Exploring The Long Run Relationship Between Air Transport and Economic Growth in Japan: New Evidence

***Nader Alzabadi*[1] *Nawal Bouchentouf*[2]**

Abstract

This study examines the long-term relationship between air transport and economic growth in Japan between 1980 and 2023. The autoregressive distributed lag ARDL model and the Granger causality test were used. The results of the bounds cointegration test revealed that all study variables are cointegrated. The long-term results showed that air transport passengers have a positive and statistically significant impact on economic growth, as well as financial development and urbanization. An increase of 1% in the number of air transport passengers contributes to a 0.08% increase in GDP per capita. The short-term results showed that energy use and urbanization have a positive impact on economic growth. Granger's causality results show that there is a one-way relationship from economic growth and financial development to air transport passengers, furthermore, there is a two-way relationship between air transport, energy consumption and the social globalization index. Based on these findings, and in light of the study's results, it is clear that giving great importance to the Japanese air transport sector and its development is a priority, given its positive impact on long-term economic growth.

Keywords: Air transport; economic growth; ARDL; Japan

Jel: C30; E43; L83

[1] Lecturer, Nobel institute of economic studies, Istanbul, Turkey, alzabadi@yahoo.com.

[2] Assistant professor, depart of economics, Tlemcen university, Algeria, Bouchentouffi@hotmail.com

1. INTRODUCTION

Air transport has expanded significantly in recent decades, as globalization and trade openness have played a major role in connecting countries around the world. This development has contributed to the revitalization of commercial activities. Comparative advantage in the tourism sector has a crucial role in developing the field of air transport, countries that enjoy sustainable economic growth have been able to develop their aviation industries in a way that serves the economy as a whole. Thoumrungroje and Tansuhaj (2007) as well as Čiarnienė and Kumpikaitė (2008) have established that advancements in transportation are a key outcome of globalization, which has drastically transformed business practices and increased the extent of globalization.

Cidell (2006) identified three main processes related to globalization that significantly affected air transportation: a surge in trade, advancements in technology, and deregulation. The notable influence of globalization plays a role in generating numerous job opportunities and fostering economic development. The aviation industry is particularly impacted by globalization due to its direct ties to the openness of nations worldwide. Additionally, the aviation sector is a vibrant field that is greatly shaped by contemporary innovations resulting from the integration of countries globally. Air travel has emerged as the most essential, dependable, and swift mode of transportation, propelled by globalization, which, along with deregulation and decreased airfare prices, combined with rising GDP and improved living standards, serves as a primary catalyst for the growth of the airline industry (Oktal et al., 2006). Further, globalization factors positively influence airlines' performance metrics concerning both operations and financial aspects (Kuz and Miskinis, 2021).

The air transport sector has direct, indirect and induced impacts on the wheel of economic growth, the direct impact is represented by employment through activities directly linked to the air transport sector. The indirect impact is through operational activities that provide goods and services, such as aviation fuel, construction, infrastructure, information technology, the financial sector, and other activities indirectly linked to the transport sector in general. The air transport sector has enabled many activities to increase productivity, facilitate trade and tourism development, improve efficiency, and attract investment (Allroggen and Malina, 2014). The induced impact signifies the multiplier consequence of direct and indirect impacts (Vasigh and Pearce, 2024: 20)

In the field of trade and tourism, the air transport sector has an essential role in terms of trade and tourism, facilitating global trade. Air freight is essential for enabling international trade by swiftly and efficiently moving goods across borders. The dynamics of global trade and globalization mechanisms have molded the aviation industry. Moreover, the air transport sector boosting Tourism, the increased availability and affordability of air travel have significantly fueled the enlargement of international tourism, driving economic activity in host countries. Visitors traveling by air tend to spend on lodging, food, transportation, and attractions, thus energizing local economies and supporting small businesses (Thrane,2015; Njoya, 2020).

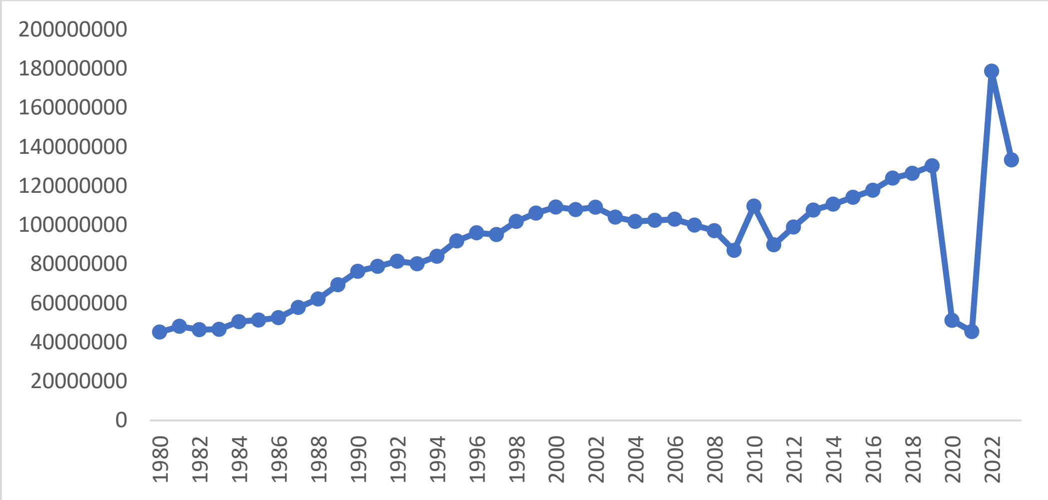
Finally, the air transport sector has a vibrant impact on Economic progress and Connectivity, the aviation sector links businesses with suppliers, customers, and partners across the globe. It raises innovation and cooperation on an international level, with business travelers relying on air transportation for meetings, conferences, and exhibitions, thus inducing economic flexibility and competitiveness. Regional Connectivity: Airports act as hubs for regional connections, linking remote and underserved areas with urban centers and global markets. Access to air travel improves mobility, supports trade, and enhances access to vital services, thereby contributing to the socioeconomic growth of rural communities (Brugnoli et al,2018).

