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Institutional Assurance, Innovation Environment, and Ecological Sustainability of Inbound Tourism: The Trade-Cost Channel

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ABSTRACT

The rapid growth of inbound tourism has brought economic benefits to China but has also increased ecological pressure on destination regions. Foreign visitors now rely heavily on digital services during their trips, yet the effectiveness of these services depends on institutional assurance and innovation capacity. This paper examines how institutional assurance and the innovation environment relate to the ecological sustainability of China's inbound tourism, and whether trade costs act as a transmission mechanism. Using panel data from 22 major tourism source countries over 2004–2024 (excluding 2020–2022), we construct an Institutional Assurance and Innovation Environment (IAI) index from three indicators: Information and Communication Technology (ICT) regulation, rule of law, and innovation output, combined through principal component analysis (PCA). The index is validated by the Kaiser–Meyer–Olkin measure and Bartlett's test of sphericity, and the models are estimated with country fixed effects. The results show that a stronger IAI is associated with higher inbound tourism performance and lower trade costs, and that lower trade costs are in turn associated with better tourism performance. A Sobel test supports the mediating role of trade costs ($z = 3.96$, $p < 0.001$), and the findings remain stable under an equal-weighted index and component-level regressions. Because lower transaction frictions reduce redundant travel arrangements and inefficient resource use, institutional and innovation conditions can support more sustainable tourism through better service coordination and more efficient destination management, helping China balance tourism growth with ecological conservation.

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ARTICLE INFO

Received: 19 May 2026 | Revised: 16 July 2026 | Accepted: 27 July 2026 | Published Online: 21 August 2026

DOI: https://doi.org/10.30564/re.v8i4.13528

CITATION

Huang, R., Sutunyarak, C., 2026. Institutional Assurance, Innovation Environment, and Ecological Sustainability of Inbound Tourism: The Trade-Cost Channel. Research in Ecology. 8(4): 308–326. DOI: https://doi.org/10.30564/re.v8i4.13528

Keywords: Institutional Assurance; Innovation Environment; Ecological Sustainability; Trade Costs; Tourism Carrying Capacity; Digital Transformation; Inbound Tourism; China

1. Introduction

According to the yearbook published by China's National Bureau of Statistics, the number of inbound tourists to China increased from 1.74 million in 1990 to 30.54 million in 2018 [1]. Although the COVID-19 pandemic interrupted this growth, it has gradually recovered to normal levels in recent years after the end of the pandemic. More foreign visitors are coming to China, and inbound tourism has become an important part of tourism service trade [2]. Indeed, the development of digital technology has boosted inbound tourism to China. Digital technology has made cross-border tourism easier than before [3]. Foreign tourists now use online information, booking platforms, digital payment systems, and smart tourism services more often [4]. These digital advancements help them plan trips, compare services, make reservations, complete payments, and coordinate different parts of their travel [5].

However, the use of digital technology has also led to a series of derivative problems, such as misinformation and payment security [6]. Foreign visitors still need reliable information, clear rules, safe payment channels, and effective consumer protection. If these basic conditions are weak, digital services may not fully improve the travel experience. They may also have a limited effect on attracting foreign tourists to China. For this reason, this study pays more attention to the institutional and innovation environment behind digital tourism services [7].

From the perspective of demand theory, higher service costs may reduce effective demand [8]. In cross-border tourism, such costs are broader than the direct expenses of travel. They also include the time and effort spent on searching for information, communicating with service providers, completing payments, understanding rules, and coordinating travel arrangements. These frictions may affect foreign tourists' willingness and ability to consume tourism services in China. If institutional assurance and innovation environment can reduce such costs, they may help improve inbound tourism performance. Based on this assumption, this study introduces the concept of trade costs in the domain of international trade and examines whether it serves as a possible explanatory channel [9].

Most existing studies have examined digital technology, information and communication technology (ICT) infrastructure, online platforms, institutional quality, or service-trade costs separately in tourism and service-trade research [10,11]. However, less attention has been paid to how institutional assurance and innovation environment jointly shape the conditions under which digital tourism services are governed, trusted, and applied. In addition, the role of trade costs in China's inbound tourism remains insufficiently examined, especially when trade costs are understood as broader transaction frictions rather than only monetary barriers. This study does not aim to propose a new general theory of tourism development. Rather, it provides an incremental extension of existing tourism economics, service-trade, and institutional literature by integrating institutional assurance, the innovation environment, and trade costs into one empirical framework. This framework helps explain how broader governance and innovation conditions may be associated with China's inbound tourism performance, especially through possible reductions in cross-border tourism transaction frictions.

More specifically, this study contributes to existing literature in three aspects. First, it extends tourism economics by linking inbound tourism performance with broader transaction frictions rather than only direct travel costs. Second, it enriches institutional theory by showing how regulatory assurance and legal predictability may support the operation of digital tourism services. Third, it connects innovation studies with sustainable tourism by highlighting how innovation capacity may improve service coordination and reduce cross-border tourism frictions. Therefore, the contribution of this study lies in integrating these three perspectives into a single empirical framework for understanding China's sustainable inbound tourism development.

Beyond economic performance, inbound tourism also has ecological implications. Larger tourist flows consume energy, water, and land resources, generate waste and carbon emissions, and may disturb natural habitats and biodiversity in destination regions. In China, popular tourist destinations often overlap with ecologically sensitive areas, such as mountains, lakes, forests, and coastal zones. The carrying capacity of these ecosystems can be strained by uncoordinated tourism growth. Therefore, understanding how institutional and innovation conditions affect tourism performance is not only an economic issue but also an ecological one. If institutional assurance and innovation capacity can reduce transaction frictions in cross-border tourism services, they may also help improve service coordination, reduce inefficient travel arrangements, and support more orderly destination management—which could indirectly mitigate ecological pressure from tourism activities. This study contributes to ecological tourism research by linking institutional governance and innovation with sustainable tourism flow management.

2. Literature Review and Hypothesis Development

2.1. Ecological Sustainability and Tourism Carrying Capacity

Tourism development and ecological conservation are often viewed as conflicting objectives. Mass tourism can lead to habitat degradation, biodiversity loss, water depletion, increased carbon emissions, and waste accumulation [12,13]. The concept of tourism carrying capacity—the capacity of a destination to accommodate visitors while maintaining acceptable ecological and social conditions—has long been a concern in sustainable tourism research [14]. Ecological-footprint approaches have also been used to quantify the environmental load of tourism activities [13,15]. In the Chinese context, rapid tourism growth has raised concerns about the ecological carrying capacity of popular destinations, particularly in mountainous and coastal areas where ecosystems are more vulnerable [12,16]. While digital tourism services may improve visitor convenience and economic efficiency, they do not automatically reduce ecological pressure [17]. Service coordination failures—such as overlapping bookings, inefficient transportation routes, and uneven visitor distribution—may increase resource use and environmental load. Institutional assurance and innovation capacity may help reduce these coordination failures and thus contribute to more ecologically sustainable tourism flows.

