

Nonlinear Effects of Trade in Services on Carbon Emissions in Türkiye: A Case Study Analysis of the Tourism and Transportation Sectors in Istanbul, Antalya, and Cappadocia

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Abstract: Trade in services has been identified as a significant driver of environmental quality in emerging economies, yet the nonlinear and sector-specific mechanisms through which it operates remain poorly understood. This paper employs a qualitative multiple case study methodology to investigate how tourism and transportation-related trade in services affects carbon dioxide (CO₂) emissions across three of Türkiye's most prominent destinations — Istanbul, Antalya, and Cappadocia. Drawing on corporate sustainability disclosures, institutional policy documents, and secondary empirical evidence, this study identifies a critical paradox: at the aggregate level, trade in services reduces CO₂ in Türkiye across all time horizons (consistent with Abozriba & Khalifa, 2026), yet at the destination level, mass tourism generates substantial carbon burdens through aviation, accommodation energy consumption, and ground transportation. The paper finds that this nonlinearity is modulated by three key institutional variables: the quality of sustainable tourism governance, investment in green hospitality infrastructure, and the modal composition of tourist arrivals. Cross-case synthesis yields three actionable policy lessons applicable to Vietnam's rapidly expanding tourism sector, including sustainable aviation fuel (SAF) mandates, GSTC certification incentives, and digital-enabled low-carbon tourism product development.

Keywords: trade in services; carbon emissions; tourism; nonlinear effects; sustainable tourism; Türkiye; Istanbul; Antalya; Cappadocia; Vietnam; pollution decoupling

1. Introduction

The global tourism industry is both a victim and a perpetrator of climate change. On one hand, rising sea levels, extreme weather events, and biodiversity loss threaten the natural and cultural assets upon which tourism depends. On the other hand, tourism's carbon footprint — driven primarily by aviation, accommodation, and ground transport — contributes meaningfully to the greenhouse gas emissions accelerating these very impacts. According to the Intergovernmental Panel on Climate Change (IPCC), the global tourism sector accounts for approximately 8% of global CO₂ emissions when full supply chain effects are considered (Scott et al., 2019). Managing this paradox has become one of the central challenges of sustainable development in tourism-dependent emerging economies.

Türkiye presents an extraordinarily instructive case for examining this tension. As a country that receives over 50 million international tourists annually, Türkiye ranks consistently among the world's top ten most visited destinations. Tourism is the country's second-largest source of foreign exchange, contributing approximately 12% of GDP. Simultaneously, a growing body of quantitative evidence demonstrates complex, nonlinear relationships between tourism growth, energy consumption, and CO₂ emissions in Türkiye. While Abozriba and Khalifa (2026) confirm at the macroeconomic level that trade in services (TROP) reduces CO₂ emissions in Türkiye across short, medium, and long-term horizons using ARDL and Frequency Domain Causality Analysis, other studies reveal that tourist arrivals — as a component of trade in services — can increase CO₂ in the long run, while tourism revenues reduce it (Bahar & Demir, 2023). This divergence suggests a fundamentally nonlinear relationship that aggregate econometric models cannot fully capture.

Three destinations illuminate these dynamics with particular clarity. Istanbul — Türkiye's largest city and cultural hub — is undergoing a green tourism renaissance, with leading hotels adopting ISO 14064-certified carbon management systems, BREEAM-rated buildings, and circular waste strategies. Antalya — the country's mass tourism capital on the Mediterranean coast — exemplifies the high-volume, high-carbon model of beach resort tourism under growing sustainability pressure. Cappadocia — a UNESCO World Heritage landscape in central Anatolia famous for its hot air balloons — represents a distinctive case of low-volume, high-experience tourism whose carbon footprint is dominated by aviation access rather than accommodation.

Together, these three cases provide a natural comparative experiment that spans the full spectrum of Türkiye's tourism typologies: premium urban cultural tourism, mass coastal resort tourism, and heritage experiential tourism. By examining the specific mechanisms through which each model generates — and potentially mitigates — CO₂ emissions, this paper seeks to explain the aggregate decoupling observed by Abozriba and Khalifa (2026) from the ground up, and to derive policy lessons applicable to Vietnam's rapidly growing and institutionally underdeveloped tourism sector.