The World Travel and Tourism Council reported that in 2024, the tourism industry inject global economy by US$10.9 trillion, representing 10% of the global gross domestic product. It is projected that by 2034, this sector will contribute a remarkable $16 trillion, which will account for 11.4% of the world economy. Furthermore, this growing sector is expected to provide jobs for 449 million individuals worldwide, making it a major source of employment. This underscores the vital importance of travel and tourism in global employment, as about 12.2% of the worldwide workforce is engaged in this dynamic industry.

The transportation sector in Japan is considered one of the most important sectors, as Japan has 98 airports that provide air transport services. The development of this sector has been contributed to by many factors, whether external, such as openness and globalization, or internal, due to urbanization, economic growth, and geography, which has witnessed significant development over the past decades. The Japanese aviation market is anticipated to expand from its 2024 valuation of USD 10.49 billion to USD 13.35 billion by 2029, with an annual growth rate of 4.94% from 2024 to 2029 (WTTC, 2025).

Regarding the development of air transport in Japan, the number of air transport passengers in 1980 reached 45 million, this sector continued to grow significantly and reached 130 million in 2019. Between 2020-2021, there was a clear decline in the number of passengers due to Covid-19. After the end of the epidemic, the air transport market returned to its normal level. This explains that the Japanese air transport sector is a dynamic and vital sector for economic activity. Figure (1) shows the development of Japanese air transport passengers (AT) during the period between 1980-2023.

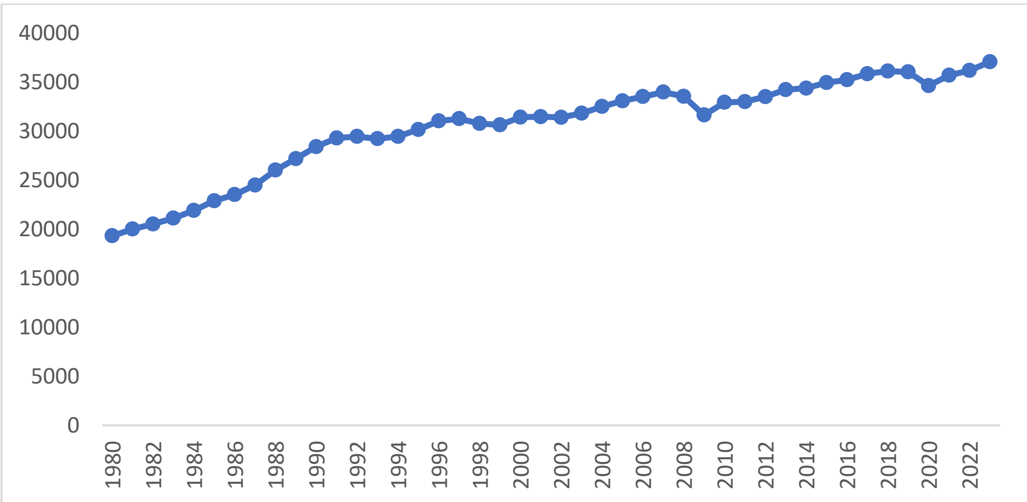
Figure 1. The development of Japanese air transport passengers during the period between 1980-2023.



Source: World Bank.

The Figure 2 shows that there is a balanced growth in Japanese GDP per capita during the study period. In 1980, the per capita GDP was equivalent to USD 19334.4, this growth continued until 2008, when Japan was affected by the global financial crisis GDP per capita fell slowly. After that, it rose again until the Covid-19 crisis, after which it rose again. This development in the GDP per capita output indicates that the Japanese economy is significantly affected by global economic conditions, which are reflected in the integration degree of Japanese economy in worldwide economy. Figure (2) shows the direction of the development of output during the period between 1980-2023.

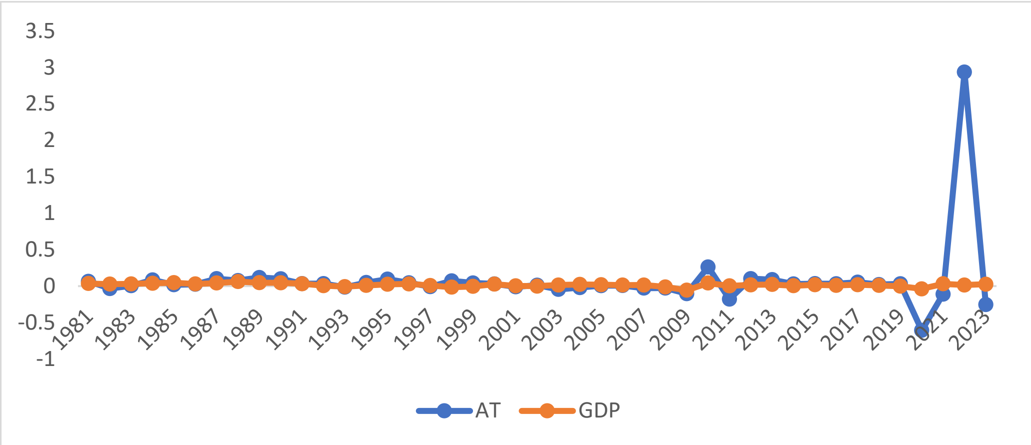
Figure 2. The development GDP per capita trend during the period between 1980-2023.



Source: World Bank.