2.2. Institutional Assurance, Innovation Environment, and Inbound Tourism Performance

In inbound tourism, foreign visitors usually make many decisions before they arrive in China. They need to check destination information, compare hotels and attractions, book services, and decide how to pay [18,19]. Digital tools make these steps more convenient, but they create some problems at the same time. Tourists may still worry about whether online information is accurate, whether booking rules are clear, whether payment is safe, and whether service problems can be handled properly.

For these reasons, institutional assurance and innovation environment should be considered together with digital tourism services. Institutional assurance means that rules, legal support, and governance systems are clear enough to support reliable transactions [20]. It can help reduce uncertainty in online booking, payment, data use, and consumer protection. Innovation environment is related to the ability of firms and markets to develop and use new technologies [21]. A stronger innovation environment may help tourism firms improve service design, build platform-based services, and respond more quickly to foreign tourists' needs [22]. These two conditions may improve China's inbound tourism performance. Clearer rules can make tourism transactions more predictable. Better legal and regulatory support can improve trust. Stronger innovation capacity can also help firms provide more convenient and better coordinated services [23,24].

Previous studies often examine institutional quality, digital tourism services, and innovation capacity as separate factors. However, in cross-border tourism, these factors may work together as complementary conditions within a broader enabling environment. Drawing on the logic of trade boundary expansion and trade structure optimization, digital tourism services require not only technical tools, but also regulatory assurance, legal predictability, transaction trust, and innovation capacity. ICT regulation helps reduce digital service constraints by providing the policy and regulatory basis for online booking, digital payment, data use, and platform operation. Rule of law strengthens legal predictability, transaction security, consumer protection, and dispute resolution, which helps convert potential tourism demand into actual cross-border consumption. Innovation output supports the development, updating, and application of new tourism service technologies, which may increase service choices and improve service efficiency. Therefore, these three dimensions are theoretically distinct, but they jointly support the reliable operation and continuous improvement of digital tourism services. This study therefore treats institutional assurance and innovation environment as an integrated enabling environment for China's inbound tourism performance, while the latter empirical checks further examine whether the three components operate in similar or different ways.

H1. *Institutional assurance and innovation environments are positively associated with China's inbound tourism performance.*

2.3. Trade Costs and the Mediating Mechanism

According to demand theory, the level of tourism costs affects effective tourism demand. In cross-border tourism, the cost, namely the trade cost is more complicated. In this paper, trade costs are not limited to monetary expenses [25]. They are understood as broader transaction frictions in cross-border tourism services. Stronger institutional assurance may reduce these frictions by making online transactions more predictable and trustworthy. A stronger innovation environment may also reduce frictions by improving information matching, booking efficiency, digital payment, and service coordination [26].

H2. *Institutional assurance and innovation environments are negatively associated with trade costs in cross-border tourism services.*

Trade costs may further affect inbound tourism performance. When transaction frictions are high, international tourists need more time and effort to search for information, compare options, complete bookings, make payments, and coordinate travel services. These barriers may reduce the willingness or ability of tourists to consume inbound tourism services. By contrast, lower trade costs can make tourism services easier to access, purchase, and experience [27]. At the micro-tourist level, this mechanism can be understood through the decision process of foreign visitors. Before travelling to China, tourists need to search for destination information, compare service options, evaluate booking rules, arrange payment methods, and estimate the reliability of service providers. During the trip, they also need to communicate with local platforms and service providers, solve possible payment or refund problems, and coordinate transportation, accommodation, attractions, and other tourism services. Weak institutional assurance may increase perceived risk and uncertainty, while insufficient innovation capacity may reduce service convenience and coordination efficiency. These frictions increase the time, effort, and perceived risk faced by tourists. By contrast, clearer ICT regulation, stronger legal predictability, and better innovation capacity may reduce perceived uncertainty, improve trust in digital tourism services, and lower the non-monetary costs of cross-border tourism consumption. Therefore, trade costs operate not only as macro-level frictions, but also as micro-level barriers that influence tourists' travel planning, purchase decisions, and actual tourism consumption.

H3. *Trade costs are negatively associated with China's inbound tourism performance.*

Based on the above logic, trade costs may serve as a transmission channel between institutional assurance and innovation environments and inbound tourism performance. In other words, institutional and innovation conditions may first reduce transaction frictions in cross-border tourism services, and these lower frictions may then support better inbound tourism performance [28].

H4. *Trade costs mediate the relationship between institutional assurance and innovation environments and China's inbound tourism performance.*

Building on the theoretical discussion and hypotheses developed above, **Figure 1** summarizes the proposed relationships. Under the context of digital tourism transformation, institutional assurance and innovation environments are expected to be directly associated with inbound tourism performance and indirectly associated with it through trade costs.

Figure 1 presents the macro-level research framework of this study. At the micro-tourist level, trade costs can be understood as tourist transaction frictions in information search, booking and payment, communication, service coordination, and perceived uncertainty. Reducing these frictions may improve tourists' travel-planning and consumption experience, thereby supporting higher inbound tourism performance.

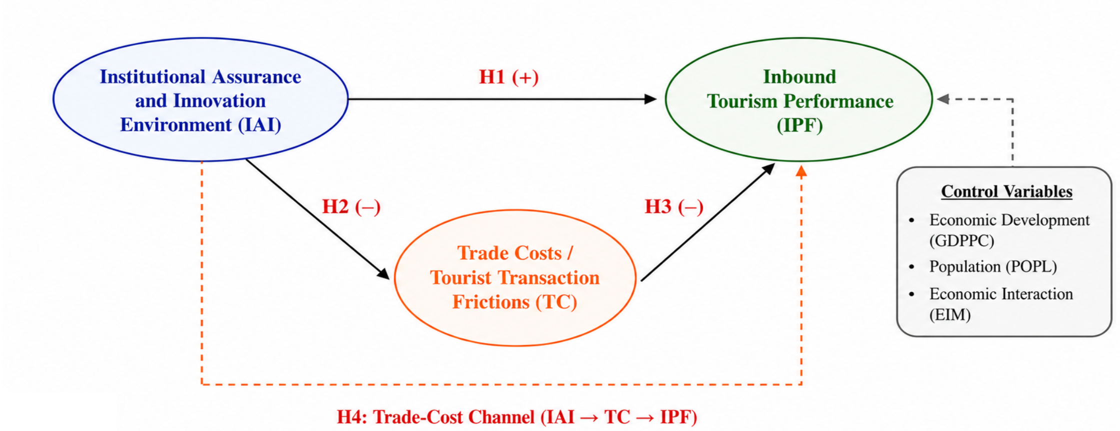

Figure 1. Research Framework.

Note: The signs (+) and (−) indicate the expected direction of the relationships.

