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Planes, Trains and Tourists Gains: Cogent Role of Transport Infrastructure on India's Foreign Tourist Growth

Abstract

The relationship between transport infrastructure and tourism development is substantial, as tourists' mobility largely depends on infrastructure. Therefore, this paper examines the role of transport infrastructure as a significant determinant of foreign tourist growth in India. This study employs 44 years of time-series data from 1980 to 2023, because the Government of India declared its first tourism policy in the 1980s. To understand the rate at which the system reverts to the long-run equilibrium following a short-run shock, we use the Autoregressive Distributed Lag (ARDL) model and the Error Correction Model (ECM). The results of this paper show a long-term relationship between variables such as air transport, GDP and exchange rates, which provide substantial access to foreign tourist benefits. Rail and road infrastructure have a minor contribution to foreign tourist arrivals. The error-correction model indicates robust short-term adjustment towards equilibrium following short-term disturbances. Finally, the Granger causality results indicate unidirectional and bidirectional causality between the variables, supporting the centrality of the transport variable in foreign tourist development in India. The article offers an innovative method that combines multimodal transport variables and non-transport variables to assess the process of tourist progression in India.

Keywords: exchange rate, foreign tourist, India, time series and transport infrastructure

1. Introduction

Tourism is an industry that has blossomed since the beginning of human evolution and has unlocked its vast, untapped potential worldwide (Yanying et al., 2026). The World Travel & Tourism Council (2023) reports that the tourism industry employed 330 million people and created 27.4 million jobs in 2023, accounting for 9.1 percent of the world's GDP, underscoring its importance as one of the most significant drivers of the global economy. Among the earliest uses of the term tourism was the outing undertaken for religious or philosophical purposes (Mallick et al., 2020; Oberoi et al., 2022; Saini et al., 2023; Kansra et al., 2024). Tourism, as a social phenomenon, highlights the complex relationships formed through interactions among travellers, residents, and governments across countries worldwide. One of the most important elements of the broader tourist system is the link between transport and tourism (Liu et al., 2023; Rohini & Meenakshi, 2024).

As the Indian economy grows steadily in the infrastructure sector, the tourism sector will flourish amid a wealth of opportunities, an endeavour that is marked by caution and astuteness. India, with its diverse landscapes, rich biological and cultural heritage, offers a potential that cannot be duplicated in tourism development.

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India has unequivocal potential for tourism development, with a richness of life in innumerable forms and a heritage woven in colour. According to the International Union for Conservation of Nature and Natural Resources (2023), India can be considered a kingdom of unmatched biodiversity due to its unique and marvellous ecosystems. In the words of Das and Hussain (2016), India, due to its rich culture, traditions, physiography and ecosystems, is an attractive location for such initiatives. People travel long distances and use various methods for various purposes, and transportation is the key to their movement. Tourism primarily relies on transportation for two main reasons: first, it enables people to travel from one place to another, and second, once they arrive at their destination, they can easily get around. This process spreads visitors' movement, exposing them to more areas than they would otherwise reach (Dileep & Pagliara, 2023).

Tourism-linked transport comprises a range of modes operating within extensive networks of points and routes. Modes such as air, rail, road, and water vary in their provision within each set (Duval & Macilree, 2024). These networks, which facilitate transport modalities, serve as vital economic channels to numerous destinations (Duval, 2007). Networks can be domestic or global, with tourist movement, including passengers on domestic and international airlines and regional or interstate road travel, representing an established method of visitor arrivals. Transport infrastructure is a major facet and determinant of the success of any tourist destination industry (Nenavath, 2023). This is especially clear in the case of geographically expansive destinations, such as India, which depend heavily on all modes of transport. This paper therefore, analyses how transport infrastructure is a major determinant of foreign tourist growth in India. This is done by incorporating the traditional demand function for international tourism and including variables for transport and non-transport infrastructure. The two unique contributions of the article to the literature available in the Indian context include the use of both transport and non-transport factors that were not well explored and had little focus in previous research, including rail infrastructure, power production, and population density. Second, the study covers the time frame from 1980, the year of the original tourism policy in India, and offers a long-term vision that has never been addressed in the literature.