It is noted from Figure (3) that the growth rate in the number of air passengers transport and the GDP Per capita growth rate during the study period are moving at the same level, which indicates that Japanese air transport has a strong relationship with economic growth. In 2022, after recovering from Covid-19, air transport witnessed a significant increase not only in Japan but also globally as a whole. The air passengers transport average growth rate during the study period was 0.071, while GDP Per capita average growth rate was 0.015, meaning that the growth in air passengers transport is higher than the economic growth, which indicates that the impact of air transport is positive on Japanese economic growth due to induced impact.

Figure 3. The Japanese growth rate of air transport passengers (AT) and GDP per capita from 1981 to 2023.



Source: Obtained based on World Bank open data. 2024.

2. LITERATURE REVIEW

Numerous studies have addressed the role of air transport in economic growth. Some of these studies have found that air transport has a positive impact on economic growth, while others have found the opposite. Kiracı and Bakır (2019) investigated the causal links between air transportation and economic growth, taking income levels into account. Regarding this analysis, high-income, upper-middle-income, lower-middle-income, and low-income countries have been included. Data collected from 1990 to 2016, a total of 70 countries were categorized by their income levels and analyzed quantitatively. The study employed panel causality tests as developed by Kónya (2006) and Emirmahmutoğlu & Köse (2011). The results show that the rise GDP has a significant impact on air transport. In addition, they suggest that the nature of the unidirectional or bidirectional causal relationships between GDP and air transport differs according to the income level of each country.

Hakim and Merkert (2016) exposed the causal link between air transportation and economic development in South Asia. Panel data spanning 42 years (1973–2014) was employed, the study used Pedroni/Johansen cointegration testing techniques, Granger long-run, and Wald short-run causality examinations. To account for spatial differences, we applied Time Series cross-section (TSCS) Granger causality tests for each of the eight countries analyzed individually. Our findings indicate a long-term uni-directional Granger causality from GDP to air passenger traffic as well as to air freight volumes. In contrast to previous studies, we did not identify a long-term bi-directional causality, emphasizing the relevance of spatial factors and context (particularly in low-income regions with large populations). The lack of short-run causality and the identified time lags of 3–4 years should inform aviation companies and policymakers when planning the necessary infrastructure to accommodate the significant potential for growth in air transport.

Rodríguez-Brindis et al. (2015) diagnosed the long-term effects between air transport demand and economic growth in Chile. Using quarterly data from 1986 (Q1) to 2014 (Q29), Using Johansen cointegration, the existence of a cointegration vector is demonstrated in which the corresponding elasticities are positive. The result displayed that there is a positive and bidirectional causal relationship.

Additionally, Brida et al. (2016a) studied the relationship between air transport demand and economic growth in Italy from 1971 to 2012. utilizing Johansen co-integration analysis. The results reveal that the elasticities were determined to be positive. The Granger Causality test identified a unidirectional causal link from air transportation to GDP. These results imply that Italy could boost its economic growth by effectively utilizing the air transport sector and improving its governance capabilities. In a similar vein, Brida et al. (2016b) explored the causal relationships between real GDP and the number of air passengers arriving at and departing from airports in Mexico. Their Johansen co-integration analysis also indicated one cointegrated vector with positive elasticities. The study revealed a positive and bidirectional causal relationship. The impulse response analysis suggested that an increase in the scale of air transport development in Mexico promotes the country's economic growth.

Baltaci et al. (2015) inspected the relationship between air transport and economic growth in Turkey. A cross-regional panel data analysis approach. The results of this study show that there is a positive relationship between the number of energetic airports, frequency of air traffic, and regional economic growth. Balsalobre-Lorente et al. (2020) presented evidence of an uneven relationship between air travel and economic growth within the Spanish economy from 1970 to 2015; they highlight the positive influences of social globalization and urbanization on Spain's economic progress. Gómez et al. (2018) examined the causal relationship between energy consumption and income in Mexico from 1965 to 2014, uncovering structural breaks in the data. Results signified a long-term interaction among production, labor, capital, and energy.

Gurgul and Lach (2011) used quarterly data from Poland to analyze the link between coal consumption and the economy, using GDP as a standard and incorporating employment as a variable. Their findings indicated a nonlinear causality between coal consumption and GDP, as well as other interrelations, and while they applied the Toda-Yamamoto bootstrap methods, employing quarterly data may have uncovered more latent patterns within the data. Onifade et al. (2022) examined the importance of the tourism-induced growth hypothesis regarding air transport across seven emerging (E7) nations—China, India, Brazil, Mexico, Russia, Indonesia, and Turkey. They utilized second-generation panel data estimators, including cross-sectional autoregressive distributed lag, augmented Mean Group, and Dumitrescu-Hurlin Causality techniques, and established a long-run equilibrium relationship among the specified variables, validating the critical role of air transport in promoting economic growth, as a one percent increase in airline passenger arrivals significantly boosts growth in the E7 nations by 0.77%.

Khanal et al. (2022) inspected the impact of air transport on economic growth in Australia in both the long-run and short-run. Employed the nonlinear autoregressive distributed lag (NARDL) modeling approach on data from Australia dating from 1971 to 2019, and also explored the impact of selected control variables (such as energy consumption, financial development, socialization, and urbanization) on economic growth. Results indicated statistically significant asymmetric effects of air transport on economic growth in both the short and long run. Positive variations in air transport foster long-term economic growth in Australia, while adverse changes in air transport have a more pronounced negative effect on economic progression than their positive counterparts.

Mehmood et al. (2014) tested the aviation-led growth hypothesis in Romania by investigating the causal relationship between aviation and economic development. they utilized econometric tests, including unit root tests and Johansen's (1988) cointegration tests. Fully Modified OLS, Dynamic OLS, and Conical Cointegration Regression methods are used to estimate the cointegration equation over the period from 1970 to 2012. The empirical findings indicate a cointegration relationship between aviation demand and economic growth. Additionally, graphical techniques such as the Cholesky impulse response function (both accumulated and non-accumulated) and variance decomposition have been employed to enhance the analysis's robustness. The positive impact of aviation demand on economic growth is consistent across all three estimation methods of the cointegration equation. Finally, a Granger causality test is conducted to determine the direction of the causal relationship. The results underscore the significance of the aviation sector in contributing to economic growth in Romania.

