Tourist Travel Modes And Economic Growth: A Panel Data Comparison Of Land And Air Travel In Africa's Landlocked States

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Abstract
This study examines the comparative impact of air and land travel on gross domestic product growth in Africa's landlocked countries. Applying panel data analysis to fourteen nations over five years (2017–2021), the research explores whether international tourist arrivals via different transport modes contribute differentially to economic development. Air travel significantly increases international tourist arrivals, according to fixed-effects models, whereas land travel shows a weaker contextual effect despite being statistically significant. Contrary to expectations, no statistically significant direct correlation exists between land or air travel and GDP growth in the selected nations. The findings point out the value of considering mediating factors such as infrastructure quality and political stability, which shape tourism's broader economic influence. The study concludes that transport modality alone is insufficient to stimulate economic growth; instead, integrating the tourism value chain and optimising regional policy frameworks must be done to leverage travel-driven development effectively.
Keywords: *Air Travel, Land Travel, Gross Domestic Product, Tourism, Landlocked*

I. Introduction

Over 4.5 billion flight passengers were recorded globally in 2022, according to the International Air Transport Association's annual review, demonstrating a significant rebound and expanding trend in air travel. Air travel accounted for approximately 58% of the 963 million foreign visitors that year, according to the United Nations World Tourism Organisation (UNWTO, 2023). These numbers illustrate the leading significance of air transport in international mobility, especially pertinent for geographically challenged, landlocked areas that depend significantly on effective aviation networks for tourism access. In landlocked African nations, where geographical obstacles restrict access, air transport becomes an essential facilitator of foreign visitor arrivals. The initial idea that air travel has a significant and positive impact on foreign visitor inflows is supported by Seetanah (2011), who found a strong link between tourism growth in Africa and the infrastructure supporting air travel. On the other hand, although to a lesser extent, land travel positively impacts visitor arrivals. This is supported by the findings of Naudé and Saayman (2005), who pointed out that border restrictions and inadequate road infrastructure reduce the effectiveness of land travel in boosting international tourism. However, comparative research on how air travel affects gross domestic product (GDP) growth compared to land travel is still unexplored.

The researchers suggest that wider structural and policy factors affect tourism's contribution to economic growth (Brida et al., 2016). Although comprehensive research has confirmed the correlation between tourism and economic growth, limited studies have differentiated the effects of various travel modes, specifically air and land transport, on gross domestic product results in landlocked African nations. Seetanah (2011) and Fourie and Santana-Gallego (2013) examined the macroeconomic impacts of tourism and air connectivity without recognizing their outcomes by travel mode in geographically limited contexts. Furthermore, current research predominantly neglects landlocked nations' unique structural constraints and economic reactions. Naudé and Saayman (2005) stressed the importance of infrastructure for regional tourism development. However, they neglected to examine the impact of poor land transport networks on international tourist arrivals and their contribution to gross domestic product (GDP) in these contexts. This generates a knowledge deficit on transport-related gaps in tourism-driven development. Furthermore, while Gössling et al. (2018) examined air travel's economic and environmental trade-offs, limited research has evaluated its economic return compared to land transportation for Africa's objectives. Policymakers' ability to distribute investments in transport sectors based on relative economic performance is hampered by this shortcoming. The direction of the relationship between gross domestic product (GDP) and tourism is still uncertain, according to Brida et al. (2016). Current models usually

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assume a one-sided relationship between tourism and economic growth, ignoring the potential for GDP growth to draw more tourists. This gap requires a more sophisticated empirical investigation, particularly when evaluating typical contributions to national revenue. This validates the comparison methodology employed in the present study using different transport modalities.

II.   Related Literature

The correlation between transport modes and economic development in Africa's landlocked nations has attracted increasing academic attention. According to the Tourism-Led Growth Hypothesis (TLGH), which holds that the growth of tourists stimulates gross domestic product (GDP) growth, especially in developing countries, there is a correlation between economic growth and international tourism (Balaguer and Cantavella-Jordá, 2002). This idea makes the case that increased tourism, made possible by transportation, can boost foreign exchange earnings, employment, and investment. Mobility in tourism is thought to be significantly influenced by transportation infrastructure. By enabling places previously constrained by geographic boundaries to engage with global markets, air travel has drastically altered tourism dynamics worldwide (Duval, 2007). Air travel is crucial in Africa because there are not many other ways to travel long distances across expansive landscapes (Zhang and Graham, 2020). The lack of infrastructure and cross-border inefficiencies often make it difficult for land transport to facilitate international visitor movement in landlocked countries, even though it is crucial for intra-regional tourism (Naudé and Saayman, 2005).