The subsequent section of the study is organised as follows: Section 2 elucidates a comprehensive segment of the existing literature. Section 3 delineates the current state of road infrastructure and its correlation with economic growth. Section 4 of this paper outlines the variables, data and methodology. Section 5 of the study delineates and examines the findings derived from the analysis. Finally, sections 6 and 7 discuss the study's conclusion, limitations and scope for future research.

2. Literature review

Tourism development and the nature of transport systems are so interrelated that transport infrastructure is critical to the movement of large numbers of tourists. One can therefore argue that transport infrastructure contributes positively to attracting inbound tourists, thereby improving tourism growth. According to Prideaux (2000), one of the crucial elements that influence a destination's ability to attract tourists is transport infrastructure. The author identifies the transportation system used in tourism as the interaction and functioning of transport modes, together with the transport services that help tourists travel to and from destinations. Unlike other determinants, transport infrastructure is the strongest determinant of destination choice, as Khadaroo and Seetanah (2007, 2008) conclude, and therefore tourists are more vulnerable to it.

An influential article by Khan et al. (2017) highlighted the importance of airways and rail transport in boosting the impact of inbound tourism, underscoring the significance of the transport sector in promoting global tourism growth. The centrality of air transport has a significant impact on personality, promoting inbound tourism. Inbound tourism further contributes to the development of urban tourism economies in developing regions through this promotion (Zheng et al., 2016). Moreover, improved transport infrastructure, particularly road and air transport, is likely to reduce the transportation costs of leisure tourists (Khadaroo & Seetanah,

2008). According to Khoshnevis Yazdi and Khanalizadeh (2017), to attract more tourists and to predict a significant rise in tourism, the availability of transport infrastructure is inevitable. Moreover, in order to contribute to the discussion, the articles by Spasojevic et al. (2018) and Nguyen (2021) also emphasised the inseparable nature of air transport, including air movements and route preparation.

The development of transport supports economic growth and creates interest in tourism promotion in the community (Kanwal et al., 2020). High-speed rail systems facilitate increased visitation, despite the initial transport infrastructure not being explicitly designed for tourism (Yao et al., 2022; Shen et al., 2023b). The transport infrastructure provides access to previously unreachable sightseeing sites for tourists (Hussain et al., 2023). Barman and Nath (2018) performed a study in the Indian context and found that infrastructural development is significantly correlated with relative pricing. Another effect of air transport on tourism demand, also identified in the study, was its beneficial impact. The links between transit and travel will remain close, which is emphasised by Duval and Macilree (2024).

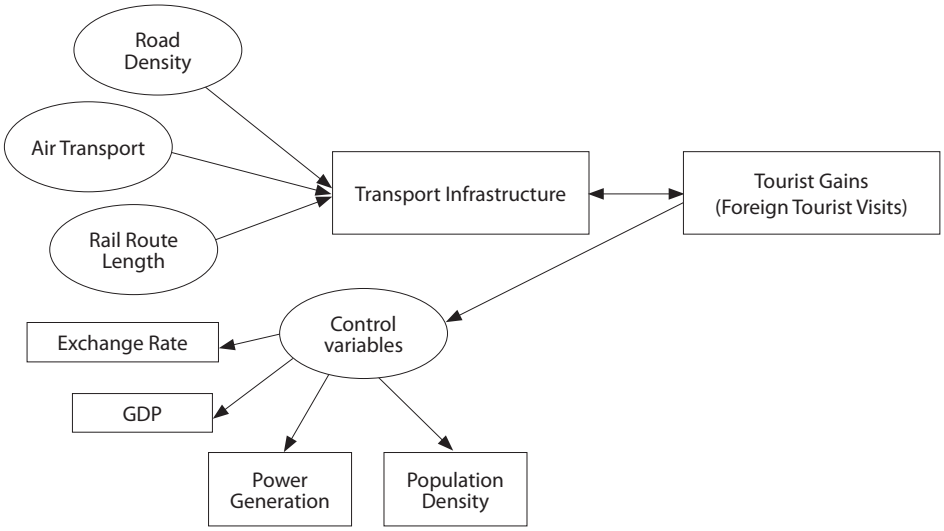
An important omission in the current literature is the lack of a multidimensional analysis of the impact of transport infrastructure on tourism-led growth. Previous research has explored the importance of transport infrastructure in enhancing accessibility and the benefits it provides to tourists. Conversely, few studies have comprehensively combined macroeconomic theory to examine the role of transport infrastructure in facilitating tourism and contributing to overall economic development, given advancements in connectivity, market growth, and increased productivity. The current research fills this gap by integrating multimodal transport variables (air, rail, road) with key macroeconomic variables, such as exchange rate, gross domestic product, power generated, and population density, to provide a comprehensive and balanced analysis of their combined effects on foreign tourist inflow. In this way, planning transport investments in line with the prospective tourism industry aligns with the paradigm of endogenous growth theory, in which the externalities associated with infrastructural development induce demand and result in long-term growth of tourism and the economy.