Destek and Aslan (2017) utilize bootstrap Granger causality analysis, revealing that there is a connection between energy consumption and economic growth. Fang and Chang (2016) investigate the causal link among energy, human capital, and economic growth. Saidi and Mbarek (2016) analyze the interaction between nuclear energy, renewable energy, CO_2 emissions, and economic growth across nine developed nations. Chang et al. (2014) confirmed the causal relationship between nuclear energy consumption and economic growth in G6 countries.

Li (2015) discovered that the advancement of civil aviation contributed positively to economic growth. Shen and Zou (2016) demonstrated that there was a bidirectional Granger causality between air transportation and the economy in China, finding indicated that, economic growth promotes air transport growth more significantly than vice versa.

Lu and Li (2016) revealed a stable long-term equilibrium relationship between aviation mileage and national income levels in China. Button and Yuan (2013) discovered the causal relationship between air freight transport and economic development, concluding that airfreight transport positively influences local economic growth. Fernandes and Pacheco (2010) investigated the causal relationship between GDP and air passenger traffic, establishing a unidirectional Granger causality from economic growth to domestic air transport demand. Vijver et al. (2015) assessed the connection between air transport and regional development in Europe, using employment as a reliable and measurable indicator of regional development. The methodology focused on whether air transport causally impacts employment and vice versa, revealing that both causal directions exist in European urban areas. Furthermore, Hu et al. (2015) explored the short-run dynamics, long-run equilibrium relationships, and Granger causal associations between economic growth and domestic air passenger traffic, based on quarterly panel data from 29 provinces in China over the period from 2006Q1 to 2012Q3. They used tests for panel unit roots, cointegration in heterogeneous panels, and panel causality within a bi-variate panel vector error correction model (PVECM) estimated by the system generalized moment method (SYS-GMM). The findings provide evidence of a long-run equilibrium relationship between economic growth and domestic air passenger traffic, specifically noting that a 1% increase in air passenger traffic corresponds to a 0.943% rise in real GDP. A strong long-run bi-directional Granger causal relationship was identified between these two series, along with a short-run unidirectional Granger causality flowing from domestic air passenger traffic to economic growth.

Cruz-Rodríguez, and Rodríguez-Flores (2019) investigated the causal link between economic growth and air passenger transportation in Mexico from 2003 to 2017. They employed cointegration analysis through Pedroni and Johansen tests, vector error correction models, and the Granger causality test. Their findings show that an increased traffic volume affects the direction of causality. Fernandes et al. (2021b) used a Granger causality analysis to examine the relationship between domestic air passenger transport and the GDP of small regional municipalities in the Amazon region of Brazil. The outcomes of their analysis reveal a bidirectional relationship between the economy and air transport both in the short and long term.

This study aims to explore the long-run relationship between air transport passengers and economic growth in Japan from 1980 to 20213. To avoid model errors, control variables are used, such as financial development, Urbanization, energy use, and social globalization Index.

3.DATA, MODEL SPECIFICATION AND METHODOLOGY

3.1 Data

This study employs time series data from 1980 to 2023 for Japan, which formed the groundwork for the analysis. Data concerning GDP per capita, air transport passengers carried, energy usage, financial progress, and urbanization were obtained from the World Development Indicators (WDI). Furthermore, details regarding the social globalization index were gathered from the KOF Swiss Economic Institute. The KOF Globalization Index assesses economic, social, and political dimensions of globalization (KOF, 2023) and consists of 12 economic indicators related to banking confidence, production levels, new orders, consumer sentiment, and housing. Table 1 presents the sources of data and descriptions of the variables.

Table 1. Data sources and variable description

Variables	Description	Source
Gross domestic product (GDP)	GDP per capita (current USD)	WDI
Air transport (AT)	Air transport, Passengers carried	WDI
Energy use (EU)	Primary energy uses per capita	WDI
Financial development (FD)	Domestic credit to the private sector (%GDP)	WDI
Social globalization (SG)	Social integration index	KOF
Urbanization growth (UR)	Urban population growth (annual %)	WDI

The data in Table 2 presents descriptive statistics for a set of variables. It was found that the mean of the variables falls within the expected range, indicating the absence of outliers in the dataset. However, the calculated standard deviations suggest that there is a considerable amount of variability in the data. Furthermore, all the analyzed parameters exhibit negative skewness, with none exceeding the range limit of +1 and -1. The resulting Kurtosis value for each parameter is less than 3, indicating normal distribution. The Jarque-Bera test confirms the normal distribution of the parameters. Consequently, the researcher was able to utilize the data for further analysis.

Table 2. Descriptive statistics

Variables	Mean	Median	Max	Mini	Std. Dev.	Skewness	Kurtosis	JB	Prob.
L(GDP)	10.311	10.356	10.52	9.87	0.177	-1.131	3.216	9.47	0.009
L (AT)	18.263	18.385	19.00	17.66	0.351	-0.498	2.306	2.70	0.257
L (FD)	5.142	5.1348	5.38	4.82	0.135	-0.439	2.760	1.52	0.468
L (SG)	4.219	4.2520	4.37	4.06	0.114	-0.232	1.381	5.20	0.074
L (EU)	10.669	10.679	10.81	10.45	0.108	-0.365	2.033	2.69	0.260
L (UR)	4.422	4.3921	4.52	4.33	0.078	0.191	1.222	6.06	0.048
L (FD)	5.142	5.1348	5.38	4.82	0.135	-0.439	2.760	1.52	0.468