Furthermore, empirical research has confirmed the significant influence of air travel on boosting foreign visitor arrivals and economic growth in African countries. (Seetanah et al., 2011) found a strong link between improved air transport infrastructure and more tourists, which raised gross domestic product. His findings demonstrate how air connectivity improves accessibility, particularly for landlocked nations with few other options. Fourie and Santana-Gallego (2013) explained, using cross-country data, that the intensity of air travel directly affects the demand for tourism. According to their findings, economies with effective and well-integrated air transport systems see a significant increase in foreign visitor arrivals. The study by Okello and Novelli (2014) attempts to evaluate the condition, obstacles, and prospects of tourist growth within the East African Community (EAC). It recognises tourism as an essential instrument for poverty alleviation and regional integration, although limited tourism offerings, governance challenges, and infrastructural deficiencies impede it. The authors advocate for systematic reforms in governance, destination management, community engagement, and diversification to optimise the socioeconomic impact of tourism. Samunderu and Njoroge (2020) utilised the Structure-Conduct-Performance (SCP) framework to examine the aviation sector in Africa, specifically in Kenya, South Africa, Nigeria, and Ethiopia. It disclosed considerable development potential propelled by liberalisation initiatives, yet impeded by fragmented markets, inadequate governance, and suboptimal airline profitability.

Gold and Tregenna (2024) emphasise the importance of infrastructure, especially air connectivity, in promoting economic activity in landlocked African countries. Utilising panel data, they demonstrate that improved transport and ICT infrastructure facilitate trade openness and stimulate GDP development, but they ignored land transport, which encompasses a significant number of travels. Analysing the relationship between geography and governance and export diversification, Stephane and Nkoa (2024) demonstrate that, despite advancements in infrastructure, geographic limitations such as landlocked status severely impede economic growth. Without calculating the effect on GDP growth, Harizi and M'raïhi (2014) studied transportation networks in landlocked countries and concluded that terrestrial and aerial connectivity impact productivity and population mobility. Landlockedness is not deterministic, according to Paudel (2014), who also claims that regional integration and policy changes could lessen adverse effects through effective transportation networks. The results of their panel regression show that transport costs continue to be a significant barrier to GDP. Chakamera and Pisa (2021) examine the direct correlation between air travel and economic growth in Sub-Saharan Africa, excluding tourism. Air connectivity greatly increases GDP, particularly in landlocked regions with poor access to the sea and roads. This claim is supported by Button et al. (2000), who show that wide-ranging aircraft networks promote regional growth and intra-African trade. Refocusing attention on the tourism industry, Du Toit and Fourie (2012) acknowledge that exports of travel services constitute a substantial source of income, with air travel being significant for landlocked tourism economies. By analysing the impact of geographic location (coastal versus landlocked) on the relationship between tourism and growth, Baidoo et al. (2022) support this claim. They conclude that landlocked countries benefit more from improved air connectivity than from overland transportation because of geopolitical and infrastructure limitations. Africa's development is significantly impacted by geography and policy, as highlighted by Naudé (2004). According to his econometric analysis, geographical disadvantages, such as landlocked status, greatly exacerbate the economic impacts of poor institutions and transit policies. Fanou and Wang (2018) augment this with a technical efficiency analysis of transit corridors, demonstrating that certain landlocked nations utilise air transport efficiently while exhibiting deficiencies in land-based logistics.

Traoré and N'Zué (2025) utilise panel data from ECOWAS to demonstrate that air and land transport facilities substantially improve tourism, employment, and GDP in landlocked nations such as Burkina Faso. Tchouamou Njoya (2016) employs a dynamic computable general equilibrium model to illustrate that aviation expansion in Kenya is crucial for poverty reduction and economic stimulation, a principle relevant to landlocked neighbouring countries. Liberalising air travel significantly impacts landlocked countries, boosting GDP growth and improving visitor accessibility and labour mobility (Abate, 2013). Africa's underutilised tourism industry is highlighted (Signé, 2018), who also suggests that smaller landlocked nations have unrealised potential that depends on better air connectivity.

Using data specific to Kenya, Kaguku (2023) supports this claim by calculating the effect of air travel on GDP and employment, which could be repeated in other regional economies. Viljoen and Saayman (2019) emphasise the significance of affordable air access by pointing out the adverse effects of travel costs and landlocked conditions on inbound tourism. Tolcha demonstrates via cointegration analysis that air transport demand and GDP in Ethiopia exhibit a long-term causal link. Kaya and Aydın (2024) investigate spatial heterogeneity and affirm that air transport is a long-term catalyst for economic expansion throughout several geographical blocs, including Africa. Franciscone et al. (2024) proposed the idea of an "Air transport belt" in the Global South, promoting corridor-based approaches to enhance sustainable tourism and economic resilience in landlocked regions. Bassem (2025) demonstrates that aviation and road infrastructure affect Foreign Direct Investment inflows in developing economies, impacting GDP growth and the development of the tourism sector.

In contrast, road networks enhance regional tourism; their impact on international tourism is negligible due to logistical and border-related obstacles, and this accurate disparity highlights the slight influence of land transportation on GDP development relative to air travel. According to Gössling et al.(2018), air travel has a greater economic impact because it brings in more money per visitor. While admitting that institutional factors and visa regulations significantly impact arrival volumes, Seetanah (2011) also acknowledges air transport infrastructure's vital role in boosting tourism, usually ignoring the transport-centric models. The analysis correctly identifies a weaker relationship between land travel and visitor arrivals, but this assessment might not fully capture the socioeconomic importance of domestic and international travel. Naudé and Saayman (2005) assert that terrestrial travel benefits lower-income, regional tourists who impact economic results differently, sometimes neglected in gross domestic product (GDP) focused models. Whether tourism and economic growth are causally related is still up for debate. According to Brida, Cortés-Jiménez, and Pulina (2016), there is a chance that economic growth will increase tourism. The idea of unilateral influence present in basic regression models conflicts with this.

