Case Studies on Transport Policy 21 (2025) 101550

Contents lists available at ScienceDirect

Case Studies on Transport Policy

journal homepage: www.elsevier.com/locate/cstp

# Aviation industry growth in a landlocked developing country: The case of Mongolia

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ARTICLE INFO

*Keywords:*
Air connectivity development
Air transport supply and demand
International air passengers
Mongolia's aviation markets
Landlocked developing countries (LLDCs)

ABSTRACT

Improving air connectivity is crucial for landlocked developing countries (LLDCs) like Mongolia for the benefits of supporting trade flows, economic growth, and tourism. Analysing data from Mongolia's international aviation markets (2014–2023), this study examines market dynamics shaping flight frequencies, airline competition, and ticket prices. Findings indicate that on routes where additional flights and seat capacity are introduced if air travel demands do not keep pace, airlines are forced to lower fares to fill seats and thereby suffer from a reduced yield. High-frequency routes, such as those to Beijing, Seoul, Istanbul, and Tokyo, experience intense competition and aggressive pricing, putting additional pressure on yield. In view of the overall inverse relationship between yield and flight frequency, airlines seem to prioritise profitability on certain routes by limiting flights to maintain airfare levels. Mongolia's market has largely been dominated by full-service carriers (FSCs) with a limited presence of low-cost carriers (LCCs). To enhance air connectivity and industry growth, the Mongolian aviation industry may explore options such as (a) enhancing efficiency in the aviation sector to reduce operational costs; (b) facilitating strategic alliances or route-based cooperations with foreign airlines; (c) introducing more flexibility and freedom in airline operation, notably on seat capacity and route choices in the high and low seasons; and (d) allowing LCC growth on domestic and regional routes, including but not limited to low cost subsidiary of incumbent full service airline. The Mongolian government should also promote national and foreign network carrier services linking major international hub airports with Mongolia's main airport in conjunction with efforts to boost international tourism and e-commerce. Practical insights for enhancing Mongolia's aviation sector are discussed.

## 1. Introduction

Landlocked developing countries (LLDCs) have been continuing to face structural, infrastructural, and economic challenges to accessing world markets (Faye et al., 2004). The United Nations (2024) defines LLDCs as the countries lack of territorial access to the sea, where high trade costs impose serious constraints on social and economic development. There are a total of 32 countries classified as LLDCs[1]. One of the key challenges facing those countries is the lack of efficient air transport networks connecting with major markets for exports and imports, cargo flows, passenger travel, tourism flows, and human exchange, etc. (Czerny et al., 2018; Tsui & Wu, 2022). As a result, LLDCs often lag behind comparable countries or neighbours with well-established air connectivity.

Trade and transport connectivity are essential for the landlocked countries (Hasanova, 2022). It is commonly accepted that well-established air connectivity with key major markets would have allowed LLDCs to overcome many possible burdens of landlockedness (Tsui & Wu, 2022). One of the key benefits of air connectivity is to help LLDCS bypass and transit neighbour countries' infrastructure for

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[1] These are the countries classified as LLDCs: Afghanistan, Armenia, Azerbaijan, Bhutan, Plurinational State of Bolivia, Botswana, Burkina Faso, Burundi, Central African Republic, Chad, Eswatini, Ethiopia, Kazakhstan, Kyrgyzstan, Lao PDR, Lesotho, Malawi, Mali, Mongolia, Nepal, Niger, North Macedonia, Paraguay, Republic of Moldova, Rwanda, South Sudan, Tajikistan, Turkmenistan, Uganda, Uzbekistan, Zambia, and Zimbabwe.

https://doi.org/10.1016/j.cstp.2025.101550
Received 21 April 2025; Received in revised form 22 June 2025; Accepted 15 July 2025
Available online 16 July 2025

efficient trade or people movement (Faye et al., 2004; Snow et al., 2003). To facilitate LLDCs' air connectivity with overseas markets, well-established and connected airport networks are essential. It is important for governments and policymakers of LLDCs to promote air connectivity and aviation infrastructure that facilitate the country's economy and consumer wellbeing. Efficient and affordable aviation services are crucial for LLDCs to compete in the global economy and promote trade- and tourism-related sectors (e.g., Button et al., 2015; Goldstein, 2001; Tolcha et al., 2020).