3.2 Model

In economics, forecasting long-term relationships is an essential tool that helps economic decision-makers adopt policies and plans that promote economic growth and lessen obstacles. Today, the aviation industry is one of the inputs to economic growth, it is linked to many other macroeconomic variables such as financial sector and energy consumption, especially in light of the abandonment of traditional means of transportation and the transition to air transport. Following Balsalobre-Lorente et al. (2021), Marazzo et al. (20210), Adedoyin et al. (2020), Wang et al. (2019), a functional equation of the model is presented as:

$$GDP = f(AT, EU, FD, SG, U) \tag{1}$$

$$GDP_t = \beta_0 + \beta_1 AT_t + \beta_2 EU_t + \beta_3 FD_t + \beta_4 SG_t + \beta_5 U_t + \varepsilon_t \tag{2}$$

Where β_0 and ε_t are the intercept and the error term respectively. In addition, β_1, β_2, $\beta_3, \beta_4, \beta_5$ represents the coefficients. By taking the natural logarithm of equation (2), the study model becomes as following equation:

$$LGDP_t = \beta_0 + \beta_1 LAT_t + \beta_2 LEU_t + \beta_3 LFD_t + \beta_4 LSG_t + \beta_5 LU_t + \varepsilon_t \tag{3}$$

3.3 Methodology

The main aim of this research was to assess the applicability of the Aviation-Led growth Hypothesis (ALGH) in the context of Japan by examining the relationships between air transport and economic growth over both short and long terms using an ARDL model proposed by Pesaran et al. (2001). Moreover, this study incorporated several explanatory variables, such as energy consumption, financial development, social globalization, and urbanization, as control variables to avoid the potential for biases due to omitted variables. The significant increase in air travel can mainly be attributed to the rise of globalization. As global connectivity expands, there is a rising need for air transportation to facilitate international trade, tourism, and cultural interactions. Therefore, social globalization significantly influences air transport, alongside energy use and financial development. The ARDL framework allows for the investigation of cointegration between variables over both short and long term. This method presents multiple benefits compared to traditional cointegration techniques (Voumik et al., 2023). Unlike earlier cointegration methods, it does not require the integration property of a series to be tested beforehand. The ARDL model addresses endogeneity by incorporating the lag length of the variable. It is also applicable to any situation involving the integration of an exploratory series (Yusoff et al., 2023). The ARDL model maintains statistical significance even with limited sample sizes. Therefore, the ARDL cointegration method enables an accurate estimation of the long-term relationships among variables. When the independent variables are either I(0) or I(1), the ARDL bound test provides two asymptotic critical value bounds. The equation (4) was used to estimate the cointegration among a set of variables.

$$\Delta LGDP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 LAT_{t-1} + \beta_3 LEU_{t-1} + \beta_4 LFD_{t-1} + \beta_5 LSG_{t-1} + \beta_6 LU_{t-1} + \sum_{i=1}^{q} \gamma_1 \Delta GDP_{t-i} + \sum_{i=1}^{q} \gamma_2 \Delta LAT_{t-i} + \sum_{i=1}^{q} \gamma_3 \Delta LEU_{t-i} +$$

$\sum_{i=1}^{q} \gamma_4 L\Delta FD_{t-i} + \sum_{i=1}^{q} \gamma_5 \Delta LSG_{t-i} + \sum_{i=1}^{q} \gamma_6 \Delta LUR_{t-i} + \varepsilon_t$
(4)

After establishing the long-term relationship between the series, it is important to consider the short-term coefficient. This research assessed the error-correction model (ECM) using Equation (5) and calculated the short-term coefficients. Equation (5) demonstrates the dynamics of error correction and the long-term connections between the series.

$\Delta LGDP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 LAT_{t-1} + \beta_3 LEU_{t-1} + \beta_4 LFD_{t-1} + \beta_5 LSG_{t-1} + \beta_6 LU_{t-1} + \sum_{i=1}^{q} \gamma_1 \Delta GDP_{t-i} + \sum_{i=1}^{q} \gamma_2 \Delta LAT_{t-i} + \sum_{i=1}^{q} \gamma_3 \Delta LEU_{t-i} + \sum_{i=1}^{q} \gamma_4 L\Delta FD_{t-i} + \sum_{i=1}^{q} \gamma_5 \Delta LSG_{t-i} + \sum_{i=1}^{q} \gamma_6 \Delta LUR_{t-i} + \theta ECM_{i-1} + \varepsilon_t$
(5)

Where q representing the lag length of the series, Δ as the first difference operator, and θ as the coefficient of the ECM. $\beta_1 - \beta_6$ represent the long run coefficients, $\gamma_1 - \gamma_6$ represent the short run coefficients.

4. EMPIRICAL RESULTS

4.1 Lag selection

In Table 3, the findings of the optimal lag selection are displayed. Identifying the best lag in the ARDL model aims to address the issue of autocorrelation within the model system by treating the lag in endogenous variables as an exogenous variable. The optimal lag determination is based on the likelihood ratio (LR), final prediction error (FPE), AIC, Schwarz information criterion (SIC), and Hannan–Quin criterion (HQ) values. As indicated in Table 2, the chosen lag is lag 2 as the optimal lag implies that all variables not only influence each other in the same period but also in the preceding two periods.

Table 3. Lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	315.4468	NA	1.12e-14	-15.09496	-14.84420	-15.00365
1	623.7200	511.2824	1.95e-20	-28.37659	-26.62122	-27.73738
2	715.1284	124.8505*	1.47e-21*	-31.07943*	-27.81947*	-29.89233*
3	749.2488	36.61699	2.22e-21	-30.98774	-26.22318	-29.25275

4.2 Unit root tests

Before engaging in a cointegration test, it is essential to perform unit root tests to assess the stationarity characteristics of the parameters. This step is vital as it aids in selecting an appropriate test for the subsequent phase of the study and identifies the type of stationarity of the parameters being analyzed. Two-unit root testing methods were implemented in this study: Augmented Dickey-Fuller and Phillips-Perron. As shown in Table 4, all parameters evaluated displayed stability at the level I(0) or after the first difference I(1). This indicates that cointegration and the ARDL estimator can be utilized with the data.