3. Conceptual framework

In one of the seminal research papers by Dash and Sahoo (2010), it was established that the evolutionary economic development of India has been strongly associated with improvements in infrastructure, specifically transport infrastructure. The expansion and maintenance of these key arteries have triggered the growth of various companies, especially in the new tourism industry. The dynamic Indian economy is geared towards moderate and prudent investment in transport infrastructure, as this serves as a significant springboard for tourism-based growth, improved connectivity, accessibility, and economic prospects (Sharma et al., 2025).

The majority of the extant literature highlights the indivisible role of transport infrastructure in shaping the growth of the Indian tourism industry and, subsequently, the broader growth of the country's economy. Improved road conditions and expansion of the highway network have been shown to increase farm households' market participation, resulting in significant financial benefits for rural regions. In addition, the strategic improvement of Indian highway infrastructure has facilitated the efficient redistribution of labour across industries, making human capital more productive and driving structural change (Sahoo & Dash, 2009). Similar outcomes have been witnessed in other developing economies, where strong transport infrastructure has been crucial in realising the economic potential of the tourism sector. The tourism sector is a pivotal catalyst for national progress, significantly enhancing the country's brand value, image, and regional identity. Barman and Nath (2019) identified a strong correlation between relative pricing and infrastructural development, which supports tourism growth in India. Figure 1 of this study illustrates the conceptual framework, which highlights that independent transport infrastructure variables, such as planes, trains, and roads, can Granger-cause foreign tourist visits (tourist gain) either unidirectionally or bidirectionally. Lastly, controlled variables such as exchange rate, GDP, population density and power generation exhibit both unidirectional and bidirectional causality.

Figure 1
Schematic profile of the transport and control variables on tourist gains



Source: Authors compilation.

4. Materials and methods

44 years of 'time series' yearly data from 1980 to 2023 are utilised in this paper. This study commenced in 1980, as the Government of India (GoI) announced its first tourism policy that year. We used 'Total Foreign Visits' in India as a proxy variable to assess tourist gains. The data on foreign visits was retrieved from the Ministry of Tourism. A seminal paper by Al-Mulali et al. (2019) concluded that the number of tourist arrivals is a better indicator than tourist receipts. Furthermore, data on transport infrastructure variables, such as air passenger movements, national highway density, and rail route length, were used as proxy variables for transport infrastructure, retrieved from various available data sources, including CMIE and Indiastat. Lastly, the World Development Index (WDI) and CMIE economic outlook provided data on key controlled variables, including exchange rates, gross domestic product, population density, and power generation. Detailed information on study variables and data sources is shown in Table 1.

Table 1
Study variables

Variable	Full form	Data sources
FTV	Foreign Tourist Visit (in Millions)	Ministry of Tourism, Government of India (Indiastat.com)
AIR	Air Transport, Passenger Carried (in Millions)	Ministry of Civil Aviation, Government of India (Indiastat.com)
RAIL	Route Length in KMs	Ministry of Railways, Government of India (CMIE Economic Outlook, Indiastat.com)
NHD	National Highway Density (Kilometres per 100 Sq. Km)	Ministry of Road Transport & Highways, GoI (CMIE Economic Outlook, Statista and WDI)
EXR	Exchange Rate	World Development Index (WDI)
POWER	Power Generation (in Million KwH)	Ministry of Power, Government of India (Indiastat.com, CMIE Economic Outlook)
GDP	Gross Domestic Product	Ministry of Statistics and Programme Implementation (CMIE Economic Outlook)
POPD	Population Density (People per Sq. Km of Land Area)	(Indiastat.com, CMIE Economic Outlook)

Source: Calculations based on secondary data from E-views.