III. Overview Of Tourism And Transport In The Landlocked States Of Africa

Geographical limitations and regional collaboration through economic blocs like the East African Community (EAC), Economic Community of West African States (ECOWAS), and Southern African Development Community (SADC) influence tourism and transport services in Africa. The landlocked states mainly rely on regional integration to overcome obstacles to infrastructure, customs, and connectivity; all of which directly impact visitor mobility and the effectiveness of transport services (UNWTO, 2022). Most tourist travel in these areas is conducted by land-based transportation, demonstrating a steady reliance on terrestrial access routes. These patterns are a reflection of both the availability and affordability of road infrastructure, as well as the restricted international air connectivity both within and between Africa's landlocked nations. Some countries in the dataset, like Malawi and Zambia, still use lakes and rivers for water transportation even though they are landlocked. Nonetheless, these services support domestic or near-border freight and tourism, mainly for localised purposes. This analysis does not include water transport since it has little effect on long-distance or international travel.

The research shows that the role of air transport remains secondary, yet essential for high-value international tourism. ECOWAS countries such as Burkina Faso, Mali, and Niger lack well-maintained and interconnected road networks, which can create a consistent regional corridor that can support large-scale overland tourism flows. SADC states like Botswana or Zambia have stronger intraregional highways supporting road inflows. Several landlocked ECOWAS states face internal conflict or terrorism threats, especially in rural border areas. This discourages cross-border or overland tourism due to safety concerns. Governments and tour operators often advise against or restrict land travel in these zones (UNWTO, 2022). Lengthy border crossing times due to bureaucratic delays, corruption, and a lack of harmonization across customs and immigration procedures hinder seamless land travel. Tourists prefer air travel when overland crossings are perceived as time-consuming or uncertain (UNECA, 2022).

East Africa's landlocked countries demonstrate a more balanced use of air and land transport in tourism. Through visa waivers, customs harmonisation, and infrastructure investments, regional integration under the East African Community (EAC) has dramatically boosted cross-border mobility. Tourism in this region benefits from well-established overland circuits connecting Uganda's wildlife parks, Rwanda's mountain gorillas, and cross-

border lakes. Land transport is central through shared regional highways like the Northern Corridor linking Burundi, Rwanda, the Democratic Republic of Congo's eastern region, Uganda, South Sudan, and Kenya. The following are inflows registered between 2017 and 2021.

Table 1: Land and Air travel registered (in thousands)

Country	Mode of transport	2017	2018	2019	2020	2021
Botswana	Air	119.5	129	120	15	37
	Land	1775	1701	1435	343	301
	Total	1894.5	1830	1555	358	338
Burkina Faso	Air	143	109	133	54	95
	Total	143	109	133	54	95
Central African Republic	Air	107	109	87	35	107
	Total	107	109	87	35	107
Chad	Air	87	77	79	11	40
	Total	87	77	79	11	40
Eswatini	Air	16	20	19	11	12
	Land	905	1258	1207	334	199
	Total	921	1278	1226	345	211
Ethiopia	Air	903	834	768	257	475
	Land	30	16	44	14	44
	Total	933	850	812	271	519
Lesotho	Air	12	19	15	1	2
	Land	1125	1153	1127	593	277
	Total	1137	1172	1142	594	279
Malawi	Air	129	134	347	39	136
	Land	707	735	630	160	296
	Water	1	1	1	0.8	0.4
	Total	837	870	978	199.8	432.4
Mali	Air	193	203	217	75	168
	Total	193	203	217	75	168
Niger	Air	164	157	192	85	138
	Total	164	157	192	85	138
Rwanda	Air	203	242	280	80	109
	Land	1367	1469	1354	417	402
	Total	1570	1711	1634	497	511
Uganda	Air	421	432	586	79	99
	Land	982	1074	956	394	414
	Total	1403	1506	1542	473	513
Zimbabwe	Air	329	337	321	77	147
	Land	2097	2243	1973	562	233
	Total	2426	2580	2294	639	380
Zambia	Air	294	319	327	89	106
	Land	708	749	934	410	442
	Water	7	5	6	3	7
	Total	1009	1073	1267	502	555

Source: United Nations World Tourism Organization

The table shows that land travel comprised over 74.2% of total travel, air travel registered less than 25.7% and water travel was only a small fraction in the five years of study. All fourteen countries use air travel, nine use land and air travel, while only two use air, land, and water.