The stationarity of the variables was assessed at the outset of the time series analysis through the use of unit root tests. Utilizing unit root testing can help avoid erroneous regression analyses (Ridzuan et al., 2017). This process involves examining the regression variables to determine their stationarity and then employing those stationary processes to estimate the target equation. According to existing empirical literature, it is essential to establish the integration sequence before applying cointegration techniques.

The unit root test was used to analyze the stationarity of the featured variables. If the mean-variance and covariance of a variable's probability distribution changes over time, it is considered non-stationary (Borhan et al., 2023). Considering the variations in power and sample size across the tests, several researchers have suggested the use of multiple unit root tests to determine the series' integration order. Three-unit root test were used, the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979), DF-GLS and the Phillips-Perron (P-P) (Phillips and Perron, 1988) were employed to determine the stationarity of the variables.

Table 4. The results of unit root tests

	ADV		DF-GLS		PP	
	At level	First difference	At level	First difference	At level	First difference
L (GDP)	-4.027***	-4.547***	0.397	-4.124***	-4.125***	-4.534***
L (AT)	-2.270	-10.108***	-1.0242	-10.218***	-2.627*	-15.690***
L (FD)	-2.433	-4.079***	-1.011	-4.087***	-2.275	-4.035***
L (EU)	-1.350	-6.506***	-0.910	-5.705***	-1.429	-6.614***
L (UR)	-1.415	-2.025	-1.158	-1.974**	-0.260	-1.763
L (SG)	-0.549	-5.729***	0.866	-5.786***	-0.559	-5.739***

*, ** and ***, 1%, 5% and 10%

4.3 Cointegration Test

The dataset's stationarity can be assessed based on the outcomes of the unit root test. To investigate whether a cointegration relationship existed between the parameters in use, the ARDL Bounds test was conducted. Table 5 displays the results of the cointegration analysis. The obtained cointegration F-statistic (13.478, refer to Table 5) exceeds the upper acceptable value. This test establishes that the study variables are cointegrated.

Table 5. ARDL bounds test results

Null hypothesis: No degree of relationship					Result
		Sig.	I(0	I(1)	
F value	13.478	10%	2.08	3	Cointegrated ***
K	5	5%	2.39	3.38	
		2.5%	2.7	3.73	
		1%	3.06	4.15	

*, ** and ***, 1%, 5% and 10%

4.4 Model estimation

Table (6) shows that the long-term results show that a 1% increase in the number of air transport passengers contributes to a 0.08% increase in GDP per capita. This means that increased air transport has a positive and statistically significant effect on economic growth in Japan. The results also show that a 1% increase in financial development contributes to a 0.45% increase in GDP per capita. Financial development has a positive effect on the transportation and tourism sectors. Regarding urbanization growth, the results show that a 1% increase in urbanization contributes to a 1.7% increase in GDP per capita. In the short term, the results show that a 1% increase in energy consumption contributes to a 0.065% increase in GDP, in addition, an increase a 1% increase in urbanization contributes to a 0.53% increase in GDP per capita.

Table 6. Long and short run results

Variable	Long run		Short run	
	coefficients	Prob.	Coefficients	Prob.
L (AT)	0.083795	0.0053***	0.000904	0.8431
L (FD)	0.454812	0.0000***	0.017367	0.5475
L (SG)	-0.027793	0.8790	-0.008475	0.8797
L (EU)	0.126489	0.1294	0.648864	0.00***
L (UR)	1.766150	0.0000***	0.538561	0.0002***
c	-2.587943	0.0128	-	-
ECM	-	-	-0.304935	0.00***

*, ** and ***, 1%, 5% and 10%.

The ECM value mirrors the speed at which the system moves from a temporary balance to a state of permanent stability. Both the coefficient and the derived ECM are negative at the 1% significance level. According to the ECM values, short-term deviations from the long-term equilibrium path are generally adjusted by an average of 53.49 %, 4. The negative and significant ECM coefficient indicates that any long-term disparities among the model variables will adjust or align with the long-term equilibrium.

4.5 Granger Causality Test

Granger's causality results in Table (7) show that there is a one-way relationship from economic growth and financial development to air transport passengers, furthermore, there is a two-way relationship between air transport, energy consumption and the social globalization index (Granger, 1969).

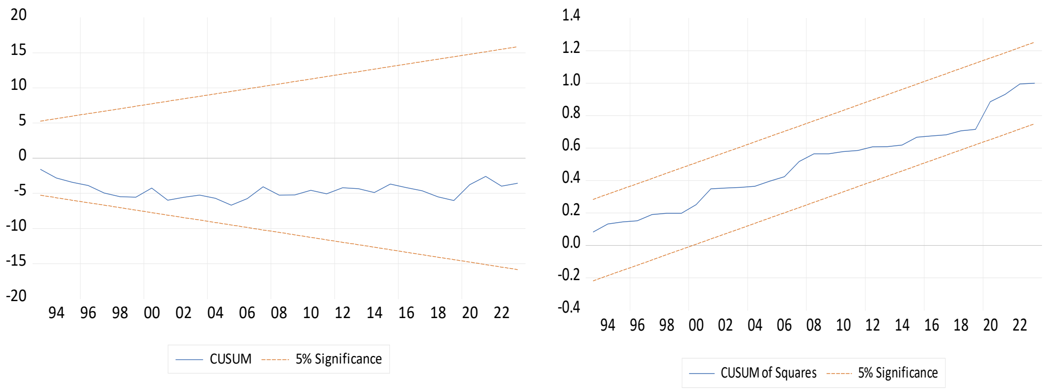
Table 7. Granger causality results

Null Hypothesis:	F-Statistic	Prob.
L (AT) does not Granger Cause L (GDP)	1.42139	0.2543
L (GDP) does not Granger Cause L (AT)	10.0106	0.0003***
L (AT) does not Granger Cause L (FD)	0.23549	0.7914
L (FD) does not Granger Cause L (AT)	4.42244	0.0190**
L (AT) does not Granger Cause L (EU)	3.66756	0.0352**
L (EU) does not Granger Cause L (AT)	2.80573	0.0734**
L (SG) does not Granger Cause L (AT)	3.29927	0.0480**
L (AT) does not Granger Cause L (SG)	4.99690	0.0120**

4.6 CUSUM and CUSUMQ Tests

The CUSUM test depends on the total recursive sum of the recursive residuals, whereas the CUSUMSQ test is based on the cumulative sum of the squares of the recursive residuals (Brown et al., 1975).