To examine the relationship between transport infrastructure and tourism development, we employed the Autoregressive Distributed Lag (ARDL) model, which accounts for both long- and short-term relationships among the variables (Sharma et al., 2025). Moreover, the cointegrating relationships between two or more non-stationary time series variables have been determined using the 'Bounds' cointegration test. Other methods used to cointegrate, such as the vector error correction model (VECM) and the Johansen cointegration method, were rejected primarily because they were unable to address mixed orders of integration variables adequately. In this way, the ARDL bounds testing methodology serves well in testing both I(0) and I(1) variables and provides strong results in such situations (Pesaran et al., 2001). Secondly, an ARDL model is appropriate when the sample and time series data are limited and the time series is short, thereby providing an efficient estimate of the short- and long-run dynamics of the system.

After cointegration, we used the Error Correction Model (ECM) to estimate the short-run and long-run relationships. The error correction model will help capture how quickly the system returns to its long-run equilibrium following a brief shock to the short run. We have also used the Granger Causality model to determine the causal relationship between the economic variables (Granger, 1988). In its simplest form, Granger Causality is a statistical method that examines the precedence or predictive relationship. Finally, to address issues of model bias and poor performance, we conducted a stability test to ensure the relationships we observed are statistically significant and reliable.

The empirical presentation of the ARDL model is as follows:

$$\mathrm{LFTV_t} = \alpha + \sum_{i=1}^{p} \beta i\ \mathrm{LFTV_{t\text{-}i}} + \sum_{j=0}^{q1} \gamma j\ \mathrm{LAIR_{t\text{-}j}} + \sum_{j=0}^{q2} \delta j\ \mathrm{LRD_{t\text{-}j}} + \sum_{j=0}^{q3} \theta j\ \mathrm{LRAIL_{t\text{-}j}} + \sum_{j=0}^{q4} \lambda j\ \mathrm{LGDP_{t\text{-}j}} + \sum_{j=0}^{q5} \Phi j\ \mathrm{LPOWER_{t\text{-}j}} + \sum_{j=0}^{q6} \mu j\ \mathrm{LPOPD_{t\text{-}j}} + \sum_{j=0}^{q7} \psi j\ \mathrm{LEXR_{t\text{-}j}} \quad (1)$$

Mathematical representation of the Error Correction Model (ECM)

$$\mathrm{LFTV_t} = \alpha + \sum_{i=1}^{p\text{-}1} \beta i\ \mathrm{LFTV_{t\text{-}i}} + \sum_{j=0}^{q1} \gamma j\ \mathrm{LAIR_{t\text{-}j}} + \sum_{j=0}^{q2} \delta j\ \mathrm{LRD_{t\text{-}j}} + \ldots\ldots\ldots\ldots + \sum_{j=0}^{q7} \psi j\ \mathrm{LEXR_{t\text{-}j}} \quad (2)$$

5. Results

According to Granger (1969), it is critical to ensure the stationarity of the study data series, and we assessed this using the Augmented Dicky-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests (Dickey & Fuller, 1979; Phillips & Perron, 1988; Kwiatkowski et al., 1992). Table 2 of the present study shows that all variables are stationary at the first difference. Stationarity at I (1) is an essential step, as most cointegration methods are inefficient while addressing the I (2) series.

Table 2
Unit root test for stationarity

Variable	ADF	PP	KPSS	Inference
ΔLFTV	-5.63	-18.05	125.61	I (1) stationary
ΔLAIR	-6.06	-6.05	114.23	I (1) stationary
ΔLRAIL	-7.85	-7.74	130.77	I (1) stationary
ΔLNHD	-4.70	-4.76	4.46	I (1) stationary
ΔLEXR	-4.27	-4.23	34.04	I (1) stationary
ΔLPOWER	-8.97	-8.69	172.95	I (1) stationary
ΔLGDP	-4.57	-4.61	70.13	I (1) stationary
ΔLPOPD	-4.34	-4.31	107.57	I (1) stationary

Source: Calculations based on secondary data from E-views.