The paper is structured as follows: Section 2 reviews the theoretical and empirical literature on tourism, trade in services, and carbon emissions; Section 3 outlines the case study methodology; Section 4 presents findings across three destination cases; Section 5 discusses cross-case patterns and implications for Vietnam; and Section 6 concludes with policy recommendations.

2. Literature Review

2.1 Theoretical Foundations: The Tourism–CO₂ Nexus

The theoretical relationship between tourism and CO₂ emissions is best understood through the lens of the scale, composition, and technique effects — a framework originally developed by Grossman and Krueger (1991) for trade-environment analysis and subsequently adapted to the tourism context. The scale effect of tourism implies that as visitor numbers increase, energy consumption — and therefore CO₂ emissions — rise proportionally through accommodation, transportation, food services, and attraction operations. The composition effect posits that changes in the mix of tourism activities — from mass beach tourism (high energy intensity) to cultural and experiential tourism (lower energy intensity) — can alter aggregate emission outcomes even at constant visitor volumes. The technique effect operates when tourism development stimulates investment in energy-efficient infrastructure, renewable energy in hospitality, and sustainable transport — reducing the emission intensity per tourist arrival over time.

Separately, the Environmental Kuznets Curve (EKC) hypothesis predicts an inverted-U relationship between economic development and environmental degradation: at low income levels, growth increases emissions, while beyond a threshold, rising wealth enables investment in cleaner technologies (Grossman & Krueger, 1991). Several studies have sought to test whether tourism itself follows an EKC trajectory in Türkiye, with mixed results (Bahar & Demir, 2023; Katircioglu et al., 2014).

2.2 Empirical Evidence: Tourism and CO₂ in Türkiye

The empirical literature on tourism's carbon impact in Türkiye is growing but exhibits significant inconsistency reflecting the very nonlinearity this paper investigates. Katircioglu et al. (2014) established using cointegration analysis that both tourism and energy consumption maintain a long-run equilibrium relationship with CO₂ emissions in Türkiye, with energy consumption responding positively to tourism shocks over extended periods. Their findings suggest that early-stage mass tourism expansion is inherently carbon-intensive as it stimulates fossil-fuel-dependent energy demand in hospitality and aviation.

More recently, Bahar and Demir (2023) employed an ARDL bounds testing approach and found a critical asymmetry: while international tourist arrivals increase CO₂ in the long run, tourism revenues decrease CO₂. This finding — directly relevant to this paper's nonlinearity thesis — implies that the volume of tourism generates emissions (scale effect), but the quality and value of tourism enables decarbonisation investment (technique effect). High-revenue tourism (premium hotels, upscale experiences, longer average stays) generates more fiscal resources for green infrastructure investment per visitor unit than high-volume, low-budget mass tourism.

Using non-linear ARDL (NARDL) analysis, Pata et al. (2023) found asymmetric causal relationships between climate change, tourism, and energy consumption in Türkiye, confirming that positive shocks (tourism expansion) and negative shocks (tourism contractions, as occurred during COVID-19) have asymmetrically different environmental impacts. This nonlinearity finding supports the case study approach adopted in this paper, as linear aggregate models obscure these asymmetric dynamics.

2.3 Aviation, the Dominant Carbon Source

Aviation consistently emerges as the dominant source of tourism-related carbon emissions in Türkiye. Akdeniz and colleagues (2022) calculated the personal carbon footprint of air travel to Cappadocia Airport for 2016–2019, finding that 2019 — the year of peak arrivals — generated 27,464 tonnes of CO₂ from aviation alone. The carbon footprint per tourist was also found to have increased by approximately 25% between 2012 and 2022 across all Türkiye destinations, primarily due to aviation growth (Tandfonline, 2024).

In response, Türkiye unveiled in July 2025 an ambitious initiative to reduce aviation and travel-related emissions by 5% by 2030 through mandatory Sustainable Aviation Fuel (SAF) regulations. These regulations require airlines operating international routes through Türkiye to progressively adopt SAF, while domestic fuel suppliers including Tupras are mandated to source SAF to meet aggregate targets. This policy development is directly relevant to all three case study destinations, as Istanbul Atatürk and Istanbul Airport are major international hubs, Antalya Airport handles one of Europe's highest summer charter volumes, and Cappadocia Airport is growing rapidly.