Figure 4. CUSUM and CUSUMQ Tests



4.7 Diagnostic tests

The reliability of the ARDL results was assessed through various diagnostic tests. Table 8 presents the Breusch-Godfrey Lagrange Multiplier (LM) test for autocorrelation, showing no evidence of serial correlation. The Breusch-Pagan-Godfrey test indicated the absence of Heteroscedasticity in the data. The Jarque-Bera Normality test confirmed that the residuals follow a normal distribution based on the Jarque-Bera statistic and p-value.

Table 8. Results of diagnostic tests

Diagnostic tests	Coef.	Prob.	Decision
Jarque-Bera test	0.313	0.855	Residuals are normally distributed
Breusch-Godfrey Serial Correlation LM Test:	1.446	0.2519	No serial correlation exists
Breusch-Pagan-Godfrey	1.008	0.4587	No heteroscedasticity exists
Ramsey Reset test	0.220	0.642	The model is properly specified

5. CONCLUSION

The Japanese aviation sector is considered one of the vital sectors that contribute to supporting economic activities. Japan, with its unique geographical location and islands areas, imposes great importance on air transport. This study aimed to identify the long-term relationship between air transport and economic growth, during the period from 1980 to 2023. Was relied upon as it is the most appropriate standard test to discover the long-term relationship ARDL. The results showed, based on the cointegration bounds test, that there is cointegration between the variables of the standard model. The long-term results showed that air transport has an impact on economic growth in Japan, an increase a 1% increase in air transport contributes to increase in GDP per capita by 0.08%. The results also showed that financial development (Domestic credit to private sector % GDP) and urbanization contribute to supporting economic growth. In the short term, the results showed that energy consumption and urbanization have a statistically significant impact on economic growth. Finally, the results of the Granger causality test indicated that there is a one-sided relationship from economic growth to air transport, as well as a one-sided relationship from financial development to air transport. On the other hand, it was shown that there is a two-way relationship between air transport and both energy consumption and the social globalization index.

References

Allroggen, F, and Malina, R. (2014), "Do the regional growth effects of air transport differ among airports?," *J. Air Transp. Manage*, 37, 1-4.

Balsalobre-Lorente, D., Gokmenoglu, K.K., Taspinar, N, and Cantos-Cantos, J.M. (2019), "An approach to the pollution haven and pollution halo hypotheses in MINT countries. Environ," *Sci. Pollut. Res*, 26 (22), 23010–23026.

Baltacı, N., Sekmen, Ö, and Akbulut, G. (2015), "The relationship between air transport and economic growth in Turkey: Cross-regional panel data analysis approach," *Journal of Economics and Behavioral Studies,* 7(1), 89-100. doi:https://doi.org/10.22610/jebs.v7i1(J).566.

Brida, J.G., Bukstein, D, and Zapata-Aguirre, S. (2016a), "Dynamic relationship between air transport and economic growth in Italy : a time series analysis," *Int. J. Aviat. Manag*, 3 (1), 52–67. https://doi.org/10.1504/IJAM.2016.078660.

Brida, J.G., Rodríguez-Brindis, M.A, and Zapata-Aguirre, S. (2016b), "Causality between economic growth and air transport expansion: empirical evidence from Mexico," *World Rev. Intermodal Transp. Res,* 6 (1), 1–15. https://doi.org/10.1504/ WRITR.2016.078136.

Brown, R. L., Durbin, J, and Evans, J. M. (1975), "Techniques for testing the constancy of regression relations over time," *Journal of the Royal Statistical Society*, 37(2), 149–192.

Brugnoli, A., Dal Bianco, A; Martini, G, and Scotti, D. (2018), "The impact of air transportation on trade flows: A natural experiment on causality applied to Italy," *Transp. Res. Part A,* 112, 95–107.

Button, K, and Yuan, J. (2013), "Airfreight Transport and Economic Development: An Examination of Causality," *Urban Studies,* 50, 329-340.

Chang T. Gatwabuyege, F., Gupta, R., Inglesi-Lotz R., Manjezi, N.C., B.D. and Simo-Kengne, B.D. (2014), "Causal relationship between nuclear energy consumption and economic growth in G6 countries: Evidence from panel Granger causality tests," *Progress in Nuclear Energy*, 77, 187-193.

Cidell, J. (2006), "Air transportation, airports, and the discourses and practices of globalization," *Urban Geography,* 27(7), 651–663. https://doi.org/10.2747/0272-3638.27.7.651.

Cruz-Rodríguez, I. J, and Rodríguez-Flores, J. F. (2019), "Crecimiento económico y tráfico aéreo de pasajeros: un análisis para las entidades federativas en México," *Estudios Sociales Revista De Alimentación Contemporánea Y Desarrollo Regional*, 29(53). https://doi.org/10.24836/es.v29i53.651

Destek, M.A, and Aslan, A. (2017), "Renewable and non-renewable energy consumption and economic growth in emerging economies: Evidence from bootstrap panel causality," *Renewable Energy,* 111, 757-763.