With confirmation of the variable's stationarity, we proceeded with the bounds test for cointegration. The results of the bounds test, as shown in Table 3, feature an F-statistic value of 14.68, which clearly refutes the null hypothesis of no long-run relationship between the variables and suggests a noteworthy cointegration relationship. The estimated long-run coefficient values suggest that variables such as air transport (LAIR), exchange rate (LEXR) and gross domestic product (LGDP) statistically and positively increase foreign tourist visits. The long-run coefficients of air transport also show that a 1 per cent increase in the volume of air passengers causes a 1.31 per cent growth in the number of arrivals of foreign tourists. The impact of the effect highlights the need of better air connectivity to boost tourism inflows and economic activity to come with it, and the exchange rate subsequently leads to a 1 percent growth in GDP, and a 1.34 percent and 1.96 percent increase in tourist arrivals. Therefore, improved air connectivity, accessibility of travel and economic development support tourist benefits. Variables such as national highway density and rail infrastructure, although the coefficient values are positive, are statistically insignificant ($p > 0.05$). Hence, it can be inferred that the coefficient of national highway density (LNHD) equals 0.57, meaning that an increase in the percentage of highway density leads to an equivalent increase in tourist arrivals by 0.57 percent- a small impact as compared to the effect of air transport.

Table 3
ARDL long run form and bounds test

ARDL Long Run Form and Bounds Test **Dependent variable: D(LFTV)** Selected Model: ARDL (2, 0, 0, 1, 0, 3, 2, 3)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
LEXR	1.958515	0.419332	4.670560	0.0001
LAIR	1.306724	0.169012	7.731564	0.0000
LGDP	1.340706	0.527829	2.540041	0.0187
LNHD	0.574099	0.347435	1.652392	0.1127
LPOPD	-1.619186	1.469798	-1.101638	0.2825
LPOWER	7.485946	5.605780	1.335398	0.1954
LRAIL	1.246935	2.616237	0.4766135	0.6383
EC = LFTV - (1.9585*LEXR + 1.3067*LAIR -1.3407*LGDP + 0.5741*LNHD -1.6192*LPOPD + 7.4859*LPOWER -1.2469*LRAIL)				
F-bounds test		Null hypothesis: No levels of relationship.		
Test statistic	**Value**	**Signif.**	**I (0)**	**I (1)**
F-statistic	14.68218	10%	2.03	3.13
k	7	5%	2.32	3.50
7		2.5%	2.6	3.84
		1	2.96	4.26

Source: Calculations based on secondary data from E-views.

The results of Table 4 reveal short-run dynamics and an error-correction model (ECM). The coefficient of the error correction model is negative and statistically significant (-1.3396, $p = 0.0000$), indicating a robust correction mechanism that returns LFTV to equilibrium following short-term deviations. Tourism exhibits notable path dependence (D(LFTV(-1)) = 0.5791, $p = 0.0000$), indicating that past tourism levels have a significant impact on current tourism inflows. Advancements in power infrastructure have a delayed but substantial positive impact on tourist gains (D(LPOWER(-1)) = 25.30, $p = 0.0076$). Similarly, improvement in railway infrastructure enhances tourist gains (D(LRAIL(-1) = 13.89 ($p = 0.0046$); D(LRAIL(-2)= 15.50 ($p = 0.0076$)).

Table 4
Short-run dynamics and error correction model (ECM)

Error Correction Model (ECM)				
Dependent variable: D(LFTV)	Selected Model: ARDL (2, 0, 0, 1, 0, 3, 2, 3)			
Variable	**Coefficient**	**Std. error**	**t-statistic**	**Prob**
C	-2.74	0.233	-11.773	0.0000
D(LFTV(-1))	0.57	0.075	7.651	0.0000
D(LGDP)	5.52	0.909	6.076	0.0000
D(LPOPD)	-0.87	1.540	-0.570	0.5743
D(LPOPD(-1))	4.51	1.497	3.013	0.0064
D(LPOPD(-2))	7.57	1.611	4.703	0.0001
D(LPOWER)	15.49	9.553	1.621	0.1191
D(LPOWER (-1))	25.30	8.617	2.936	0.0076
D(LRAIL)	5.63	3.655	1.542	0.1373
D(LRAIL (1))	13.89	4.403	3.154	0.0046
D(LRAIL (2))	15.50	5.281	2.936	0.0076
CointEq(-1)*	-1.33	0.107	-12.443	0.0000

Source: Calculations based on secondary data from E-views.