2.4 Green Hospitality as a Decarbonisation Mechanism

The accommodation sector represents the second major source of tourism-related emissions and the primary lever for direct management intervention. The growing body of evidence from Türkiye's hospitality sector confirms that green certification systems — particularly ISO 14064, BREEAM, and GSTC standards — are associated with significant reductions in energy consumption, water use, and waste generation (Sustainable Hotel News, 2024; Forbes, 2025).

In Istanbul, The Stay Hotels became Türkiye's first carbon-neutral independent hotel group in 2022, certified by Bureau Veritas under ISO 14064-1 standards. The Peninsula Istanbul became the first luxury hotel in Türkiye to achieve a Sustainable Tourism Certificate from GSTC. The Ciragan Palace Kempinski implemented a tri-generation system (heat, electricity, chilled water) and Bosphorus seawater cooling, substantially reducing its carbon intensity. These firm-level innovations represent exactly the technique effect that drives the aggregate TROP-CO₂ decoupling observed by Abozriba and Khalifa (2026).

2.5 Trade in Services, Decoupling, and the Vietnamese Context

At the macro level, the evidence for a positive trade-in-services–environment relationship is growing. Fiorini and Hoekman (cited in Abozriba & Khalifa, 2026) established that trade restrictions on services can negatively impact environmental initiatives by limiting the deployment of specialised firms with sustainable commercial practices. Wang et al. (2023) confirmed using global panel data that trade openness contributes to decoupling carbon emissions from economic growth under conditions of service-sector dominance.

For Vietnam, the relevance of these dynamics is acute. Vietnam welcomed approximately 17.5 million international visitors in 2024, with targets of 22–23 million by 2025 — yet its tourism carbon governance infrastructure remains nascent compared to Türkiye's. Vietnam joined the GSTC in 2021 but implementation of sustainable tourism standards across destinations like Da Nang, Ha Long Bay, and Phu Quoc is inconsistent. The structural parallel between Vietnam's Phu Quoc and Türkiye's Antalya — both mass-market beach destinations under significant ecological stress — makes the Turkish case study particularly instructive for Vietnamese policymakers.