Dickey, D.A, and Fuller, W.A. (1979), "Distribution of the estimators for autoregressive time series with a unit root," *J. Am. Stat. Assoc*, 74 (366a), 427–431. https://doi.org/ 10.1080/01621459.1979.10482531.

Fang Z, and Chang Y. (2016), "Energy, human capital and economic growth in Asia Pacific countries — Evidence from a panel cointegration and causality analysis," *Energy Economics*, 56, 177-184.

Fernandes, E, and Pacheco, R. (2010), "The causal relationship between GDP and domestic air passenger traffic in Brazil," *Transportation Planning and Technology,* 33, 569-581.

Fernandes, V. A., Pacheco, R. R., Fernandes, E., Cabo, M., Ventura, R. V, and Caixeta, R. (2020), "Air transportation, economy and causality: remote towns in Brazil's Amazon Region," *Sustainability*, 13.2, 627.

Goetz, A. R. (1992), "Air Passenger Transportation and Growth in the U.S. Urban System, 1950-1987," *Growth and Change*, 23(2), 217–238.

Gomez, M., Ciarreta, A, and Zarraga, A. (2018), "Linear and nonlinear causality between energy consumption and economic growth: the case of Mexico 1965-2014," *Energies*, 11 (4).

Granger, CW.J. (1969), "Investigating causal relation by econometric model and cross -special methods," *Econometrica,* 37 (3): 4424-438.

Gurgul, H, and Lach, Ł. (2011), "The role of coal consumption in the economic growth of the Polish economy in transition," *Energy Policy*, 39 (4), 2088–2099.

Hakim, M.M, and Merkert, R. (2016), "The causal relationship between air transport and economic growth: empirical evidence from South Asia," *J. Transport Geogr*, 56, 120–127. https://doi.org/10.1016/j.jtrangeo.2016.09.006.

Hu, Y., Xiao J., Deng Y., Xiao Y, and Wang S. (2015), "Domestic air passenger traffic and economic growth in China: Evidence from heterogeneous panel models," *Journal of Air Transport Management*, 42, 95-100.

Khanal, A., Rahman, M. M., Khanam, R, and Velayutham, E. (2022), "Exploring the Impact of Air Transport on Economic Growth: New Evidence from Australia," *Sustainability, 14*(18), 11351. https://doi.org/10.3390/su141811351.

Kiraci, K, and Bakir, M. (2019), "Causal relationship between air transport and economic growth: Evidence from panel data for high, upper-middle, lower-middle and low-income countries," *Khazar Journal of Humanities and Social Sciences*, 22 (3), 24 – 43.

KOF Swiss Economic Institute. (2023), "KOF Globalization Index," [Retrieved 2023-09-10] Available at: https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html.

Kuz, A, and Miskinis, A. (2021), "The Impact of Globalization on European Airline Market," *Ekonomika,* 100(1), 117–138. doi:10.15388/Ekon.2021.1.7.

Li, G.D, and Li, X.J. (2016), "Empirical study on coordinated development of airport industry and national economy in China," *J. Civ. Aviat. Univ. China*, 5, 56–59.

Lu, L.J, and Li, X.J. (2016), "Research on the relationship between airspace resources, civil aviation income and national economy," *Shanghai J. Econ*, 12, 20–27.

Mehmood, B., Feliceo, A, and Shahid, A. (2014), "What cause what? Aviation demand and economic growth in Romania: Cointegration estimation and causality analysis," *Romanian Economic Business review,* 9 (1), 21-33.

Mukkala, K, and Tervo, H. (2013), "Air transportation and regional growth: which way does the causality run?," *Environ. Plan. A,* 45, 1508–1520.

Njoya, E.T, and Nikitas, A. (2020), "The role of air transport in employment creation and inclusive growth in the Global South: The case of South Africa," *J. Transp. Geogr,* 85, 102738.

Onifade S T., Gyamfi, B.A., Bekun, F.V, and Altuntaş, M. (2022), "Significance of Air Transport to Tourism-Induced Growth Hypothesis in E7 Economies: Exploring the Implications for Environmental Quality," *An International Interdisciplinary Journal*, 70 (3), 339 – 353.

Pesaran, M. H., Shin, Y, and Smith, R. J. (2001), "Bounds testing approaches to the analysis of level relationships," *Journal of Applied Econometrics*, 16(3), 289–326. https://doi.org/10.1002/ jae.616.

Phillips, P.C, and Perron, P. (1988), "Testing for a unit root in time series regression," Biometrika, 75 (2), 335–346. https://doi.org/10.1093/biomet/75.2.335.

Rodríguez-Brindis, M. A., Mejía-Alzate, and M., Zapata-Aguirre, S. (2015), "Causality between economic growth and air transport expansion: empirical evidence from Chile," *Revista de Economía del Rosario,*18(1), 127-144.

Saidi. K., M.B. Mbarek. (2016), "Nuclear energy, renewable energy, CO2 emissions, and economic growth for nine developed countries: Evidence from panel Granger causality tests," *Progress in Nuclear Energy,* 88, 364-374.

Shen, H, and Zou, P. (2016), "The cooperative relationship between civil aviation industry and economic development in China," *Res. Econ. Manag,* 12, 98–104.

Thrane, C. (2015), "Examining tourists' long-distance transportation mode choices using a multinomial logit regression model," *Tourism Management Perspectives*, 15, 115-121. https://doi.org/10.1016/j.tmp.2014.10.004

Vasigh, B, and Pearce, B. (2024), "*Air Transport Economics: From Theory to Applications*," 4th ed. Routledge.

Vijver, E., Derudder, B. and Witlox, F. (2015), "Air Passenger Transport and Regional Development: Cause and Effect in Europe," *Promet – Traffic &Transportation,* 28(2), 143-154.

World Development Indicators. [Retrieved 2025-02-10] Available at: https://databank.worldbank.org/source/world-development-indicators.