This study aims to contribute to the related policy- and business strategy-making by analysing the aviation market performance in Mongolia, which is an LLDC in Central Asia. Mongolia is one of the largest landlocked countries in the world, with a territory of over 1.6 million square kilometres (The United Nations, 2003). Although Mongolia has a transport network comprising four subsectors (i.e., road, railway, air, and water), aviation has a special role in its access to key markets and regions. It is evident that the full potential of Mongolia's socio-economic development has been significantly restricted and limited by its air connectivity (e.g., Czerny et al., 2018; The United Nations, 2003; Wang et al., 2019). A case study of Mongolia would be very useful for identifying the strengths and weaknesses of its air transport systems, thereby facilitating decision-making for government policy and business strategy. The aim of our study is twofold: (i) we offer an overview of the growth of air transport systems in Mongolia, focusing on the expansion of international passenger connectivity with major international hubs, the capacity and seasonality patterns of international aviation services, as well as the levels of airline competition and airfare among key routes connecting destinations in Mongolia; and (ii) we examine key drivers and limitations affecting Mongolia's aviation growth, analysing both demand-side and supply-side factors affecting the aviation sector's development. Such a case study is expected to bring important and fresh insights into the development strategy of other LLDCs' aviation sectors too.

This paper is organised as follows. Section 2 offers a synthesis of studies regarding the impacts of air connectivity on landlocked countries' economic development and consumer wellbeing, and the determinants of air connectivity development. Section 3 provides a brief overview of Mongolia's air transport systems. Section 4 describes the methodology and the data used. Section 5 presents the key empirical results. Section 5 concludes the study and discusses policy implications and future research directions.

## 2. Literature review

### 2.1. Impacts of air connectivity on landlocked countries' economic development and consumer wellbeing

LLDCs face challenges due to their lack of direct sea access, and considerable distances from global markets (Rivera, 2020). Therefore, enhanced air transport connectivity is essential for LLDCs' economic progress (Hasanova, 2022). Previous studies have highlighted the positive impact of improved air connectivity on LLDCs' economic development and consumer wellbeing. For example, Tolcha et al. (2020) emphasised that air transport is a key tool to advance economic development of 16 LLDCs in the sub-Saharan Africa, where rely heavily on air transport as a primary link to international markets due to undeveloped land transport infrastructure. Tsui and Wu (2022) examined the importance of air connectivity to LLDCs under the 'One Belt One Road' initiative implemented by the Chinese government, highlighted that the major barrier to support the growth of air connectivity among LLDCs has been the lack of funding from the national- and regional-levels. They argued that enhanced air connectivity can yield "win–win" benefits for both LLDCs and their partner countries, promoting trade in high-value goods and services, facilitating people movements, enabling tourism flows, and accelerating their overall development. Similarly, enhanced air connectivity in the Central Asia has bolstered regional and global integration, contributing to the diversification of the LLDCs' economy and creating jobs and growth opportunities (Kalyuzhnova & Holzhacker, 2021).

### 2.2. Determinants of air connectivity development

Previous works have examined different determinants affecting the development of international air connectivity. In terms of geography, a county's location may affect its ability to develop air connectivity networks, for example, the geographical disadvantages of LLDCs (Anukoonwattaka & Saggu, 2016). A country's regulatory and economic frameworks also influence air connectivity (Button & Taylor, 2000; Calatayud et al., 2016). Air liberalisation and open skies agreements bring robust outcome in terms of new routes, more frequent flights, better flight connections, and lower airfares (e.g., Fu et al., 2010; Lumbroso, 2019; Zhang et al., 2024). Government policies have also influenced the expansion of air routes. For example, China's Belt-and-Road Initiative has led to an increase in direct air routes, which has significantly boosted bilateral trade in service with participating countries (Oum et al., 2024). Additionally, the findings indicate a negative correlation between being a landlocked country and levels of travel and commercial export (Cater, 1987; Khalid et al., 2020). Additionally, aviation subsidies offered by the governments to national carriers may hinder the expansion of low-cost carriers (Button et al., 2015).