3. Data, Variables, and Measurement

This study uses country-year panel data from China's major inbound tourism source countries. The sample includes 22 partner countries listed in **Table 1**. These countries are selected for two reasons. First, they are important source markets for China's inbound tourism. Based on author calculations from the National Bureau of Statistics of China (NBS) data, the 22 sample countries accounted for an average of 84.99% (range from 76.54% to 90.57%) of China's inbound tourism service exports over the 2004–2024 period, with the share exceeding 85% in most years after 2010. Second, the required tourism, economic, trade, and digital-related indicators are relatively complete for these countries. Therefore, the sample can represent China's main inbound tourism partner markets while keeping the dataset suitable for panel analysis.

The sample countries include top 10 leading countries in China's inbound tourism, so they are representative of China's overall inbound tourism market. Besides, these source countries cover different geographic regions. Specifically, the sample includes nine countries from Asia, two from Oceania, nine from Europe, and two from North America. This regional distribution helps capture the diversity of China's inbound tourism markets in case of relying on only one specific region.

Table 1. Sample Countries by Geographic Region.

Asia	Oceania	Europe	North America
Indonesia	Australia	Russia	United States
Thailand	New Zealand	United Kingdom	Canada
Philippines		France	
Mongolia		Germany	
Malaysia		Italy	
India		Netherlands	
Singapore		Portugal	
South Korea		Sweden	
Japan		Switzerland	

Source: Compiled by the author.

Although the annual share of the 22 sample countries varies over time, these countries consistently represent the major source markets for China's inbound tourism. The variation in coverage mainly reflects changes in the composition of China's inbound tourism markets across different years rather than a change in the core status of these countries as major partner markets. Since the number of sample countries is limited, further subgroup regressions by region or market type may produce unstable estimates. Therefore, this study focuses on the full-sample analysis and discusses the generalizability of the findings as a limitation.

China's statistical yearbooks have provided statistics on the number of tourists visiting China since 1990. But the figure at that time was still small, there was only the aggregate number without distinguishing different nationalities. Then, China joined the World Trade Organization (WTO) in

2001, and more and more foreigners visited China afterwards. The statistical data began to be collected by countries. Therefore, this study starts the sample period from 2004, when the required country-level tourism and economic indicators are more consistently available for the 22 partner countries [1,29].

The study covers the period from 2004 to 2024, which gives a 21-year time span. However, the COVID-19 pandemic caused abnormal shocks to international mobility and tourism flows. The years 2020–2022 are therefore excluded from the baseline sample [30]. In addition to the abnormal shock itself, comparable bilateral tourism-flow data for the pandemic years are incomplete and may not reflect normal tourism demand or transaction conditions. For this reason, this study does not impute the missing or abnormal values for 2020–2022, because such imputation would require strong assumptions and might introduce additional measurement bias. The empirical results should therefore be interpreted as reflecting the pre- and post-pandemic normal-period relationship rather than the exceptional pandemic shock.

After removing the pandemic years, the final dataset contains 396 observations. It forms a balanced panel of 22 countries over 18 years. The data are collected from several international databases, including tourism statistics, economic indicators, trade-related variables, and digital development indicators. The detailed variable definitions, measurement, and sources will be explained below separately.

3.1. Dependent Variable

As shown in **Figure 1**, this study chooses inbound tourism performance (IPF) as the dependent variable. Inbound tourism performance normally means the actual consumption of foreign visitors in the destination country, including accommodation, transportation, catering, entertainment, shopping, and other tourism-related services. Although the average tourism expenditure per capita may vary across all the sample countries, inbound tourist passengers can still provide an indirect representative measure of inbound tourism performance in the research model.

Therefore, this study uses the number of inbound tourists from the 22 sample countries to China as the measurement of IPF. The data are extracted from the official statistics yearbook published by the National Bureau of Statistics of China from 2004 to 2024. In order to reduce the influence of scale in different sample countries, this study selects the natural logarithm of inbound tourist arrivals as the value of dependent variable when calculated in the regression analysis.

This study acknowledges that inbound tourism performance can also be measured by tourism receipts, tourist expenditure, or tourism value added. However, comparable bilateral tourism expenditure data by source country are not consistently available for all 22 countries over the full sample period. Although tourist arrivals cannot fully capture per-capita tourism consumption or the total economic value of inbound tourism, they provide a more complete and comparable country-year measure for this study. Therefore, IPF in this study should be interpreted mainly as inbound tourism flow performance rather than the full economic value of inbound tourism.

To further address possible measurement-bias concerns, this study also considered several alternative proxies for inbound tourism performance, including bilateral tourism receipts, average tourist expenditure, tourism value added, and international travel-service receipts. However, these indicators are not consistently available by source country for all 22 partner countries over the full sample period. Some of them are reported only at the aggregate national level, while others are not comparable across countries and years. Therefore, this study retains inbound tourist arrivals as the main proxy because it provides the most complete and comparable bilateral country-year measure. This choice means that the dependent variable mainly captures tourism-flow performance, and the results should not be interpreted as fully representing the total monetary value of inbound tourism.

3.2. Independent Variable

As shown in **Figure 1**, the key explanatory variable is the Institutional Assurance and Innovation Environment (IAI). Although IAI is not treated as a direct measure of digital transformation itself, this study regards it as an environmental condition that may influence how digital technologies are governed and used. Specifically, IAI is treated as a composite enabling environment formed by complementary, rather than identical, conditions. ICT regulation, rule of law, and innovation output are theoretically distinct, but they jointly reflect the institutional and innovation conditions required for the reliable operation and continuous improvement of digital tourism services. In this framework, ICT regulation helps reduce digital service constraints, rule of law strengthens transaction trust and legal predictability, and innovation output supports service renewal and efficiency improvement. Therefore, this study treats IAI as a composite enabling environment while also acknowledging that aggregation may hide some dimension-specific effects. To address this concern, additional checks are reported in the robustness analysis, including an equal-weighted IAI index and a component-level regression in which ICT regulation, rule of law, and innovation output are jointly entered into the model.

In addition, the pairwise correlations among the three components are positive: 0.691 between ICT regulation and rule of law, 0.438 between ICT regulation and innovation output, and 0.448 between rule of law and innovation output. These correlations suggest that the three components are related but not redundant, which supports the use of a composite IAI index while also justifying the need for component-level robustness checks.

Although there is no explicit definition of how to calculate this IAI indicator, this paper summarizes an indicator system based on previous literature reviews in **Table 2**. In order to calculate the IAI index, this study integrated ICT regulatory environment, legal environment, and innovation output. These three indicators are selected to reflect the two main dimensions of this study. The ICT regulatory environment and legal environment are used to capture institutional assurance, while innovation output is used to reflect the innovation environment.

Table 2. Components, Measurements, and Data Sources of the IAI Index.