Having established prerequisites like data stationarity and cointegration among variables, the next step is to assess the extent of this relationship. The cointegration indicates a long-run causal relationship; however, the nature of this relationship, whether unidirectional or bidirectional, remains uncertain (Granger, 1969). We employed the Granger causality test for different study units. As shown in Table 5, the study results reveal a bidirectional relationship between gross domestic product (LGDP; $p < 0.05$) and foreign tourist visits (LFTV; $p < 0.05$). Likewise, a bidirectional relationship was also witnessed between rail infrastructure (LRAIL; $p < 0.05$) and foreign tourist visits (LFTV; $p < 0.05$).

Table 5
Granger causality test

Null hypothesis	**F-statistic**	**Prob.**	**Outcome**
LEXR does not Granger-cause LFTV	4.218	0.0224	Causality
LFTV does not Granger-cause LEXR	0.317	0.7303	No Causality
LAIR does not Granger-cause LFTV	3.174	0.0534	Accept null hypothesis
LFTV does not Granger-cause LAIR	0.270	0.7646	(No Causality)
LGDP does not Granger-cause LFTV	10.127	0.0003	Causality
LFTV does not Granger-cause LGDP	9.797	0.0004	Causality
LNHD does not Granger-cause LFTV	4.466	0.0183	Causality
LFTV does not Granger-cause LNHD	1.092	0.3459	No Causality
LPOPD does not Granger-cause LFTV	8.668	0.0008	Causality
LFTV does not Granger-cause LPOPD	0.844	0.4377	No Causality
LPOWER does not Granger-cause LFTV	7.046	0.0026	Causality
LFTV does not Granger-cause LPOWER	0.183	0.8330	No Causality
LRAIL does not Granger-cause LFTV	3.731	0.0334	Causality
LFTV does not Granger-cause LRAIL	4.615	0.0162	Causality
LNHD does not Granger-cause LGDP	1.317	0.2801	No Causality
LGDP does not Granger-cause LNHD	5.541	0.0079	Causality
LPOWER does not Granger-cause LNHD	4.343	0.0202	Causality
LNHD does not Granger-cause LPOWER	4.253	0.0217	Causality
LRAIL does not Granger-cause LPOPD	0.472	0.6273	No Causality
LPOPD does not Granger-cause LRAIL	3.269	0.0493	Causality

Lastly, the results revealed that power infrastructure (LPOWER; $p < 0.05$) Granger causes the density of national highways and vice versa. The findings of the Granger Causality test, as highlighted in Table 5, clearly explain that variables such as exchange rate (LEXR), national highway density (LNHD) and power (LPOWER) Granger cause foreign tourists to visit or tourist gains, thereby showing a unidirectional causal relationship. Finally, we conducted diagnostic tests to check for autocorrelation, heteroskedasticity, normality and model stability. We employed the Breusch-Godfrey LM test to check for serial correlation and Prob. F (0.1638) and Prob. Chi-Square (0.0536) is greater than 0.05, suggesting no significant serial correlation at a significance level of 5 percent as shown in Table 6. Furthermore, the Breusch-Pagan-Godfrey test was conducted to check for heteroskedasticity. Since all p-values (0.4753, 0.4127, 0.9998) are greater than 0.05, there is no significant evidence of heteroskedasticity in the study model.