The potential for establishing direct flight services between two locations or countries is influenced by several market factors (Li et al., 2017; Zhang et al., 2022). The conventional factors such as macroeconomic conditions (GDP growth), booming international air travel and tourism demand, and population size are found to be closely associated with a country's or city's air connectivity (e.g., Button et al., 2015; Li et al., 2020; Sun et al., 2024; Zhang et al., 2017a,b). Van De Vijver et al., (2014) analysed the connections between trade volumes and air passenger traffic in Asia Pacific, revealing that causality flows from air travel to trade for connections between developed and less developed countries, and from trade to air travel for countries with long-standing liberal air transport policies. Tan and Tsui (2017) found a short-term causality from business travel to air cargo volumes, with a bi-directional relationship over 12 months and longer periods. Furthermore, Mukkala and Tervo (2013) explored the link between air traffic and economic growth across 86 European regions from 1991 to 2010. They discovered that air traffic drives regional economic growth in peripheral regions, though this effect is less evident in major regions, highlighting air transport's critical role in boosting economic development in remote regions. Moreover, aviation infrastructure and capacity, including terminal size, runway length, and a robust domestic connectivity network, can significantly attract international flights (Seabra et al., 2020). Interestingly, the market competition factors also shape the bilateral origin–destination passenger traffic. The presence of low-cost carriers and airline privatisation promote international air traffic and connectivity, whereas high market concentration and diplomatic tensions restrict air passenger flows (Zhang et al., 2024). Both demand-side and supply-side factors are crucial in determining international air connectivity (Seabra et al., 2020). Exogenous shocks such as global financial crisis and global pandemics (e.g. COVID-19), further impact the stability of international flight operations, often leading to route suspensions, declines in flight service and air travel (Rivera, 2020; Zhang et al., 2024).

## 3. Overview of Mongolia's international aviation market

Mongolia, a landlocked nation, relies heavily on air transport to support its tourism, trade, and logistics industries (Eldev-Ochir, 2016). In 2023, international passenger traffic to Mongolia reached 1.2 million, with over 8,000 flights operating in and out of Chinggis Khaan International Airport in Ulaanbaatar, currently the sole international gateway airport following the withdrawal of international services from

Choibalsan and Olgii[2] airports in 2017 (see Table 1). As shown in Fig. 1, Mongolia has air connections to about 15 to 20 cities in around 10 countries, with a few new routes added during the post-COVID-19 period. Key markets include Mainland China, Russia, South Korea, and Japan, with each having 3 to 7 cities connected to Mongolia. Vietnam has emerged as a significant new market with three cities connected to Mongolia since 2023.

Data compiled for Mongolia's seven main international partners (Germany, Hong Kong, Japan, Mainland China, Russia, South Korea, and Turkey) shows fluctuations in international flights and passenger volumes from 2014 to 2023 (see Fig. 2). Mongolia faced severe challenges in 2021 amid the COVID-19 pandemic, experiencing a sharp decline to just 551 flights and 42,568 international passengers. South Korea is consistently ranked first for passenger movements between Mongolia, while Mainland China, previously leading in-flight numbers, was surpassed by South Korea after the pandemic.

Historically, three major city pairs between Mongolia included Beijing, Seoul, and Moscow, ranking highest in both flight frequencies and passenger numbers (see Tables 2 and 3). However, recent growth in routes such as Istanbul, Tokyo, and Frankfurt signals new market development. The third quarter of the year (July–September) consistently experiences peak air passenger traffic, largely due to Mongolia's summer season, widely regarded as the best time to visit. While the Naadam Festival, the country's most iconic cultural event, is a major draw, many visitors are also attracted by Mongolia's rich history, vibrant festivals, and unique cultural and natural heritage. With four distinct and well-defined seasons, summer stands out as the most favourable period for travel, offering the ideal conditions to explore the country's diverse attractions (see Table 4).