IAI Component	Measurement	Data Source
ICT regulatory environment	ICT Regulatory Tracker Overall Score	International Telecommunication Union
Legal environment	Percentile rank of Rule of Law	Worldwide Governance Indicators
Innovation output	Patent applications by residents	World Bank World Development Indicators

The ICT regulatory environment is measured by the ICT Regulatory Tracker Overall Score from the International Telecommunication Union [31]. This indicator reflects the regulatory conditions related to ICT development. The legal environment is measured by the percentile rank of Rule of Law from the Worldwide Governance Indicators [32]. This indicator is used to capture the quality of legal and governance conditions. Innovation output is measured by patent applications by residents from the World Bank World Development Indicators, which reflects a country's innovation-related output [29,33].

Because the IAI index is based on the above three indicators, principal component analysis (PCA) was used to combine them into one composite index. Before running PCA, the data were checked using the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity. The individual KMO values of the three indicators are all above 0.60, and the overall KMO value reaches 0.65. This suggests that the sample is acceptable for PCA with a small set of indicators. Bartlett's test is also significant, with $\chi^2(3) = 360.08$ and $p < 0.001$. These results show that the three indicators can be used for PCA. In addition, the Cronbach's alpha of the three IAI components is 0.769, indicating acceptable internal consistency among ICT regulation, rule of law, and innovation output. This result provides additional support for treating the three indicators as related dimensions of a broader institutional assurance and innovation environment.

According to the results shown in **Table 3**, the PCA result keeps only the first principal component. Its eigenvalue is 2.061, and it explains 68.70% of the total variance. The other two components have eigenvalues below one, so they are not retained. Therefore, the first component is used to calculate the IAI index.

The component score coefficients are reported in **Table 4**. Based on these coefficients, the IAI index is calculated as a weighted composite score of the three standardized indicators.

Table 3. PCA Results for the IAI Index.

Component	Initial Eigenvalue	Variance Explained	Cumulative Variance Explained
1	2.061	68.70%	68.70%
2	0.630	21.00%	89.70%
3	0.309	10.30%	100.00%

Table 4. Component Score Coefficients of the IAI Index.

Variable	IAI Component	Component Score Coefficient
X_1	ICT regulatory environment	0.6073
X_2	Legal environment	0.6104
X_3	Innovation output	0.5058

Accordingly, the IAI index is calculated as follows:

$$IAI = 0.6073X_1 + 0.6104X_2 + 0.5058X_3$$

where X_1, X_2, and X_3 represent the standardized values of ICT regulatory environment, legal environment, and innovation output, respectively.

3.3. Mediating Variable

Trade costs (TC) are introduced in this study as the mediating variable. In the context of cross-border tourism service trade, trade costs include expenses such as transaction fees, information search costs, and regulatory barriers. Digital technology can influence these costs in several ways[34]. Institutional assurance and innovation environments may provide regulatory support and innovation-related conditions that improve the efficiency of cross-border tourism transactions. When trade costs decline, the efficiency of resource allocation in international tourism services is improved, which, in turn, fosters the expansion of tourism service exports. Therefore, trade costs may serve as a transmission channel through which institutional assurance and innovation environments are associated with inbound tourism performance. Trade costs are calculated following the equation coined by Anderson and van Wincoop[9].

$$TC_{ij} = \left(\frac{X_{ii}X_{jj}}{X_{ij}X_{ji}}\right)^{\frac{1}{2(\rho-1)}} - 1$$

This specification is widely used in empirical gravity literature examining trade frictions between two trade partners[35,36], where i and j represent China and the sample countries respectively. X_{ii} represents domestic tourism service volume, namely the domestic tourism consumption in China and X_{jj} represents domestic tourism service volume in country j. Domestic tourism service volume is calculated as the difference between a country's total tourism output and its tourism service exports. In this study, total tourism output is obtained from UN Tourism, while tourism service exports are obtained from the WTO database. X_{ij} represents China's tourism service exports to country j, namely tourism services consumed in China by residents from the 22 partner countries. This variable is calculated based on inbound tourism data from the National Bureau of Statistics of China. X_{ji} is country j's export tourism services to China, namely tourism services consumed in country j by Chinese residents. This variable is collected from the World Bank database.

Following the trade gravity framework and the bilateral gravity specification proposed by Novy[34], the elasticity of substitution parameter (ρ) is set to 8, which is consistent with the empirical international trade literature. Since the calculated trade-cost value may be sensitive to this parameter, this study further recalculates TC in the sensitivity analysis later. This study also considered alternative proxies for tourism-related transaction frictions, such as visa facilitation, direct air connectivity, digital payment accessibility, language-service availability, and information-search convenience. These proxies can reflect specific dimensions of tourism frictions. However, complete and comparable annual bilateral data for these indicators are not available for all 22 source countries during 2004–2024. As a result, this study uses the Novy-type trade-cost measure as an aggregate proxy for cross-border tourism transaction frictions, while acknowledging that it cannot capture all specific friction channels. The sensitivity tests using alternative elasticity parameters are therefore used to examine whether the main results are driven only by the baseline trade-cost calculation.

3.4. Control Variables

Following the classic trade gravity model, this study includes several control variables. The purpose is to reduce the influence of source-country characteristics and bilateral economic relations with China. Three control variables are used in the empirical analysis.

Gross domestic product (GDP) per capita (GDPPC) means the income level of each tourism source country. Residents in higher-income economies are usually more able to afford cross-border travel, so this variable helps control for the purchasing power of the source market. The GDP per capita data used in this study are obtained from the International Monetary Fund (IMF) database[37].

Population size (POPL) shows the potential scale of outbound tourism demand. A country with a larger population may have a broader group of potential tourists visiting China. The data of population (POPL) can be found from the websites of World Bank[38]. This variable should be controlled when we are taking the scale effect into consideration.

Economic interaction (EIM) is measured by the total import and export volume between China and each sample partner country. Closer trade relations may be linked to more business visits, which may be counted as inbound tourism because it is sometimes difficult to distinguish business travel from other travel purposes. This paper extracts the bilateral export and import volume between China and 22 sample countries from the WTO database[39]. The EIM is the sum of these two numbers.

In the following empirical analysis, all these three control variables are transformed into natural logarithms due to their scales. By doing so, scale differences across countries would be reduced and the stability of the panel regression estimates would be improved at the same time.

4. Empirical Model and Results

Based on the data collection and measurement procedures described in Section 3, this study constructs a panel dataset covering 22 countries over 18 years. This section conducts the empirical analysis using Stata. Descriptive statistics and correlation analysis are first reported to show the distribution of variables and their preliminary relationships. Regression analysis is then used to examine the direct relationship between IAI and IPF. In addition, trade costs are included in the econometric model to examine whether they provide a possible mediating channel between IAI and IPF. Finally, robustness and sensitivity tests are conducted to examine the reliability of the empirical results.