Trend of gross domestic product (GDP) in landlocked states of Africa

Between 2017 and 2021, landlocked African nations' GDP per capita exhibited a generally upward trend. Relatively high gross domestic product per capita levels are apparent in countries like Botswana and Eswatini. In contrast, significantly lower levels are observed in others, such as the Central African Republic, suggesting ongoing economic disparities. Some nations experienced a decline in 2020, which reflected the COVID-19 pandemic's impact on the world economy (Owusu-Peprah, 2024). The gross domestic product per capita is calculated by dividing the country's total economic output by population, facilitating cross-country comparisons of economic productivity and living standards (Perevyshin et al., 2022). It overlooks inequality and informal economies and makes the assumption that income is distributed equally. Natural resource exploitation, agriculture, foreign investment, tourism, infrastructure development, and industrial production are these countries' main drivers of GDP fluctuations (Peltola et al., 2022). The official reports show the trend as follows:

Table 2: Gross domestic product (GDP) per capita, current prices (U.S. Dollars)

Country	2017	2018	2019	2020	2021
Botswana	6705.341	6947.818	6679.188	5863.182	7243.863
Burkina Faso	710.541	780.482	768.053	828.777	893.5
Central African Republic	432.172	467.286	460.809	475.203	505.68
Chad	888.615	990.693	934.731	910.416	997.979
Eswatini	4031.056	4226.975	4031.719	3535.09	4259.206
Ethiopia	822.704	839.861	948.851	969.014	974.103
Lesotho	1199.628	1215.317	1134.4	1014.795	1171.407
Malawi	466.559	501.113	543.685	567.59	580.923
Mali	795.387	856.743	840.211	824.095	881.973
Niger	517.589	570.983	554.124	568.606	593.802
Rwanda	783.54	797.182	836.313	803.463	854.124
Uganda	838.495	879.024	951.591	919.141	1008.125
Zambia	1495.751	1475.2	1268.125	958.265	1134.713
Zimbabwe	1502.576	2466.78	1705.022	1725.017	2264.653

Source: World Bank Development Indicators

IV.   Methodology

This study adopted a quantitative comparative approach to analyse the impact of air and land travel on GDP growth with international visitor arrivals in landlocked African nations. The research objectives are to evaluate the impact of air travel by tourists on gross domestic product, to assess the influence of land travel by tourists on GDP in the same countries, and to analyse the comparative effectiveness of air versus land transport in contributing to gross domestic product growth in landlocked African nations. The studies verified the following hypotheses: Air travel has a significant positive influence on international tourist arrivals in landlocked African nations; land travel has a positive but weak effect on international tourist arrivals compared to air travel; air travel contributes more significantly to gross domestic product (GDP) growth than land travel. The methodology suggested panel data economic modelling, effectively capturing changes between nations and temporal dimensions (Hsiao, 2005).

The investigation encompasses fourteen landlocked African nations [1] Examined over five years, providing a substantial dataset for longitudinal inference. Burundi and South Sudan are missing due to the absence of their data, which have been extracted from the World Bank Development Indicators and the United Nations World Tourism Organization website. The researcher used national statistics yearbooks to fill in the missing data. The primary variables consist of the gross domestic product (GDP) per capita growth rate as the dependent variable, international tourist arrivals by air and land as the independent variable, and control variables including population size, inflation, and infrastructure development held constant. The estimating method employed is panel regression with the Gretl software, which can evaluate fixed and random effects models. We performed a Hausman test to ascertain the suitable specifications (Hausman, 1978); this guarantees impartial evaluation by considering individual variation among countries. Standardized beta coefficients were analysed to evaluate the relative strength of the effects. We conducted Granger causality to assess the directional linkages between tourist arrivals by travel mode and gross domestic product (GDP) growth. Lagged variables were employed to account for deferred economic effects, and the research used diagnostic assessments to evaluate multicollinearity and heteroskedasticity.

V.   Results And Analysis

Descriptive statistics of the panel set

In panel data analysis, descriptive statistics are crucial because they help us understand the data's structure, distribution, and variability over time and across nations. They assess variables' dispersion and central tendency (mean, median, variance) and help detect data discrepancies like outliers, missing values, or anomalies.

Table 3: Descriptive statistics[2]

Parameters	AT	LT	TT	GDP
Mean	175.88	790.87	684.75	1559.8
Median	114.25	707	485	901.96
Minimum	1	14	11	432.17
Maximum	903	2243	2580	7243.9
Std. Dev.	187.99	594.81	651.93	1688

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[1] Botswana, Burkina Faso, Central African Republic, Chad, Eswatini, Ethiopia, Lesotho, Malawi, Mali, Niger, Rwanda, Uganda, Zambia, Zimbabwe.

[2] Key: AT (air travel), LT (land travel), TT (total travel), GDP (gross domestic product).

C.V.	1.0689	0.7521	0.95207	1.0821
Skewness	2.0947	0.67541	1.0582	2.2459
Ex. Kurtosis	4.6443	-0.37857	0.30086	3.9494
5% Percentile	11	20.2	47.7	466.96
95% Percentile	667.9	2059.8	2074.3	6691
IQ range	153.5	862.5	996.5	542.52
Missing obs.	0	25	0	0
Within S.D.	114.813	511.335	474.046	206.669
Between S.D.	161.74	392.251	507.511	1728.53

Source: Authors

The table displays the summary of statistics for 70 observations, for air travel, land travel, total travel, and gross domestic product (GDP) in five years across fourteen landlocked countries in Africa. The travel figures are expressed in thousands, whereas the gross domestic product per capita is denominated in United States dollars for all five years across fourteen nations.