Export trade value and gross domestic product (GDP) data have been analysed alongside flight frequencies, passenger volumes, and airfares with Mongolia's key international aviation partners (see Table 5). Due to its strategic location, Mongolia connects itself through three key easter aviation hubs (i.e., Beijing, Seoul, Tokyo) to access wider networks and destinations in Asia, North America, and the South Pacific, while connections through three western hubs (i.e., Frankfurt, Istanbul, Moscow) facilitate access to European markets. Historically, the eastern hubs have dominated Mongolia's air traffic due to lower airfares and significant trade with East Asia. Recently, however, increased trade with European countries has driven growth in air traffic and passenger flows between Mongolia and Western hubs such as Frankfurt and Istanbul, potentially contributing to a rise in export trade value.

The development of Mongolia's international aviation markets also benefits its national carrier's growth. Among all international airlines operating in Mongolia, MIAT Mongolian Airlines, the national carrier, holds a dominant position in flight frequencies, passenger numbers, and route connectivity, as illustrated in Fig. 3. Other major carriers include Aero Mongolia, Hunnu Air, Air China, and Korean Air. While average yields among airlines have remained relatively stable, Aero Mongolia and Hunnu Air maintain the highest yields, around 0.24 and 0.18 per revenue passenger kilometers (RPK), respectively, followed by Air China, Korean Air, and MIAT Mongolian Airlines, ranging between 0.11 and 0.15 per RPK.

Low-cost carriers (LCCs) currently have a limited presence in Mongolia's international aviation markets, with flights primarily connecting Ulaanbaatar to a few South Korean cities like Busan, Cheongju, Daegu, and Seoul. Although LCCs dominate certain routes, occupying over 50 % of flights on routes to Busan, Cheongju, and Daegu, but the overall flight volumes remain low. During the analysis period, the maximum annual flight frequencies operated by LCCs reached only 210 flights for Busan, 4 flights for Cheongju, and 110 flights for Daegu, and some years seeing no LCC operations at all. On the popular Ulaanbaatar-Seoul route, LCCs hold just a 10 % share, highlighting limited LCC services and competition in Mongolia's international aviation markets.

[2] Ölgii Airport is a small regional airport in western Mongolia that primarily handles seasonal domestic passenger traffic. According to the Cirium Aviation Database, the only recorded international flight service to Ölgii Airport was a limited seasonal route from Nur-Sultan, Kazakhstan, which operated briefly between November 2014 and February 2015.

## 4. Methodology and data

For all international destinations connected to Mongolia being analysed, we collected the annual route-level data from the Cirium Aviation Database covering the period from 2014 to 2023. This yielded 198 city-pair route observations in our unbalanced panel dataset, with variables of yield, flight frequencies, and passenger numbers for each of Mongolia's international routes. Based on prior research, the panel data regression is deemed an appropriate econometric approach for this analysis (Ng et al., 2023; Tsui et al., 2021a,b), as it offers two key advantages: (i) it encompasses the entire set of Mongolia's international air transport markets, allowing significant variation across observations that support empirical identification; and (ii) the method enable to control the heterogeneity across the sampled countries connecting to Mongolia and over time (e.g., types of routes and destination characteristics), and unobserved effects in the dataset. In this study, yield and flight frequencies are used for the analysis of airline activity in Mongolia's international aviation markets, employing a three-stage least squares (3SLS) model to account for simultaneity between the supply and demand-side variables. While this study uses a quantitative lens, it is grounded in a case study approach, treating Mongolia as a case of an LLDC with distinctive aviation constraints and opportunities. As outlined by Yin (2009), case studies can support analytic generalisation, particularly when they reveal mechanisms that may apply in other comparable contexts. By combining a case study framework with 3SLS approach, we aim to identify structural patterns that may be applicable to other LLDCs, which face similar limitations and constraints in international air connectivity. 3SLS model specifications are outlined in Equations (1) and (2) below, with subscripts $i$ and $t$ representing air route and year, respectively, $\alpha_s$ and $\beta_s$ as the coefficients to be estimated, and $\varepsilon_{1it}$ and $\varepsilon_{2it}$ as the error terms. The natural logarithm is denoted by ln.