4.1. Econometric Models

To test the relationships shown in the research framework, this study estimates three panel regression models[40]. The baseline model first tests whether institutional assurance and innovation environments are associated with China's inbound tourism performance.

$$IPF_{it} = \alpha_0 + \alpha_1 IAI_{it} + \beta_i\, Controls_{it} + \varepsilon_{it} \quad (1)$$

where i represents the partner country and t represents year. IPF_{it} denotes China's inbound tourism performance associated with partner country i in year t. IAI_{it} represents the institutional assurance and innovation environment. $Controls_{it}$ includes GDP per capita, population size, and economic interaction. ε_{it} is the error term.

To examine the trade-cost channel, the second and third models are estimated as follows.

$$TC_{it} = \alpha_0 + \alpha_1 IAI_{it} + \beta_i\, Controls_{it} + \varepsilon_{it} \quad (2)$$

$$\begin{aligned} IPF_{it} = \alpha_0 + \alpha_1 IAI_{it} + \alpha_2 TC_{it} + \\ \beta_i\, Controls_{it} + \varepsilon_{it} \end{aligned} \quad (3)$$

Equation (1) tests the direct relationship between IAI and IPF. Equation (2) examines whether IAI is related to trade costs. Equation (3) includes both IAI and TC to test whether trade costs are associated with inbound tourism performance after other factors are controlled.

The proposed mediating channel can be examined through the three equations together. If IAI is positively related to IPF in Equation (1), negatively related to TC in Equation (2), and TC is negatively related to IPF in Equation (3), the results provide evidence consistent with a possible trade-cost channel between IAI and inbound tourism performance.

4.2. Descriptive Statistics and Correlation Analysis

After data collection and processing, the final dataset was imported into Stata for the empirical analysis. **Table 5** gives a basic summary of the variables used in the regression analysis. The dataset contains 396 observations, covering 22 partner countries over 18 sample years.

Table 5 shows that the main variables differ across countries and years. IPF ranges from 11.111 to 19.199, while IAI ranges from 27.610 to 123.530. This indicates that both inbound tourism performance and institutional-innovation conditions vary across the sample. TC also varies across observations, with a minimum of 0.192 and a maximum of 1.022. This also shows that trade-related frictions differ among China's tourism partner markets.

Table 6 uses a 6 × 6 matrix to illustrate the pairwise correlations among the main variables. IAI is positively correlated with IPF, which is consistent with the expected relationship. While TC is also positively correlated with IPF in the simple correlation matrix, which contradicts with Hypothesis 3 proposed in Section 2. But, this result should be further tested, because the correlation matrix does not include the influence of the control variables, such as income level, population size, or bilateral economic interaction.

Table 5. Descriptive Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
IPF	396	16.403	1.354	11.111	19.199
IAI	396	98.745	24.003	27.61	123.53
TC	396	0.714	0.202	0.192	1.022
EIM	396	17.985	0.923	14.621	20.451
GDPPC	396	9.996	1.177	6.9	11.549
POPL	396	17.551	1.481	14.772	21.095

Note: The IAI index is constructed using PCA based on standardized component variables. The index is not re-standardized after PCA; therefore, its mean is not zero. This scaling does not affect the direction or statistical significance of the regression results, but it affects the numerical interpretation of the coefficient.

Table 6. Correlation Analysis.

Variables	IPF	IAI	TC	EIM	GDPPC	POPL
IPF	1.000					
IAI	0.329***	1.000				
TC	0.655***	0.488***	1.000			
EIM	0.257***	0.092	0.189***	1.000		
GDPPC	0.394***	0.817***	0.647***	−0.096	1.000	
POPL	0.438***	−0.342***	0.170***	0.403***	−0.391***	1.000

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The positive correlation between TC and IPF (0.655, $p < 0.01$) appears counterintuitive given Hypothesis 3. However, this simple correlation may partly reflect the mechanical structure of the Novy-type trade-cost measure, because bilateral tourism flows are included in the calculation of TC and are also closely related to the dependent variable. Therefore, the correlation between TC and IPF should be interpreted with caution and should not be treated as independent evidence of a causal relationship. This is why multivariate regression with control variables is necessary to examine the conditional empirical relationship rather than relying only on the simple correlation matrix. Most correlation coefficients are below 0.8. The relatively high correlation between IAI and GDPPC is noted, but the variance inflation factor (VIF) test does not show serious multicollinearity. The mean VIF value is 3.11, and all individual VIF values are below 10.

4.3. Baseline Regression and Mediation Results

According to the econometric model established in Section 4.1, Model 1 uses IPF as the dependent variable and examines the direct relationship between IAI and inbound tourism performance. At the same time, Model 2 changes the dependent variable to TC, so that the relationship between IAI and trade costs can be checked. Besides, Model 3 adds TC into the IPF model to examine whether the trade-cost channel is present after the control variables are included. To choose between fixed-effects and random-effects estimation, this study conducts the Hausman test [41]. The test result is statistically significant, indicating that the fixed-effects model is more appropriate for the baseline regression. Therefore, the baseline models are estimated using country fixed effects. Country fixed effects help control for time-invariant differences across tourism source countries, such as geographic distance, cultural proximity, long-term travel preference, and other country-specific characteristics. Since common year-specific shocks may also affect inbound tourism, this study further adds year fixed effects as an additional robustness check in Section 4.4.

Table 7 presents the detailed results of the three regression models. In Model 1, the coefficient of IAI α_1 is 0.0281 and is significant at the 1% level. This result is consistent with H1. It means that, after controlling for GDP per capita, population size, and bilateral economic interaction, countries with better institutional and innovation conditions tend to generate stronger inbound tourism performance for China.

Table 7. Baseline Regression and Mediation Results.

Variable	Model 1 IPF	Model 2 TC	Model 3 IPF
IAI	0.0281***	−0.00226***	0.0140**
	(0.0048)	(0.00016)	(0.0058)
TC	—	—	−6.294***
			(1.527)
EIM	−0.157**	−0.0228***	−0.302***
	(0.070)	(0.0023)	(0.077)
GDPPC	0.186	−0.0274***	0.0139
	(0.160)	(0.0053)	(0.162)
POPL	0.548	0.00019	0.553
	(0.674)	(0.0225)	(0.661)
Constant	4.973	1.602***	15.059
	(10.409)	(0.347)	(10.481)
Observations	396	396	396
Country fixed effects	Yes	Yes	Yes

Note: Robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The regression results of Model 2 are presented in the second column. The coefficient of IAI α_1 is −0.00226 and is also significant at the 1% level. This result supports H2 and suggests that a better institutional and innovation environment is associated with lower trade costs in cross-border tourism services. In practical terms, clearer rules, better governance, and stronger innovation capacity may help reduce transaction frictions faced by tourists and service providers.

In Model 3, TC has a negative coefficient α2 of −6.294 and is significant at the 1% level. This is consistent with H3 proposed in Section 2. At the same time, IAI remains positive and significant, but its coefficient α_1 falls from 0.0281 in Model 1 to 0.0140 in Model 3. This decline is consistent with the possibility that trade costs explain part, but not all, of the relationship between IAI and inbound tourism performance. Therefore, the results provide evidence consistent with the partial trade-cost channel proposed in H4.