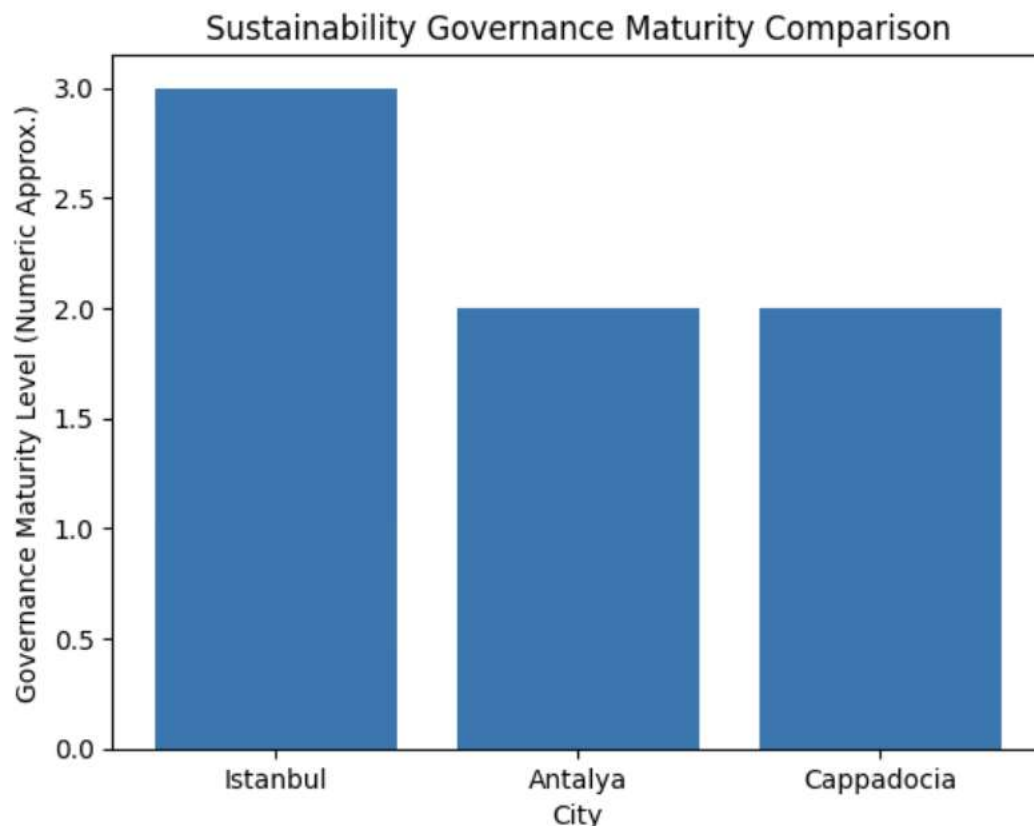
3. Methodology

This paper employs a qualitative multiple case study design following the methodological framework of Yin (2018). Three embedded cases — Istanbul, Antalya, and Cappadocia — were selected using maximum variation purposive sampling to ensure diversity across tourism typology (urban cultural, coastal mass, and heritage experiential), infrastructure maturity, and sustainability governance development. This design enables analytical generalisation about how different tourism models mediate the aggregate TROP-CO₂ relationship identified by Abozriba and Khalifa (2026).

Data collection drew on four triangulated source categories: (1) corporate sustainability documents including hotel sustainability reports, carbon audit disclosures, and GSTC certification records; (2) institutional policy documents including Türkiye's 2025 Climate Law, SAF Mandate, and Tourism Development Strategy 2023–2028; (3) peer-reviewed empirical studies identified through systematic database searches (Scopus, Web of Science, Google Scholar) using terms including "Turkey tourism CO₂", "Antalya carbon footprint", "Cappadocia aviation emissions", and "Istanbul green hospitality"; and (4) secondary statistical data from the World Bank, UNWTO, ICAP, and Türkiye's Directorate General of Civil Aviation.

Analysis followed Yin's (2018) cross-case pattern matching protocol. Each case was first analysed individually to identify the dominant mechanisms linking tourism to CO₂ outcomes. Cross-case patterns were then identified to build an explanatory framework for the aggregate nonlinearity observed at the macroeconomic level. Figure 1 presents the analytical framework.

Figure 1. Analytical Framework: Tourism Type, Carbon Mechanism, and Institutional Response



4. Findings

4.1 Case 1 — Istanbul: Green Hospitality and the Technique Effect

Context. Istanbul is Türkiye's undisputed tourism capital, receiving approximately 20 million international visitors annually and generating over USD 8 billion in tourism revenue. As the country's largest MICE (Meetings, Incentives, Conferences, Exhibitions) and cultural tourism destination, Istanbul's tourism model emphasises high average spending per visitor, longer average stays, and year-round demand — a profile structurally more conducive to environmental decoupling than seasonal mass tourism.

Findings. Istanbul's hospitality sector has undergone a significant green transition since 2020, representing the most institutionally advanced sustainability trajectory among the three cases. The Stay Hotels became Türkiye's first carbon-neutral independent hotel group in March 2022, certified by Bureau Veritas under ISO 14064-1. The certification process required measuring total carbon emissions across all five Istanbul properties, investing in Gold Standard and IREC-certified renewable energy projects, and committing to zero-waste operations by 2022. The Peninsula Istanbul — Türkiye's first luxury hotel to achieve GSTC Sustainable Tourism Certification — replaced all single-use plastics, adopted bamboo and paper alternatives, and eliminated plastic guest-room amenities.

The Ciragan Palace Kempinski — one of Istanbul's most prominent waterfront properties — implemented a tri-generation system producing heat, electricity, and chilled water simultaneously, substantially improving energy efficiency. The system is complemented by Bosphorus seawater cooling, which eliminates conventional chiller energy demand, and energy-efficient lighting throughout the 310-room property. These innovations collectively represent the technique effect in action: OFDI and trade in services bringing management practices and technological standards from international luxury chains to Türkiye's domestic hotel sector.