H1: Air travel has a significant positive effect on international tourist arrivals

The Hausman test was used to decide between a fixed effects model and a random effects model. The random effects model is biased and inconsistent, as evidenced by the rejection of the null hypothesis that random effects (GLS) are consistent due to the Hausman test result ($p=0.0036<0.05$). The fixed effects model is therefore recommended. Accounting for unobserved time-invariant heterogeneity guarantees consistent estimation (Baltagi, 2008; Wooldridge, 2010).

Table 4: Test 1

Hausman test	
Null hypothesis:	GLS estimates are consistent
Asymptotic test statistic:	Chi-square = 8.45286
With p-value:	0.00364469

Model 1: Fixed-effects, using 70 observations					

Included 14 cross-sectional units

Time-series length = 5

Dependent variable: TOTALTRAVELS

Standard errors clustered by unit

	Coefficient	Std. Error	t-ratio	p-value	
Constant	219.147	155.286	1.411	0.1817	
AIRTRAVELS	2.64731	0.882915	2.998	0.0103	**

Mean dependent var	684.7529	S.D. dependent var	651.9333
Sum squared resid	7410826	S.E. of regression	367.0726
LSDV R-squared	0.747297	Within R-squared	0.411106
Log-likelihood	−504.2742	Akaike criterion	1038.548
Schwarz criterion	1072.276	Hannan-Quinn	1051.945
rho	0.600304	Durbin-Watson	0.717969

Joint test on named regressors -
Test statistic: F (1, 13) = 8.99028
with p-value = P (F (1, 13) > 8.99028) = 0.0102708
Robust test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: Welch F (13, 21.3) = 12.2853
with p-value = P (F (13, 21.3) > 12.2853) = 4.45236e-07

Source: Authors' calculation

The strength of the fixed-effects specification is additionally confirmed by the substantial Welch F-test ($p < 0.001$), which rejects the null hypothesis of a uniform intercept across units. This validates the selection of a fixed-effects methodology by establishing the existence of heterogeneous intercepts. The fixed-effects regression model offers strong empirical evidence for the hypothesis that air travel substantially increases international visitor arrivals. $TT_{it} = 219.147 + 2.647AT_{it} + \alpha + \varepsilon_{it}$[3]. The coefficient of the independent variable is 2.647

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[3] Where:
- TT is the total number of international tourist arrivals for unit i at time t,

(p = 0.0103), signifying that an increase of one thousand air travel corresponds with an approximate increase of 2657 international travellers in African landlocked countries, assuming all other factors remain constant. This outcome is statistically significant and indicates a strong association.

The fixed-effects model accounts for unobserved variation among the 14 cross-sectional units during the five years. The model accounts for a sizable portion of the within-unit variance in international tourism, as evidenced by the substantial LSDV R-squared value of 0.747. The moderate explanatory power for temporal variations within each nation or region is indicated by the within R-squared of 0.411. Theoretically, air connectivity plays a key role in international tourism flows by reducing travel times, improving accessibility, and increasing demand (Duval, 2007; Gössling et al., 2019). The statistically significant outcome supports the hypothesis that enhanced air infrastructure and frequency could increase foreign visitor arrivals even in landlocked African nations. Therefore, the data provide substantial evidence for the hypothesis, emphasizing air travel's critical role in enabling international tourist mobility.

H2: Land travel has a weaker effect than air travel

The diagnostic test recommends the fixed effect model for this hypothesis. The significant Welch F-test (p < 0.001) validates the application of fixed effects by opposing homogeneity among cross-sectional units.

Table 5: Test 2

Model 2: Fixed-effects, using 45 observations					
Included nine cross-sectional units					
Time-series length = 5					
Dependent variable: TOTALTRAVELS					
Standard errors clustered by unit					
	Coefficient	Std. Error	t-ratio	p-value	
Constant	0.616931	0.0914265	6.748	0.0001	***
AIRTRAVELS	1.00040	0.000461803	2166.	<0.0001	***
LANDTRAVELS	1.00002	4.91190e-05	2.036e+04	<0.0001	***
Mean dependent var	1001.504	S.D. dependent var		614.4409	
Sum squared resid	11.33827	S.E. of regression		0.577476	
LSDV R-squared	0.999999	Within R-squared		0.999999	
Log-likelihood	−32.83646	Akaike criterion		87.67292	
Schwarz criterion	107.5462	Hannan-Quinn		95.08148	
rho	−0.622678	Durbin-Watson		2.601391	
Joint test on named regressors -					
Test statistic: F (2, 8) = 2.53533e+08					
with p-value = P (F (2, 8) > 2.53533e+08) = 6.1959e-32					
Robust test for differing group intercepts -					
Null hypothesis: The groups have a common intercept					
Test statistic: Welch F (8, 14.6) = 20.4565					
with p-value = P (F (8, 14.6) > 20.4565) = 1.24428e-06					