The coefficient of TC in Model 3 is −6.294. Because TC is expressed as a proportion, a 0.1-unit increase in TC, equivalent to a 10-percentage-point increase, is associated with a 0.6294-log-point decrease in inbound tourist arrivals. This corresponds to approximately 46.7% lower tourist arrivals, calculated as $[\exp(-0.6294) - 1] \times 100\%$. The result indicates an economically meaningful negative association between trade costs and inbound tourism performance.

To further examine the proposed mediating channel, a Sobel test was calculated based on the coefficient of IAI in the TC model and the coefficient of TC in the IPF model. The test result is statistically significant ($z = 3.96$, $p < 0.001$), indicating that the indirect association between IAI and IPF through TC is statistically significant. In addition, the coefficient of IAI decreases from 0.0281 in Model 1 to 0.0140 in Model 3 after TC is included. The proportion associated with the mediating channel is approximately 50.2%, calculated as (0.0281 − 0.0140)/0.0281. These results provide further evidence consistent with the view that trade costs may serve as a partial explanatory channel between institutional assurance and innovation environment and China's inbound tourism performance. However, because the trade-cost measure is partly constructed from bilateral tourism-flow information, this result should be interpreted as supporting evidence for a possible mediating channel rather than as conclusive evidence of causal mediation.

4.4. Robustness, Sensitivity, and Additional Checks

To further examine the reliability of the empirical results, this section reports several supplementary checks. First, the baseline fixed-effects model is compared with a random-effects specification. Second, a two-way fixed-effects model is estimated by adding year fixed effects. Third, the trade-cost variable is recalculated using alternative values of the elasticity parameter ρ. Fourth, additional checks are conducted for the measurement of the IAI index and potential endogeneity. These tests are intended to examine whether the main findings remain broadly consistent under alternative specifications and measurement choices.

As a robustness check, the baseline fixed-effects model is replaced with a random-effects panel model. The purpose is not to choose a new main model, but to examine whether the main findings remain similar under an alternative panel specification. The results in **Table 8** are broadly consistent with the baseline findings. IAI remains positively and significantly associated with IPF in Model 1 and negatively and significantly associated with TC in Model 2. In Model 3, the coefficient of IAI remains positive and significant, while TC keeps the expected negative sign but becomes statistically insignificant. This suggests that the main relationship between IAI and inbound tourism performance is stable across model specifications, although the strength of the trade-cost channel varies under the random-effects model.

Table 8. Random Effects Estimation.

Variable	Model 1 IPF	Model 2 TC	Model 3 IPF
IAI	0.02597***	−0.00217***	0.02480***
	(0.0045)	(0.00017)	(0.00467)
TC	—	—	−0.71515
			(0.74964)
EIM	−0.1616***	−0.02419***	−0.19112***
	(0.0591)	(0.00239)	(0.06674)
GDPPC	0.2517**	−0.02155***	0.27585**
	(0.1176)	(0.00519)	(0.12028)
POPL	0.6683***	−0.00088	0.68807***
	(0.1337)	(0.01491)	(0.13531)
Constant	2.4988	1.59427***	3.06821
	(2.4315)	(0.23585)	(2.50415)
Observations	396	396	396

Note: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

As an additional robustness check, this study further estimates a two-way fixed-effects model by adding year fixed effects to the country fixed-effects specification. Country fixed effects control for time-invariant differences across tourism source countries, while year fixed effects capture common shocks that may affect China's inbound tourism in a given year. The results are explicitly illustrated in the following **Table 9**.

Table 9. Two-Way Fixed-Effects Estimation.

Variable	Model 1 IPF	Model 2 TC	Model 3 IPF
IAI	0.0089*	−0.0011***	0.0025
	(0.0048)	(0.0004)	(0.0050)
TC	—	—	−5.5799*
			(3.0307)
EIM	−0.4589**	0.0266***	−0.3106*
	(0.2009)	(0.0074)	(0.1750)
GDPPC	0.4151*	−0.0129	0.3433
	(0.2166)	(0.0116)	(0.2047)
POPL	−0.8400	0.0393	−0.6207
	(1.0146)	(0.0566)	(1.0445)
Observations	396	396	396
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes

Note: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results show that the coefficient of IAI remains positive in the IPF model, although its significance becomes weaker. IAI also remains negatively and significantly associated with TC. After TC is included, the coefficient of TC remains negative and marginally significant. These results suggest that the main direction of the baseline findings remains broadly consistent after controlling for both country and year effects, although the trade-cost channel becomes weaker under this more demanding specification.

Since the baseline trade-cost measure is calculated using $\rho = 8$, this study further tests whether the results are sensitive to the choice of this parameter. The trade-cost variable is recalculated using alternative values of $\rho = 6$ and $\rho = 10$, and the mediation model is re-estimated.

Table 10 reports the sensitivity test using alternative values of ρ. The coefficient of TC remains negative and statistically significant at the 1% level across all three parameter settings. Specifically, the estimated coefficient of TC is −3.7821 when ρ = 6, −6.2941 when ρ = 8, and −8.8470 when ρ = 10. The coefficient of IAI also remains positive and significant. These results indicate that the negative relationship between trade costs and inbound tourism performance is not driven solely by the baseline elasticity parameter. Therefore, the trade-cost channel remains stable under alternative parameter assumptions.

To examine whether the IAI index may obscure differences among its three components, this study further conducts additional checks for IAI measurement and potential endogeneity. First, an equal-weighted IAI index is constructed using the standardized values of ICT regulation, rule of law, and innovation output. The correlation between the PCA-based IAI and the equal-weighted IAI is 0.945, indicating a high degree of consistency between the two measurement approaches. Second, the three IAI components are jointly entered into the regression model to examine whether aggregation hides dimension-specific effects. Third, a lagged explanatory-variable model is estimated by replacing current IAI with its one-period lag to reduce concerns about potential reverse causality.

Column 1 uses an equal-weighted IAI index based on the standardized values of ICT regulation, rule of law, and innovation output. Column 2 jointly enters the standardized values of ICT regulation, rule of law, and innovation output. Column 3 uses the one-period lag of the original PCA-based IAI index.

Table 11 reports the results. The equal-weighted IAI remains positively and significantly associated with inbound tourism performance, suggesting that the main result is not driven only by the PCA weighting method. In the component-level model, ICT regulation, rule of law, and innovation output all have positive coefficients, although their statistical significance differs. This suggests that the three components are related but not identical. Therefore, the composite IAI index is useful for capturing the broader enabling environment, while dimension-specific results should still be interpreted with caution. The coefficient of lagged IAI also remains positive and marginally significant, which helps reduce concerns that the main relationship is driven only by contemporaneous correlation. However, this lagged-variable check is only an exploratory way to reduce contemporaneous-correlation concerns. It does not fully eliminate reverse causality or omitted-variable bias, and the findings should still be interpreted as conditional empirical associations rather than definitive causal estimates.