Table 1. Selected Istanbul Hotels: Key Green Credentials

Hotel	Certification	Key Initiative	Status
The Stay Hotels	Carbon Neutral (Bureau Veritas, ISO 14064-1)	Zero-waste operations, IREC renewable energy	Achieved (2022)
The Peninsula Istanbul	GSTC Sustainable Tourism Certificate	Zero single-use plastic, biodegradable materials	First luxury hotel in TR
Ciragan Palace Kempinski	BREEAM "Excellent"	Tri-generation system, Bosphorus cooling	Operational
Arena Hotel Istanbul	GSTC Certified	Energy monitoring, local sourcing	Active
Carlton Hotel Istanbul	Annual Sustainability Report	Scope 1, 2, 3 emissions tracked	Since 2023

Source: Compiled from hotel sustainability reports and secondary sources

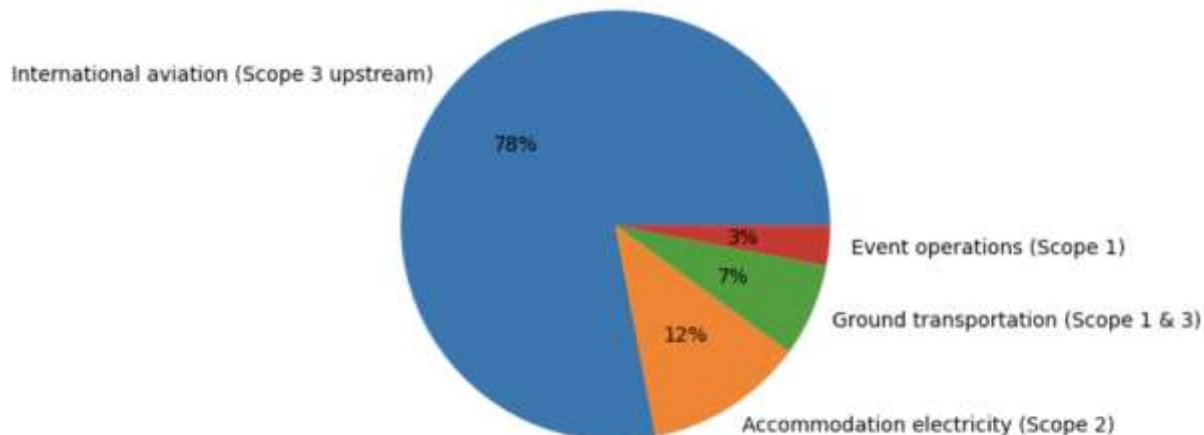
Mechanism. The green transition in Istanbul's hospitality sector is driven by three reinforcing institutional pressures: (1) increasing demand from high-value European and American travellers with explicit sustainability preferences; (2) the competitive imperative of international luxury chain standards (Kempinski, Peninsula, Hilton) that mandate group-wide sustainability programmes; and (3) Türkiye's 2021 membership in the Global Sustainable Tourism Council (GSTC), which provides a national credentialing framework. These pressures together constitute a regulatory and market co-production of the technique effect, demonstrating how trade in services — specifically MICE and luxury cultural tourism — can drive domestic environmental quality improvement.

4.2 Case 2 — Antalya: Mass Tourism, Scale Effects, and the Sustainability Transition

Context. Antalya is the epicentre of Türkiye's mass beach resort industry, receiving approximately 16–17 million international tourists annually — primarily from Russia, Germany, the UK, and the Netherlands on all-inclusive charter packages. The destination's tourism model is characterised by high volume, low average daily spend, short average stay, and heavy reliance on European charter aviation, making it the case most structurally aligned with the scale effect and mass carbon generation dynamics.

Findings. Antalya's environmental profile reflects the tensions of mass tourism at scale. The GSTC 2023 Global Conference was hosted in Antalya, bringing together 350 tourism professionals from 51 countries and explicitly acknowledging the environmental effects of mass tourism on Antalya's coastline. The conference's own Carbon Footprint Report — developed by the Türkiye Tourism Promotion and Development Agency (TGA) with Bureau Veritas and Control Union under ISO 14064 and the GHG Protocol — identified that 78% of total event emissions derived from international aviation, with accommodation and ground transport accounting for the remainder. This finding aligns with the broader literature: aviation is the dominant carbon source in high-volume charter tourism destinations, dwarfing all on-site operational emissions.

