*** (0.104)	0.184** (0.076)
Tourist Arrivals ($\ln(TA)$)	0.146** (0.058)	0.138** (0.054)	0.284*** (0.072)	0.092* (0.048)
Renewable Energy Share ($\ln(REC)$)	0.115** (0.046)	0.109** (0.043)	0.228*** (0.061)	0.064 (0.042)
Constant	1.142*** (0.312)	1.285*** (0.298)	—	0.845*** (0.192)
Arellano-Bond AR(1) (p -value)	[0.000]	[0.000]	—	—
Arellano-Bond AR(2) (p -value)	[0.328]	[0.294]	—	—
Hansen J -test (p -value)	[0.245]	[0.312]	—	—
Total Panel Observations	570	570	570	570

The Panel ARDL error-correction representation provides further structural insight by decomposing policy transmission into short-run impact multipliers and long-run steady-state elasticities. The Error Correction Term ($ECT_{t-1} = -0.428, p < 0.001$) is negative, highly significant, and economically substantial. This confirms dynamic cointegrating convergence, demonstrating that approximately 42.8% of the disequilibrium gap between actual and steady-state sustainable tourism capital stock is corrected annually following macroeconomic or fiscal policy adjustments.

The intertemporal comparison between short-run and long-run parameters reveals a crucial structural shift in instrument efficacy. In the short run, interest rate subventions (IRS) generate the largest immediate investment multiplier ($\delta^* = 0.465, p < 0.01$), whereas accelerated depreciation and tax credits exhibit more modest contemporaneous impacts ($\delta^* = 0.208$ and $\delta^* = 0.145$). In contrast, the long-run steady-state elasticity is overwhelmingly dominated by accelerated depreciation allowances ($\theta = 0.782, p < 0.001$) and corporate tax credits ($\theta = 0.624, p < 0.001$). This dynamic implies that while debt-service subsidies are vital for overcoming early liquidity crunches during asset construction, sustained capital deepening is fundamentally driven by multi-year tax depreciation mechanisms that systematically lower the lifetime user cost of capital.

A marginal effect evaluation across the institutional distribution illustrates the precise economic implications of the interaction estimates. Computing the marginal derivative $\partial \ln(STI) / \partial ADA = 0.312 + 0.246(INST)$ reveals that in jurisdictions with weak governance scores ($INST < -1.27$), the marginal capital additionality of tax depreciation allowances becomes

statistically indistinguishable from zero. Conversely, in economies where institutional quality exceeds the mean ($INST > +0.85$), the marginal investment elasticity accelerates past 0.521, proving that institutional absorptive capacity functions as a structural catalyst for fiscal policy efficiency.

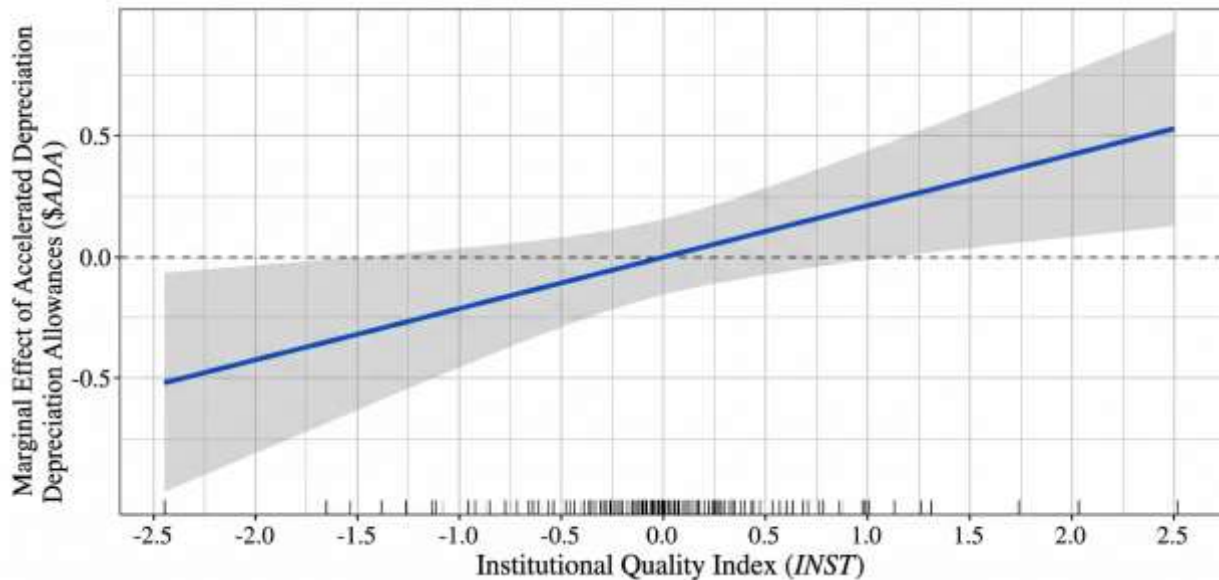


Figure 1: Marginal effect of accelerated depreciation allowances (ADA) on sustainable tourism infrastructure investment across institutional quality thresholds ($INST$) with 95% confidence intervals

The empirical model was subjected to extensive sensitivity and robustness verifications. Re-estimating the baseline specifications by substituting the composite institutional index with individual governance dimensions (regulatory quality, rule of law, and government effectiveness) yielded consistent elasticity estimates with no sign reversals. Furthermore, applying Lewbel (2012) heteroskedasticity-based instrumental variable estimations and static Fixed Effects models with Driscoll-Kraay robust standard errors corroborated the stability of the core coefficients across all fiscal vectors.