Table 10. Sensitivity Test Using Alternative Values of ρ.

Variable	ρ = 6	ρ = 8	ρ = 10
IAI	0.0139**	0.0140**	0.0142**
	(0.0057)	(0.0058)	(0.0058)
TC	−3.7821***	−6.2941***	−8.8470***
	(0.8930)	(1.5269)	(2.1878)
EIM	−0.3226***	−0.3003***	−0.2876***
	(0.0793)	(0.0773)	(0.0763)
GDPPC	0.0251	0.0139	0.0090
	(0.1613)	(0.1625)	(0.1631)
POPL	0.6612	0.5533	0.4950
	(0.6599)	(0.6602)	(0.6608)
Observations	396	396	396

Note: Robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11. Additional Checks for IAI Measurement and Endogeneity.

Variable	Equal-Weighted IAI	IAI Components Jointly Entered	Lagged IAI
IAI_equal	0.7451***	-	-
ICT regulation	-	0.2746***	-

Table 11. *Cont.*

Variable	Equal-Weighted IAI	IAI Components Jointly Entered	Lagged IAI
Rule of law	-	0.2262	-
Innovation output	-	0.1963*	-
L.IAI	-	-	0.0102*
Controls	Yes	Yes	Yes
Observations	396	396	374

Note: The dependent variable is IPF. Significance levels are based on regression *p*-values. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. To save space, the coefficients of control variables are not reported in this table.

In addition, this study considered the possibility of using instrumental-variable regression or quasi-experimental designs to further address endogeneity. However, a valid instrumental variable would need to be strongly correlated with institutional assurance and innovation environment while affecting China's inbound tourism performance only through this channel. Given the macro country-year structure of the data and the long sample period, it is difficult to identify such an instrument without introducing new exclusion-restriction concerns. Similarly, no clear exogenous policy shock is available for all 22 source countries over the full sample period to support a quasi-experimental design. Therefore, this study does not claim strict causality. The empirical results are interpreted as conditional associations and mechanism-related evidence, while the possibility of reverse causality and omitted-variable bias is further discussed in the limitations section.

5. Discussion

The empirical results provide useful implications for understanding China's inbound tourism performance under the context of digital tourism transformation. These implications should be understood mainly in relation to China's major inbound tourism source markets represented by the 22 sample countries. The positive coefficient of IAI indicates that institutional assurance and innovation environment are positively associated with inbound tourism performance. This finding suggests that digital tourism services may not depend only on the availability of digital platforms or tools. They also require a broader environment in which digital services are regulated, legally supported, trusted, and innovatively applied. Therefore, improving China's inbound tourism performance requires attention not only to digital technology itself, but also to the institutional and innovation conditions behind its use.

The results also show that IAI is negatively associated with trade costs, while trade costs are negatively associated with inbound tourism performance. This suggests that institutional assurance and innovation environment may be associated with lower transaction frictions in cross-border tourism services. For foreign visitors, these frictions may appear in information search, online booking, digital payment, language communication, refund rules, service coordination, and uncertainty about consumer protection. Clearer ICT regulation, stronger legal predictability, and better innovation capacity may help make tourism-related digital services more transparent, reliable, and easier to use. These findings provide evidence consistent with the view that trade costs may serve as a possible explanatory channel linking IAI and inbound tourism performance, although this channel should not be interpreted as definitive causal mediation.

The additional checks on the IAI index further suggest that institutional assurance and innovation environment should not be understood as a single policy lever. The IAI index gives similar weights to ICT regulation and rule of law, while innovation output also contributes to the composite index. The component-level results show that ICT regulation, rule of law, and innovation output all have positive coefficients, although their statistical significance differs. This means that the three dimensions are related but not identical. ICT regulation may help improve the reliability of digital platforms, online booking systems, digital payment channels, and data-related services [42]. Rule of law may improve tourists' confidence by strengthening legal predictability, consumer protection, contract enforcement, and dispute resolution. Innovation output may support the development of more convenient tourism services, such as platform-based service integration, smart customer service, and more efficient coordination among tourism providers [43,44]. Recent sustainability research also shows that green technological innovation can contribute to environmental resilience and sustainable resource management beyond the tourism sector. Although the study is situated in environmental science, Purigay (2025)[45] is not used as direct tourism evidence, but as a recent interdisciplinary example showing how innovation-driven solutions can support sustainable development and resource management. Recent tourism-specific studies also discuss innovation-driven tourism competitiveness and open innovation in the tourism field, further supporting the role of innovation ecosystems in sustainable tourism development[46,47].

Recent China-specific studies and reports also support the need to understand inbound tourism and sustainable tourism within the localized Chinese context. China's inbound tourism recovery in 2024 was closely related to visa facilitation, payment convenience, accommodation services, and destination-level service improvement[48]. Studies on China's urban tourism competitiveness further show that sustainable tourism development requires the integration of economic competitiveness, social governance, service quality, and environmental considerations[49]. In addition, research on low-carbon rural tourism governance in China highlights the importance of multi-level institutional coordination and stakeholder participation for achieving sustainable tourism objectives[50]. These China-focused studies support the argument that institutional assurance, digital governance, innovation capacity, and localized service coordination are important for sustainable inbound tourism development in China.

The empirical findings of this study have implications beyond economic tourism performance. The association between IAI, trade costs, and inbound tourism flows can be interpreted in the context of ecological sustainability. When trade costs—understood as transaction frictions in cross-border tourism services—are reduced, tourists may experience smoother information search, booking, payment, and service coordination. This does not necessarily increase total resource use if service coordination improves efficiency. For example, better digital information systems can help distribute tourists more evenly across destinations, reduce unnecessary repeated bookings, and minimize inefficient travel arrangements—all of which may reduce the ecological footprint per tourist.

Institutional assurance—through clearer ICT regulation, stronger rule of law, and better consumer protection—can improve the reliability of digital platforms, making it easier for tourists to trust online information and complete transactions without unnecessary delays or repeated interactions. Innovation capacity can further support the development of integrated tourism platforms that coordinate transportation, accommodation, attractions, and payment services in real time. These improvements may reduce the time, effort, and resource waste associated with poorly coordinated tourism services. In this sense, the institutional and innovation environment may contribute not only to economic efficiency but also to the ecological sustainability of inbound tourism by reducing redundant service arrangements and supporting more efficient destination management.

These implications can be further linked to the economic, social, and environmental objectives of sustainable tourism. Economically, lower transaction frictions may improve the efficiency of inbound tourism services, increase the conversion of potential tourism demand into actual visits, and support tourism-related service consumption. Socially, clearer rules, stronger consumer protection, and more accessible digital services may improve foreign visitors' sense of security, fairness, and service inclusiveness, especially when they face language, payment, or information barriers. Environmentally, better service coordination and digital information systems may help tourists plan trips more efficiently, reduce unnecessary repeated bookings and inefficient travel arrangements, and support more orderly destination management. Therefore, the sustainability contribution of IAI should be understood not only as tourism growth, but also as more efficient, inclusive, and better-coordinated inbound tourism development.