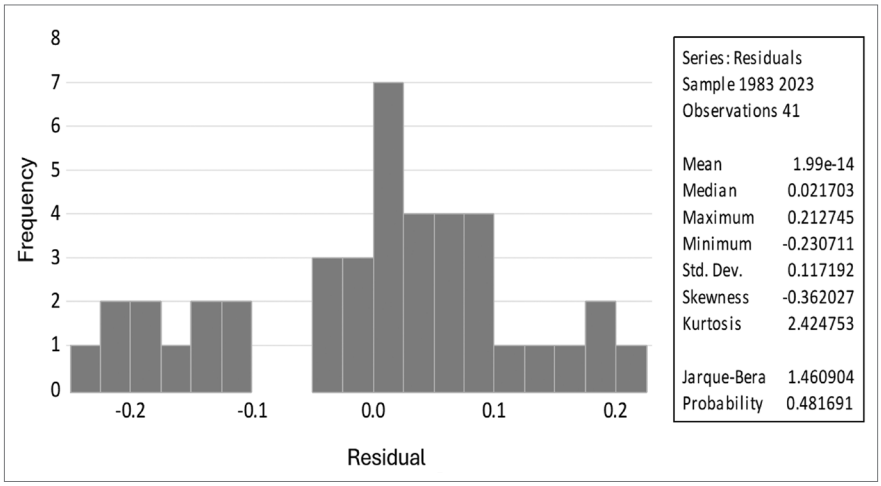
Table 6
Diagnostic tests

Breusch-Godfrey Serial Correlation LM Test Null Hypothesis: No Serial Correlation at up to 2 lags			
F-Statistics	1.9832	Prob. F (2, 20)	0.1638
Obs *R-Squared	6.7855	Prob. Chi-Square	0.0536
Heteroskedasticity Test: Breusch-Pagan-Godfrey Null Hypothesis: Homoskedasticity			
F-Statistics	1.0214	Prob. F (18, 20)	0.4753
Obs *R-Squared	18.666	Prob. Chi-Square (18)	0.4127
Scaled explained SS	3.8285	Prob. Chi-Square (18	0.9998

Source: Calculations based on secondary data from E-views.

We then employed the Jarque-Bera test for normality, and the p-value of 0.05 indicates the rejection of the null hypothesis that the residuals are not normal, as illustrated in Figure 2.

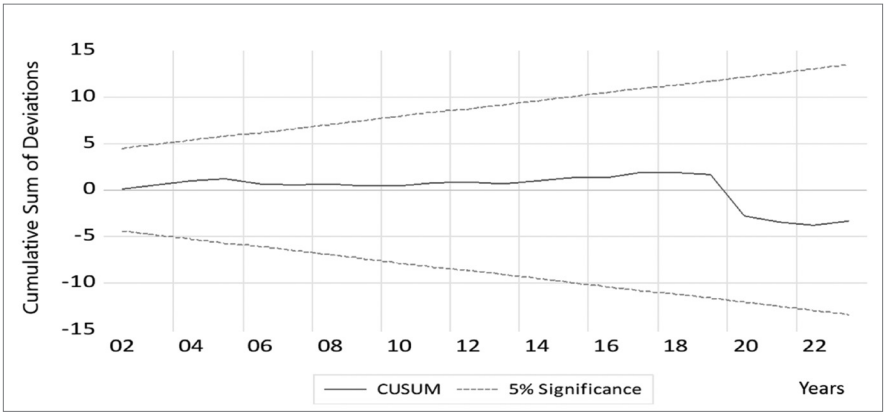
Figure 2
Schematic illustration of Jarque-Bera test



Source: Author's compilation based on analysis.

Finally, to ensure model stability, we employed the Ramsey RESET test. Figure 3 shows the cumulative sum (CUSUM) plot. The blue line in Figure 3 is well within the upper and lower bounds and lies between the 5% significance interval. Thereby, inferring the model stability.

Figure 3
Stability diagnostics



Source: Author's compilation based on analysis.

6. Study discussion and policy implications

In recent decades, tourism in India has undergone significant change, making it a promising, fast-growing sector (Sharma et al., 2022). The rapid growth of the tourism industry has compelled policymakers to shift their attention towards the tourism sector as a crucial component of economic development. Over the past several years, there has been significant growth in theoretical and empirical research on tourism and related fields. This paper presents an empirical study on the role of transport infrastructure and other controlled factors in the development of tourism in India. The study has identified that transport infrastructure plays a crucial role in the development of tourism in India. The analysis reveals that air transport, exchange rates, and GDP are significant factors influencing foreign tourist visits, underscoring the economic and infrastructural factors that contribute to tourism's benefits. The conclusion that follows in this paper is consistent with the available literature worldwide (Lekshmi & Mallick, 2022; Onifade et al., 2022; Tung & Thang, 2022; Chioma Akinyemi, 2024; Perles-Ribes et al., 2024).