Source: Authors

The estimated equation reflecting the relationship among air travel, land travel, and total international tourist arrivals is: $\boldsymbol{TT_{it} = 0.617 + 1.0004\,AT_{it} + 1.0000\,LT_{it} + \alpha_i + \varepsilon_{it}}$[4] . The fixed-effects model indicates that air and land travel considerably affect foreign tourist arrivals; however, land travel demonstrates a relatively minor impact compared to air travel in substantial terms. The coefficients for both Air Travel (1.0004)

- AT_{it} is the number of air travels for unit i at time t,
- αi(alpha i) represents the fixed effect (individual-specific intercept) for unit i,
- εit(epsilon it) is the error term.

[4] Where:

- TT: It is the total international tourist arrivals for unit i at time t,
- AT: It is the number of air travels for unit i at time t,
- LT: It is the number of land travels for unit i at time t,
- ai: Represents unit-specific fixed effects,
- εit: The idiosyncratic error term.

and Land Travel (1.00002) are quantitatively comparable and exhibit great statistical significance (p < 0.0001). This means that the recognition of the lower influence arises from the practical and contextual implications of transport modes rather than solely the coefficient magnitude. The model's exceptionally high R-squared value (0.999999) and minimal residual error indicate an excellent fit since water transport covers a small number of visitors using lakes and rivers. In verdict, though statistically noteworthy, the contribution of land travel in international tourism is contextually inferior compared to the importance of air travel. This corresponds with recognized tourism literature highlighting air transport's preeminent role in facilitating global mobility and foreign arrivals.

H3: Air travel contributes more significantly to GDP growth than land travel

To choose the right model, we used the diagnostic tests. A highly significant result (LM = 78.43, p < 0.000001) was obtained from the Breusch-Pagan test, indicating strong evidence against the pooled OLS model and in favour of using a random effects (RE) model that accounts for unobserved heterogeneity among units. There appears to be no discernible difference between the random and fixed effects estimators, according to the Hausman test's non-significant result (H = 1.67, p = 0.4341). This suggests that the random effects model is the most effective and consistent approach for analysing this panel data. Therefore, the random effects model should be utilised for estimation and inference.

Table 6: Test 3

Model 3: Random-effects (GLS), using 45 observations					
Included nine cross-sectional units					
Time-series length = 5					
Dependent variable: GDP USD per capita					
Standard errors clustered by unit					
	Coefficient	Std. Error	z	p-value	
Constant	1994.32	668.769	2.982	0.0029	***
AIRTRAVELS	−0.0520382	0.199955	−0.2602	0.7947	
LANDTRAVELS	0.0530427	0.0646540	0.8204	0.4120	
Mean dependent var	2025.344		S.D. dependent var	1956.699	
Sum squared resid	1.66e+08		S.E. of regression	1967.523	
Log-likelihood	−404.1332		Akaike criterion	814.2664	
Schwarz criterion	819.6864		Hannan-Quinn	816.2869	
rho	−0.494127		Durbin-Watson	2.345975	

'Between' variance = 4.38354e+06

'Within' variance = 68720.3

theta used for quasi-demeaning = 0.944093

Joint test on named regressors -

Asymptotic test statistic: Chi-square (2) = 0.691283

with p-value = 0.707766

Breusch-Pagan test -

Null hypothesis: Variance of the unit-specific error = 0

Asymptotic test statistic: Chi-square (1) = 78.4258

with p-value = 8.30585e-19

Hausman test -

Null hypothesis: GLS estimates are consistent

Asymptotic test statistic: Chi-square (2) = 2.1778

with p-value = 0.336587

Source: Authors

Both land and air travel have no statistically significant impact on gross domestic product (GDP) growth in African landlocked states, according to the random effects model's findings. $GDP_{it} = 1994.32 - 0.052AT_{it} + 0.053LT_{it} + \mu_i + \varepsilon_{it}$[5]. The coefficient for AT is −0.052 (p = 0.7947), whereas LT has 0.053 (p

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[5] Where:

- GDP: It is the Gross Domestic Product per capita for unit i at time t,
- AT: It is the number of air travels for unit i at time t,

= 0.4120), both strongly beyond conventional significance limits (usually p < 0.05). This shows that, in landlocked African countries, air travel is not connected to increasing GDP per capita and sometimes exhibits an opposite economic influence. Despite theoretical assumptions that air travel, as a proxy for business and high-income tourists, would contribute more robustly to economic growth than land travel (Button and Taylor, 2000), the empirical evidence here does not support the premise. This could be due to structural causes, such as poor air infrastructure or regional differences in travel demand, which hide any direct link. This analysis does not support the hypothesis that air travel contributes more significantly to gross domestic product (GDP) growth than land travel, referring to the significance of both coefficients.