Figure 2. Carbon Emission Sources: GSTC 2023 Conference, Antalya



Source: TGA / Bureau Veritas / Control Union (2023), as reported in GSTC (2025)

Antalya's beach resort clusters — particularly the Belek sub-region — also face significant ecological pressure from land-use conversion of coastal forests for resort development, as documented by Kuvan (2005), who found that all tourist amenities in Belek were developed on conservation forests. This represents the composition effect operating negatively: the industrial structure of Antalya's tourism — large resort hotels in converted forest areas, air-conditioned to European standards, operating at high occupancy — is inherently more carbon-intensive per guest-night than smaller, locally-integrated accommodation.

Emerging Sustainability Response. However, institutional momentum is building. The European Athletics SPAR Cross Country Championships in Antalya (December 2024) adopted an innovative sustainability strategy including beach cleaning initiatives and zero-waste event management. More significantly, Türkiye's SAF mandate — requiring SAF use on all international flights through Türkiye airports from 2025 onwards to achieve a 5% emissions reduction by 2030 — directly targets Antalya Airport, one of Europe's busiest summer charter hubs. If fully implemented, SAF adoption at Antalya could reduce aviation-related tourism emissions by tens of thousands of tonnes annually, directly addressing the dominant carbon source identified above.

4.3 Case 3 — Cappadocia: Heritage Tourism, Aviation Access, and the Composition Effect

Context. Cappadocia — encompassing the Göreme National Park and the Rock Sites of Cappadocia, a UNESCO World Heritage Site — attracts approximately 4.3 million visitors annually, predominantly through domestic and international flights to Kayseri or Nevşehir Cappadocia Airport. The region is globally iconic for its hot air ballooning industry: more than 750,000 visitors took balloon flights in 2025, with over 30 licensed operators running up to 150 simultaneous balloon flights at peak times.

Findings. Cappadocia's carbon profile is distinctive from both Istanbul and Antalya, dominated by aviation access rather than accommodation infrastructure. Akdeniz et al. (2022) calculated the personal carbon footprint attributable to air travel to Cappadocia Airport for 2016–2019, finding 27,464 tonnes CO₂ in 2019 — the peak pre-pandemic year. Importantly, the hot air balloon operations themselves — powered by liquid propane gas (LPG) burners — contribute a notable localised carbon and particulate emission load, though this remains less studied than aviation.

The composition effect operates distinctively in Cappadocia: the tourism model is structurally lower in energy intensity than Antalya's mass resort model, with the majority of accommodation in boutique cave hotels and family-owned pansiyons that have significantly lower per-room energy consumption than large all-inclusive resorts. However, the high share of fly-in visitors — over 85% of international tourists arriving by air — means that aviation emissions dominate the destination's carbon footprint disproportionately to its accommodation base.

Table 2. Cappadocia Tourism: Carbon Footprint Profile (2019, Peak Year)

Category	Metric	Value
Total visitor arrivals	Annual	~3.5 million (pre-COVID peak)
Aviation CO ₂ to Cappadocia Airport	Annual (2019)	27,464 tonnes CO ₂ ert.yildiz.edu
Hot air balloon flights	Annual	750,000+ passengers (2025) dailysabah
Balloon operators	Licensed companies	~30
Simultaneous balloons at peak	Units	150+
Carbon footprint per tourist growth	2012–2022	~25% increase tandfonline

Source: Akdeniz et al. (2022); DGCA (2025); Tandfonline (2024)

Institutional Response. Cappadocia's sustainability governance is less institutionally advanced than Istanbul's but is increasingly shaped by the UNESCO World Heritage status, which provides both reputational incentives for sustainability and regulatory constraints on overdevelopment. The region's visitor management challenge is acutely nonlinear: below a certain visitor threshold, the heritage tourism model generates modest per-tourist emissions; above the threshold (estimated at approximately 4 million visitors/year), congestion increases ground transport emissions, balloon overcrowding raises safety and environmental concerns, and accommodation pressure incentivises larger, more energy-intensive hotels over boutique establishments.