$$\begin{aligned}\ln(Yield)_{it} = {} & \alpha_0 + \alpha_1 \ln(Frequency)_{it} + \alpha_2 \ln(Distance)_i + \alpha_3 \ln(HHI\_pax)_{it} \\ & + \alpha_4 \ln(GDP\_bothcountries)_{it} + \alpha_5 \text{Mongolian\_air}_{it} \\ & + \alpha_6 \text{Mongolian\_air\_only}_{it} + \alpha_7 COVID_t + \alpha_8 Yearlydummies \\ & + \varepsilon_{1it}\end{aligned} \tag{1}$$

$$\begin{aligned}\ln(Frequency)_{it} = {} & \beta_0 + \beta_1 \ln(Yield)_{it} + \beta_2 \ln(Passenger)_{it} + \beta_3 \ln(Distance)_i \\ & + \beta_4 \ln(GDP\_bothcountries)_{it} + \beta_5 \text{Number\_airline}_{it} \\ & + \beta_6 \text{Mongolian\_air}_{it} + \beta_7 \text{Mongolian air\_only}_{it} \\ & + \beta_8 Flight\_share\_Mongolian_{it} + \beta_9 COVID_t \\ & + \beta_{10} Yearlydummies + \varepsilon_{2it}\end{aligned} \tag{2}$$

Table 6 provides an overview of the definitions and data sources for variables of interest used in this analysis, with descriptive statistics detailed in Table 7. Most variables of interest were transformed into logarithmic form (see Table 6), with the exception of $Number\_airline_{it}$, $Mongolian\_air_{it}$, $Mongolianair\_only_{it}$, $Flight\_share\_Mongolian_{it}$, and $COVID_t$. This transformation allows the coefficients of explanatory variables to be interpreted as elasticities, consistent with previous studies (e.g., Chow et al., 2021; Lim & Zhu, 2017; Tsui et al., 2021a,b). Given the endogenous nature of yield and flight frequencies (Lurkin et al., 2017; Ng et al., 2023), Equations (1) and (2) were estimated jointly using 3SLS due to the problem of endogenity. Endogeneity arises because increased flight frequencies contribute to more convenient travel and thus higher service quality, it also expands airline seat supply,

**Table 1**
Overview of Mongolia's three international airports (flight volumes and passenger numbers).

| | Total number of flights handled | | | Total air passenger numbers carried | | |
|---|---|---|---|---|---|---|
| | Choibalsan | Olgii | Ulaanbaatar | Choibalsan | Olgii | Ulaanbaatar |
| **2014** | 273 | 9 | 6,271 | 9,082 | 671 | 773,196 |
| **2015** | 210 | 9 | 5,931 | 8,012 | 670 | 752,791 |
| **2016** | 160 | 0 | 6,152 | 6,090 | 0 | 784,826 |
| **2017** | 0 | 0 | 6,985 | 0 | 0 | 897,911 |
| **2018** | 0 | 0 | 7,103 | 0 | 0 | 961,872 |
| **2019** | 0 | 0 | 8,257 | 0 | 0 | 1,098,953 |
| **2020** | 0 | 0 | 2,273 | 0 | 0 | 168,424 |
| **2021** | 0 | 0 | 551 | 0 | 0 | 42,568 |
| **2022** | 0 | 0 | 3,853 | 0 | 0 | 547,522 |
| **2023** | 0 | 0 | 8,527 | 0 | 0 | 1,239,243 |