The policy suggestions can also be differentiated by stakeholder group. For government and tourism regulators, the priority is to improve digital-service rules, cross-border payment standards, data governance, consumer protection, and multilingual public tourism information. For digital platforms and tourism enterprises, the priority is to improve foreigner-friendly booking interfaces, transparent refund rules, international payment compatibility, and real-time customer support. For destination managers and local service providers, the priority is to strengthen coordination among attractions, hotels, transportation providers, and payment-service providers, so that foreign visitors can complete travel planning, payment, mobility, and service recovery more smoothly. These stakeholder-specific suggestions are consistent with the empirical findings that IAI is positively associated with inbound tourism performance and negatively associated with trade costs.

At the same time, the policy implications should be interpreted within the scope of the empirical evidence. Accordingly, the policy recommendations are mainly derived from the empirical associations among IAI, trade costs, and inbound tourism performance. Recommendations related to clearer digital-service rules, stronger consumer protection, better payment convenience, and improved service coordination correspond to the institutional, legal, innovation, and transaction-friction dimensions examined in the empirical analysis. The 22 sample countries represent China's major inbound tourism source markets, but they do not cover all potential source countries or smaller emerging markets. Therefore, the findings should not be generalized to the entire inbound tourism ecosystem without caution. Suggestions related to multilingual platforms, smart customer service, digital payment convenience, and tourism service coordination can be understood as practical extensions of a broader institutional and innovation environment, but they are not directly measured variables in this study. Therefore, the findings should be understood as conditional empirical associations and mechanism-related evidence rather than strict causal estimates.

This study does not claim direct measurement of ecological impacts, but it provides a framework for linking institutional conditions, transaction frictions, and tourism sustainability. Future research could use destination-level ecological indicators, such as carbon emissions from tourism, water consumption per tourist, or biodiversity pressure indices, to directly test the ecological implications of institutional assurance and innovation-driven service coordination.

6. Conclusion

Models 1 to 3 in Section 4 examine the relationships among institutional assurance, innovation environment, trade costs, and China's inbound tourism performance. The results show that a stronger IAI is associated with better inbound tourism performance. Trade costs also provide evidence consistent with a partial explanatory channel. The findings generally support the relationships proposed in H1–H4, although the results should not be interpreted as definitive causal proof. To be specific, China's inbound tourism development depends not only on digital tools, but also on the conditions that support their use. From the perspective of the IAI index, clearer ICT regulation, stronger legal protection, and better innovation capacity may help reduce transaction frictions in cross-border tourism services.

This study also has several limitations. First, the results should be interpreted as macro-level empirical associations rather than strict causal estimates. Although the fixed-effects models, robustness analyses, sensitivity tests, and the lagged explanatory-variable check help reduce some concerns, they cannot fully eliminate reverse causality or omitted-variable bias. In particular, the lagged IAI model should be understood as an exploratory check rather than a complete solution to endogeneity. Stronger tourism performance may encourage institutional cooperation, digital service improvement, and innovation activities. This study also considered instrumental-variable regression and quasi-experimental designs. However, a convincing instrument or common exogenous policy shock suitable for all 22 countries over the full sample period could not be identified. Therefore, the empirical findings should be understood as conditional associations rather than causal estimates. Future research may use stronger identification strategies, such as instrumental variables, dynamic panel estimators, or quasi-experimental designs, to further examine the causal mechanism among institutional assurance, innovation environment, trade costs, and inbound tourism performance.

Second, the IAI index is a composite measure. Although PCA results, Cronbach's alpha, the equal-weighted index, and component-level regression provide support for the measurement strategy, ICT regulation, rule of law, and innovation output are not identical dimensions. The composite index may still hide some dimension-specific mechanisms. In addition, the mediation results should be interpreted with caution because the trade-cost variable is partly constructed using tourism-flow information that is closely related to the dependent variable. Although the empirical results are consistent with the proposed trade-cost channel, they should not be interpreted as definitive evidence of causal mediation. The measurement of both inbound tourism performance and trade costs also has limitations. Alternative dependent-variable proxies, such as bilateral tourism receipts, tourist expenditure, tourism value added, or travel-service receipts, may better capture the monetary value of inbound tourism. Alternative trade-friction proxies, such as visa convenience, air connectivity, digital payment accessibility, and language-service availability, may capture more specific channels of tourism transaction costs. However, these indicators are not consistently available for all 22 source countries over the full sample period. Future studies may use more detailed bilateral expenditure data, tourist-level survey data, platform data, or destination-level service data to reduce measurement bias and provide stronger evidence.

Third, the sample is limited to 22 major source countries, which represent China's main inbound tourism markets but may not fully capture smaller or emerging markets. The exclusion of 2020–2022 also remains a limitation because the COVID-19 period involved abnormal international mobility shocks and incomplete bilateral tourism-flow data. Future studies may use broader samples, alternative measures of tourism transaction frictions, and more complete post-pandemic data to provide stronger evidence.

By combining tourism economics, institutional theory, and ecological sustainability perspectives, this study provides an integrated explanation of how institutional assurance and the innovation environment may be linked to sustainable inbound tourism through reductions in transaction frictions. While the empirical analysis focuses on tourism performance as a flow measure, the findings suggest potential indirect contributions to ecological sustainability through improved service coordination, reduced inefficient travel arrangements, and more orderly destination management. Nevertheless, the theoretical contribution should be viewed as an incremental extension rather than a transformative claim, and the findings are most applicable to China's major inbound tourism source markets represented by the 22 countries in the sample. Future research should incorporate direct ecological indicators, such as carbon footprint, water consumption, or biodiversity impacts, to further examine the environmental implications of institutional and innovation conditions for tourism development. Overall, this study contributes to the growing literature on tourism–ecology interactions by highlighting the role of governance and innovation in shaping more efficient, better-coordinated, and potentially more ecologically sustainable cross-border tourism.

Author Contributions

Conceptualization, methodology, data collection, formal analysis, and writing—original draft preparation, R.H.; supervision, validation, writing—review and editing, and guidance on research design and theoretical framework, C.S. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work, ensuring its accuracy and integrity.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The data used in this study are available from the authors upon reasonable request.

Acknowledgments

The authors would like to express their sincere gratitude to Chakrabongse Bhuvanarth International College of Interdisciplinary Studies, Rajamangala University of Technology Tawan-Ok, for academic support. The authors also appreciate the valuable guidance and feedback provided during the development of this study.

Conflicts of Interest

The authors declare that there is no conflict of interest.

AI Use Statement

The authors declare that no artificial intelligence (AI) tools were used in the preparation of this manuscript.

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