The national highway density and the rail infrastructure show a positive relation, although the statistical significance is not significant. Thus, to suggest that these modes are auxiliary in attracting foreign tourist visits, and the research results are similar to those obtained by Fan (2021) and Shen et al. (2023a). The lag effects of constructing railway routes and power infrastructure support the argument that investing in them is necessary to achieve their highest potential. Nguyen (2021) states that investment in rail and power infrastructure is the most favourable contributor to tourism and is likely to attract foreigners. The study's findings, supported by cointegration analysis, demonstrate that there are long-run links between travel growth and transport characteristics. Focusing on the path dependency of tourism, the error correction model (ECM) justifies a strong adjustment mechanism that returns to equilibrium after temporary deviations in the short run. Given the mutual reinforcement between economic growth and transportation development, the Granger causality test reveals bilateral relationships between GDP and tourism, as well as between rail infrastructure and tourism. Interestingly, the study reveals a one-way causal relationship between national highway density, power infrastructure, and foreign tourist visits. This points out their fundamental significance in enabling connectedness and accessibility, as it means that, although these factors significantly influence tourist gains, they have a lesser impact on tourism demand.

This study has substantial policy implications for the development of tourism in India, as evidenced by the findings. To begin with, to attract the attention of global travellers and improve regional and rural connectivity through the Ministry of Civil Aviation of India, policymakers should balance air connectivity by identifying new routes and modernising airports under the UDAN project. Secondly, high-speed rail investments

and express highways can provide access to remote tourist attractions (under the Bharatmala Pariyojana and Amrit Bharat Station Scheme), facilitating tourism development in new regions that were previously inaccessible. The role of road and rail infrastructure in attracting foreign tourists is less important, but it cannot be neglected, as it is more significant than it may seem.

The paper identifies the delayed yet significant contribution of the power infrastructure to tourism's gains. As a result, decision-makers and investors should ensure that adequate electricity supply to tourist destinations enhances service quality and attracts visitors. To make tourism greener, renewable energy projects can also be incorporated. Additionally, favourable exchange rates or the facilitation of purchases positively affect foreign tourist visits. Policymakers should have measures to sustain competitive exchange rates that encourage international visitors while maintaining other economic objectives. Finally, the study highlights that transport infrastructure enables access to areas that were previously unavailable. The Federation of Hotel and Restaurant Associations of India (FHRAI) and the state government should collaborate to establish local infrastructure networks tailored to different areas within the tourism context. Under the Swadesh Darshan 2.0 and PRASHAD schemes, the central and state governments are expected to place greater emphasis on the even distribution of funds and investment in physical infrastructure to promote balanced zonal growth.

7. Limitations and future research

The current research offers insights worth considering on transport infrastructure and the potential for improved international tourism in India, along with some drawbacks that have also been identified. To start with, there is a problem of endogeneity; tourism and transport infrastructure may be reinforced by factors whose effects can go both ways, and hence the two-way relationships that observational data can hardly decipher. Although the Granger causality and cointegration tests have been used to test dynamic relationships, there are other unresolved concerns, including reverse causality and the lack of observation on specific variables, such as destination-specific policies or region-based investments, which may have simultaneous effects on both transport investment and tourist flows, thereby biasing the estimated effect.

Secondly, the data granularity is a limitation to the analysis. The study is based on 44 years of national-level time-series data. Aggregated data provide a global picture, but at the cost of obscuring important differences at the regional or local levels, where tourism dynamics and infrastructure development exhibit significant variation. Such a macro-level approach does not account for state-specificities and may thus limit the applicability of the results and overrepresent regions of fast or slow growth.

Finally, omitted-variable bias may result from failing to account for other potential determinants, such as environmental quality, tourism promotion activities, or socio-political developments, leading to specification errors and biased estimates. Although key controls, such as exchange rates, GDP, population density, and power generation, have been taken into account, region-specific variables that may have affected the results have been omitted. Considering these shortcomings, further research should use disaggregated or regional-level data to reveal the spatial heterogeneity of the tourism-growth nexus. State-of-the-art district-level panel data or spatial econometrics would enable control for unobserved heterogeneity and facilitate stronger causal inference. Additionally, a combination of quantitative and qualitative information on local policies related to tourism or infrastructure development would enhance understanding of the underlying processes. The efforts to address these shortcomings will enable future research to inform more effective policy interventions for sustainable tourism development.

Declaration of Competing Interests

The authors declare that they have no known competing interests that could have appeared to influence the work reported in this paper.

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