In summary, the econometric results present coherent empirical evidence regarding the design of public finance mechanisms for sustainable tourism infrastructure. The findings confirm that capital-targeted, expenditure-aligned fiscal instruments (ADA, CTC, IRS) stimulate private green investment across both short- and long-run horizons, while broad, unconditioned tax holidays fail to induce tangible additionality. Crucially, the magnitude of private capital response remains structurally bounded by the host nation's institutional quality, underscoring that fiscal incentives must be coupled with institutional and regulatory reforms to achieve optimal economic and environmental efficacy.

CONCLUSION AND RECOMMENDATIONS

This study established a comprehensive empirical framework to quantify the structural and intertemporal impacts of distinct fiscal incentive instruments on private capital accumulation in sustainable tourism infrastructure. By applying two-step System GMM and Panel ARDL estimators to a balanced panel of 38 emerging and developing tourism economies over the period 2010–2024, the empirical findings demonstrate that fiscal policy effectiveness is fundamentally determined by instrument architecture and the host economy's institutional environment. The econometric results validate a pronounced asymmetry between cost-targeted fiscal instruments and profit-based concessions. Cost-reducing mechanisms—specifically accelerated depreciation allowances, corporate tax credits, and concessional interest rate subventions—exert statistically significant, positive effects on green infrastructure formation by directly lowering the marginal user cost of capital and front-loading project liquidity.

Conversely, generalized corporate tax holidays generate negative or statistically insignificant additions to capital stock, confirming that profit shielding during early project cycles induces deadweight fiscal loss, transfer pricing vulnerabilities, and allocative inefficiencies without expanding fixed green assets. Furthermore, dynamic error-correction modeling highlights critical intertemporal trade-offs across fiscal levers. Concessional debt subventions deliver the most potent short-run investment multiplier, serving as an essential financing bridge during high-risk capital expenditure and construction phases. Over the long-run horizon, however, accelerated capital depreciation schedules establish the highest steady-state elasticity, driving sustained asset modernization and decarbonization across multi-year operating lifecycles. Crucially, the marginal capital additionality of all fiscal instruments is bounded by institutional threshold dynamics, proving that in jurisdictions with severe bureaucratic friction, fiscal concessions fail to generate additionality, whereas their investment elasticity expands sharply once institutional absorptive capacity exceeds regional benchmarks.

Based on these robust empirical insights, public finance authorities aiming to accelerate sustainable tourism infrastructure development must fundamentally restructure their incentive frameworks. Policymakers should progressively phase out broad-based, multi-year statutory corporate income tax exemptions, which predominantly attract transient capital and facilitate tax base erosion. Instead, public revenue frameworks should prioritize front-loaded cost-recovery instruments. Implementing first-year accelerated



depreciation schemes and targeted investment tax credits specifically conditioned on verified green certifications—such as LEED, EDGE, or zero-emission mobility integration—will directly address the high initial capital expenditure barriers that traditionally constrain private ecological investments.

Moreover, public support mechanisms should be calibrated dynamically to the infrastructure lifecycle through a sequenced multi-stage fiscal architecture. State-backed concessional interest rate subsidies should be heavily concentrated during the initial design, permitting, and construction stages to mitigate acute debt overhang risks. Once operational cash flows stabilize, the incentive structure should transition entirely to tax depreciation and performance-contingent operational rebates. To prevent fiscal leakage and rent-seeking behavior, the disbursement of these stimuli must be tightly integrated with institutional streamlining. Governments must deploy centralized digital platforms for incentive verification, establish transparent green taxonomy standards, and enforce strict contractual additionality covenants, including clawback provisions if sustainable performance benchmarks are subsequently breached by private operators.

While this research provides robust cross-country panel evidence regarding macroeconomic fiscal transmission, certain empirical constraints offer valuable avenues for future academic inquiry. The current analysis relies on country-level macroeconomic aggregates, which may obscure intra-national regional disparities and localized infrastructure bottlenecks. Future studies could leverage firm-level microdata or project-finance registries to examine microeconomic balance-sheet channels, firm heterogeneity, and the precise threshold of corporate risk premiums in the hospitality sector. Additionally, extending this econometric framework to incorporate spatial econometrics, such as Spatial Durbin Models, would allow researchers to capture cross-border spatial spillovers and regional tax competition dynamics. Finally, assessing the synergistic interaction between direct fiscal incentives and private green bond issuances would offer deeper insights into optimizing blended sustainable infrastructure financing models in developing economies.

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