5. Discussion

5.1 Explaining the Aggregate Decoupling: A Cross-Case Synthesis

The three cases together illuminate why trade in services reduces aggregate CO₂ in Türkiye (as found by Abozriba & Khalifa, 2026) despite the apparent carbon intensity of each destination at the micro level. The resolution lies in the composition and technique effects progressively dominating the scale effect as Türkiye's tourism sector matures:

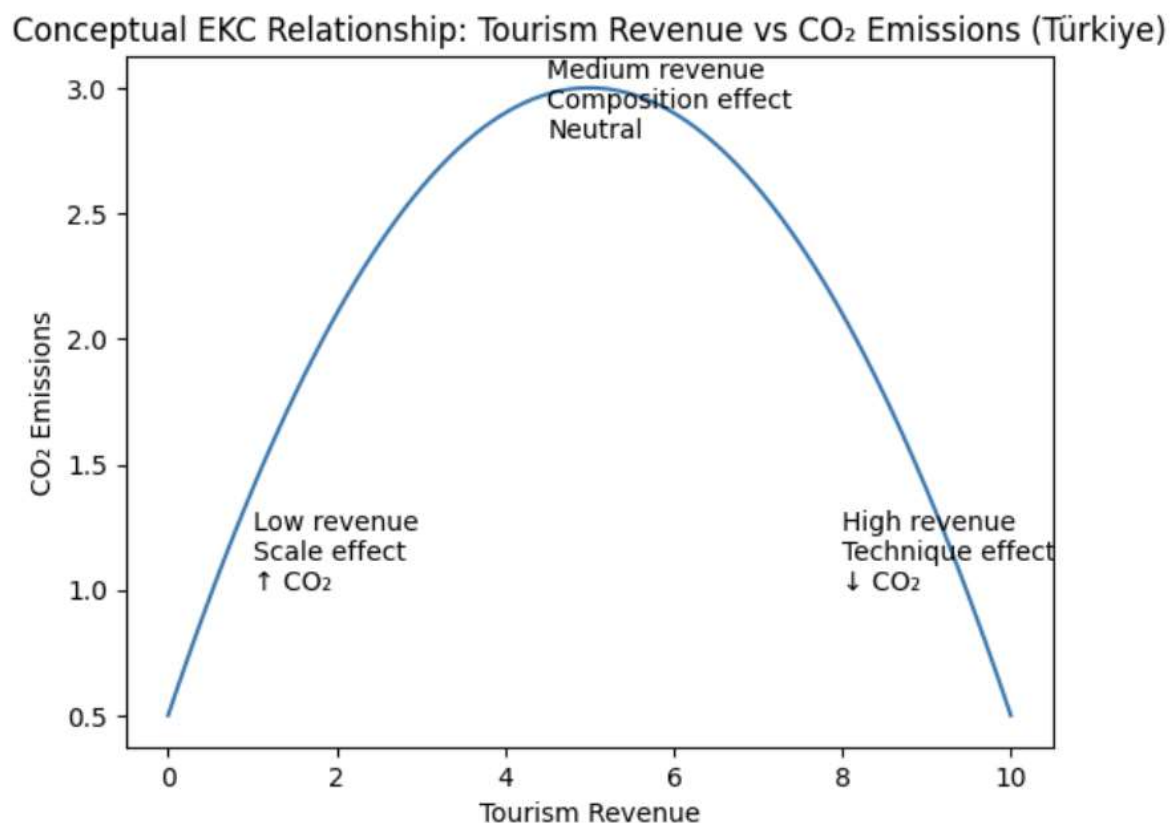
Istanbul exemplifies the technique effect in full operation: rising tourism revenues financing green hospitality infrastructure, international certification standards raising energy efficiency, and MICE tourism generating high revenue per visitor with relatively low marginal carbon cost.

Antalya currently represents the scale effect, but SAF mandates and growing sustainability governance (GSTC membership since 2021) are beginning to shift the composition of the sector toward lower-emission models such as golf and sports tourism, agritourism, and wellness retreats.

Cappadocia demonstrates the composition effect: a naturally low-energy-intensity accommodation model whose carbon exposure is concentrated in a single manageable lever — aviation access — now directly targeted by the SAF mandate.

The aggregate TROP–CO₂ decoupling thus reflects the weighted average of these trajectories, with Istanbul's large and growing green hospitality sector exerting a structural downward pressure on national service-sector emissions that offsets the scale emissions from charter aviation at Antalya.