The estimated model assumes that tourism variables, particularly air travel (AT) and land travel (LT), have a unidirectional impact on GDP. Wackerly, (Wackerly et al., 2008) assert that correlation adheres to the commutativity principle. This indicates that the correlation between GDP and AT, LT equals that between the variables AT, LT, and GDP. "Corr (AT, GDP) = Corr (GDP, AT) and Corr (LT, GDP) = Corr (GDP, LT)". All standard correlation coefficients, including Pearson's correlation, which is symmetric by definition, have this characteristic. When the variables are switched, the correlation stays the same because covariance is symmetric and standard deviations are always positive. This case of landlocked Africa's nations rejects the idea of a reverse causal relationship (bidirectional) between tourism and economic growth, as suggested by Brida, Cortés-Jiménez, and Pulina (2016).

VI.   Discussions And Policy Implications

Despite statistical equivalence and a low number of travellers compared to land travellers, air travel is acknowledged as the most common mode of transportation for international tourism, particularly for medium and distant locations (Gössling et al., 2019). Air travel facilitates faster and more efficient international transit, frequently associated with wealthy travellers and extensive tourist facilities. This model demonstrates empirical insignificance; more exhaustive research consistently associates air travel with economic development via improved global connection, trade facilitation, and access to international markets (Button and Taylor, 2000). Air travel promotes foreign investment prospects that are less linked to terrestrial transportation, especially in non-contiguous or island economies. It is more closely associated with high-value economic sectors such as tourism, finance, and high-tech services, suggesting a more significant structural impact on gross domestic product growth, through mediating factors, even if not statistically represented. On the other hand, land travel typically consists of many visitors, reflecting border-adjacent or regional tourism, which is frequently characterised by short stays and lower spending (UNWTO, 2022). Usually, its purpose is to boost regional or local businesses.

Tourist arrivals are a key mediating variable in analysing the relationship between tourist transportation modes and gross domestic product (GDP) growth in landlocked African countries. Access to transport directly impacts the number of foreign visitors, boosting demand for services, infrastructure investment, and jobs (UNWTO, 2023). Air and land travel directly affect the amount and frequency of tourist visits, impacting gross domestic product (GDP).

This variable naturally mediates the relationship between modes of transport and economic outcomes. The quality of tourism infrastructure serves as a secondary mediating influence. Transport modes alone do not ensure GDP growth without adequate infrastructure, including airports, highways, hotels, and travel services. If destinations offer reliable and easily accessible amenities, improved air connectivity draws more tourists (Canton, 2021). As a result, the amount and quality of infrastructure associated with tourism mediate the impact of air and land travel on gross domestic product (GDP). Political stability is an important moderating factor that significantly affects the strength and direction of the relationship between gross domestic product and modes of transport. Despite improved accessibility, tourists avoid land routes in politically unstable countries out of concern for their safety, which reduces their gross domestic product (GDP) impact. However, in conflict-affected areas, flying is considered safer, which could increase its influence on tourism and gross domestic product (Group, 2022). As a result, political stability affects how transit choices affect the economy. The causal relationship between variables is summarised in the following figure.

* LT: It is the number of land travels for unit i at time t
* μi: Represents unit-specific random effects,
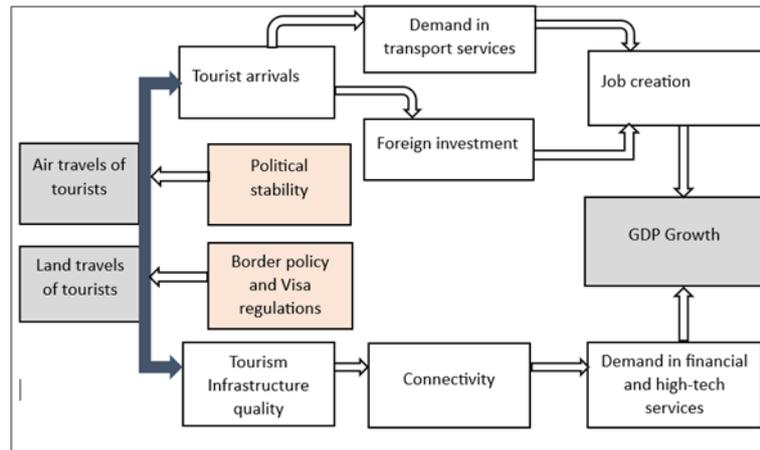* εit: Idiosyncratic error term.

Figure 1*: Moderation and mediation factors*

Policymakers, travel companies, and travellers must heed strategic recommendations to improve sustainable tourism in landlocked African nations.

For Decision-Makers

Government representatives in landlocked African countries should encourage investments in aviation infrastructure because air travel and foreign visitor arrivals are significantly positively correlated. Tourist accessibility can be significantly improved by expanding airport capacity, improving regulatory frameworks, and expanding airspace through regional agreements such as the Single African Air Transport Market (SAATM) (Zhang and Graham, 2020). Reducing air travel costs and visa restrictions, which have been identified as obstacles to tourism growth, should also be the focus of policy attention ("UNWTO, 2023). Nonetheless, the statistically significant impact of air and land travel on the number of foreign visitors suggests that the development of integrated transport should be a top priority. In addition to improving land border infrastructure, road networks, and regional connections, policymakers should allocate funds for transport infrastructure. Naudé and Saayman (2005) believe that enhancing land infrastructure in Africa could alleviate obstacles that limit cross-border tourism. The uniformity of visa and customs protocols among neighbouring states can significantly improve the efficiency of terrestrial travel. According to the research, a seaport connected to the Cross-Sahara Railway could serve as a rail link between West Africa and Eastern regions. For landlocked nations like Chad, Niger, Mali, and Burkina Faso, it can enhance transportation. It would increase cross-border cooperation, multi-country tourism, and economic benefits by providing convenience, better transit, and easier access to biological and cultural sites. The railway could create jobs, boost trade, and enhance infrastructure, increasing tourism's GDP contribution. Furthermore, the statistical discrepancy between air and land travel's impact on GDP growth highlights the need for policymakers to reconsider the assumption that tourism alone drives economic growth in landlocked African countries. Enhancing tourism's value chains, such as local entrepreneurship, more effective hospitality, and cultural asset management, should take priority over focusing exclusively on travel volume. Brida, Cortés-Jiménez, and Pulina (2016) warn that the economic advantages of tourism depend more on structural integration and productive links than on mobility alone. Revenue sharing between airlines and local communities can fairly distribute tourism benefits in Africa's landlocked nations. A small portion of passenger traffic or ticket sales revenue would fund local development for tourism initiatives, infrastructure, or environmental conservation. This aligns with corporate social responsibility and fosters ongoing airline community involvement. Implementation requires governance, stakeholder engagement, and financial responsibility. Efficient revenue sharing can increase tourism's GDP contribution, mitigate the adverse effects of enclave tourism, and contribute to development.

Travel agencies

Travel agencies operating in or targeting landlocked African countries may exploit the apparent demand elasticity for air travel. Agencies can increase demand and location appeal by developing inclusive, competitively priced packages that combine air travel with local culture and eco-tourist activities. A significant increase in foreign arrivals and tourist spending can be achieved by strategically matching travel services with air mobility. In addition, travel agents must modify their services to reflect the equal significance of air and land travel in promoting tourism. While air travel remains predominant in scale, road travel provides access to regional markets and caters to cost-conscious consumers. Agencies can create multi-modal travel packages that integrate airplane access with land trips to surrounding cultural, ecological, or heritage areas, boosting value for international and regional tourists (Gossling, 2018). Due to the weak economic relationship between travel volume and GDP

results, travel agents must modify their business models to improve local economic engagement. This includes working with local startups and promoting premium, experience-based travel that keeps more of the financial resources in the area (Gossling, 2018). To promote inclusive and sustainable tourism ecosystems, agencies must look beyond the practicalities of travel facilitation.

Tourists

Tourists intending to visit landlocked African nations should be advised to choose air travel for its dependability and connectivity to primary tourism centres. Despite the infrastructural constraints of land travel, air transport is the most efficient and secure method for international access (Duval, 2007). Early bookings and airline partnerships with tour operators, who offer affordable travel options and encourage sustainable tourism development in underserved areas, benefit tourists. They might consider terrestrial travel as an alternative approach to exploring regional locations outside urban and air-connected areas. Despite its small impact, land travel is statistically significant, offers real cultural experiences, and has economic benefits compared to air-connected regions. Duval (2007) observes that road-based travel facilitates greater interaction with local populations, aligning with the sustainable and holistic tourism principles increasingly preferred by global travellers. Tourists traveling to landlocked African countries should be encouraged to make deliberate travel decisions that support local populations. The results show that travel, whether by air or land, does not always lead to financial gain. By purchasing from local artists, guides, and lodging facilities, tourists can substantially contribute to the local economy. According to Duval (2007), ethical travel is becoming increasingly crucial in aligning tourism behaviours with local development goals.

Limitations and future research directions

The research is limited to landlocked countries in Africa. Future scholars may undertake investigations globally to enhance the comprehensiveness of the research. The study restricted the search to tourist travels; subsequent research could broaden the study's reach by using business people and integrating cargo transport. We considered land transport unique, while other scholars can separately analyse the role of road transport, railway transport, and water transport travellers in different regions to boost GDP growth. They can expand the equation by adding connectivity or air and land transportation infrastructure parameters.

VII.   Conclusion

This study critically evaluated the connection between GDP growth and foreign visitor arrivals by air and land. Results show that air travel greatly increases foreign visitor arrivals more than land travel, confirming its crucial role in promoting cross-border travel in landlocked African countries. However, neither land nor air travel showed a statistically significant direct effect on GDP growth, indicating that greater mobility alone cannot promote economic growth. This outcome indicates that the Tourism-Led Growth Hypothesis (TLGH) may not have universal implications. The hypothesis may be compelling in certain nations, but not in those with insufficient tourism infrastructure and limited economic absorption capacity. These findings highlight the significance of mediating factors such as political stability, regional cooperation, and tourism infrastructure. The report suggests that policymakers prefer the development of air and land system infrastructure and invest in integrated transportation networks. Maximising the economic benefits of tourism requires strengthening institutional frameworks, improving border processes, and assisting regional tourism value chains.

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