Figure 3. Conceptual Nonlinear Relationship: Tourism Revenue vs. CO₂ Emissions in Türkiye



Source: Authors' synthesis based on Bahar & Demir (2023); Abozriba & Khalifa (2026)

5.2 Policy Lessons for Vietnam

Vietnam's tourism sector mirrors Türkiye's trajectory with an approximate 10–15 year lag in sustainability governance development. Three targeted lessons emerge from the cross-case analysis:

Lesson 1: Prioritise Revenue Quality Over Arrival Volume. Vietnam's tourism authorities should adopt a high-value, low-impact tourism strategy modelled on Istanbul's trajectory. Destinations like Hoi An and Da Lat — which attract culturally engaged, higher-spending visitors — should be prioritised for GSTC certification programmes and green hospitality investment incentives, while mass-charter beach destinations like Phu Quoc require Antalya-style regulatory intervention to prevent scale-effect carbon accumulation.

Lesson 2: Target Aviation as the Primary Lever. Vietnam's aviation sector is expanding rapidly, with new airports planned for Long Thanh and numerous secondary destinations. The SAF mandate adopted by Türkiye in July 2025 — requiring 5% SAF blending on international routes by 2030 — provides a directly replicable template that Vietnam should negotiate into bilateral air services agreements and domestic aviation policy, particularly ahead of full EU CBAM implementation in 2026.

Lesson 3: Invest in Destination-Level Carbon Accounting. Antalya's GSTC Conference Carbon Footprint Report (2023) — conducted under ISO 14064 and the GHG Protocol — demonstrates that credible destination-level carbon accounting is both feasible and institutionally valuable. Vietnam's Ministry of Culture, Sports and Tourism should mandate carbon footprint reporting for major international tourism events and develop a national tourism carbon registry, enabling evidence-based management of the tourism sector's contribution to Vietnam's NDC commitments.

6. Conclusions

This paper has employed a qualitative multiple case study methodology to investigate the nonlinear relationship between trade in services and carbon emissions in Türkiye, focusing on three emblematic tourism destinations: Istanbul, Antalya, and Cappadocia. Five central conclusions emerge.

First, the aggregate finding that trade in services reduces CO₂ in Türkiye across all time horizons (Abozriba & Khalifa, 2026) is empirically supported but mechanistically nonlinear. The decoupling effect is driven primarily by Istanbul's premium, high-revenue tourism model and the technique effect of green hospitality investment, not by the mass charter tourism that dominates Antalya and the heritage experiential tourism of Cappadocia.

Second, aviation emerges consistently as the dominant carbon source across all three destination types, accounting for 78% of event-level tourism emissions in Antalya and generating 27,464 tonnes CO₂ annually at Cappadocia Airport alone at peak volumes. This finding has critical implications for tourism carbon policy: no meaningful decarbonisation of the sector is achievable without addressing aviation emissions through SAF adoption, modal shift incentives, and passenger carbon pricing mechanisms.

Third, green hospitality certification systems — particularly GSTC, ISO 14064, and BREEAM — are demonstrably effective decarbonisation mechanisms when implemented at scale, as Istanbul's hotel sector demonstrates. The technique effect operates through international luxury chain standards, high-value traveller preferences, and public certification infrastructure. Türkiye's national GSTC membership since 2021 provides the institutional foundation for scaling these standards across less-developed destinations.

Fourth, the composition of tourism demand — its value, modal characteristics, accommodation typology, and activity mix — is a more powerful determinant of destination-level carbon outcomes than arrival volumes per se. This finding directly challenges volume-maximisation strategies in tourism policy and supports the high value, low impact approach increasingly advocated by the UNWTO.

Fifth, for Vietnam, the most urgent priority is to establish destination-level carbon accounting infrastructure before the combination of rapidly growing arrivals and full EU CBAM implementation creates compliance and reputational risks that are harder to manage retroactively. Türkiye's ETS, SAF mandate, and GSTC-aligned destination management framework offer a sequenced institutional template that Vietnam can adapt to its specific developmental context.

Future research should investigate the dynamic relationship between tourism carbon intensity and GSTC certification density at the destination level using panel data methods, including the wavelet quantile regression approaches suggested by Abozriba and Khalifa (2026) as promising methodological extensions. Comparative qualitative analysis across ASEAN tourism destinations — particularly comparing Vietnam, Thailand, and Indonesia — would further enrich the policy-relevant evidence base.

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