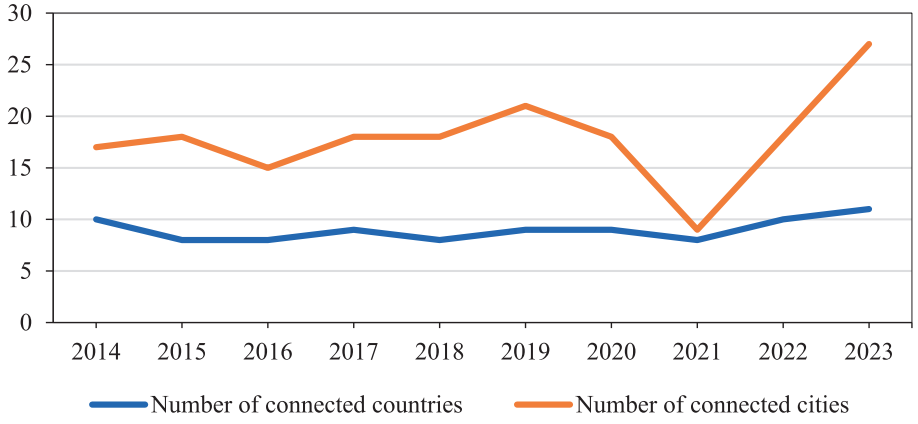


**Fig. 1.** Mongolia international aviation markets.

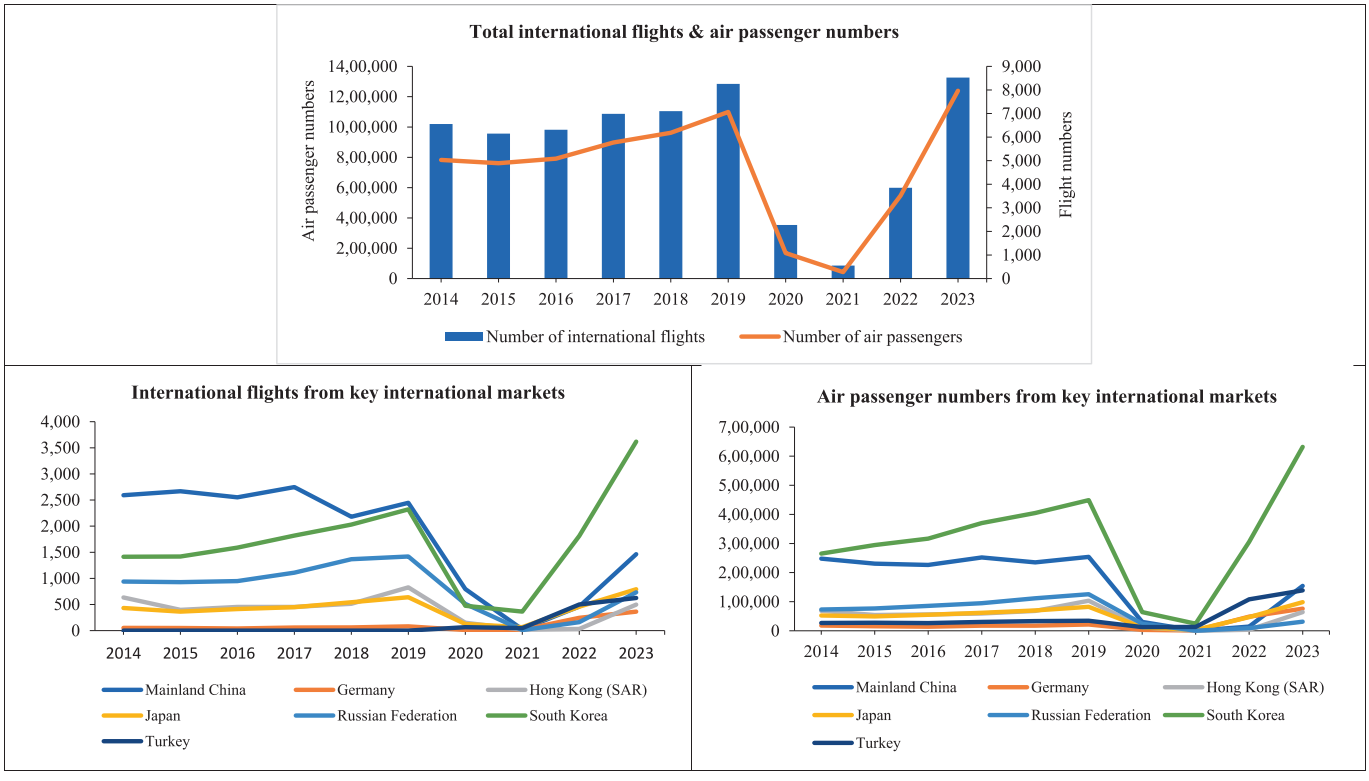


**Fig. 2.** Mongolia's total international flights and air passenger numbers from key international markets. *Remarks*: Data sourced from the Cirium Aviation Database.

**Table 2**
Top 10 international cities with the highest flight volumes to and from Mongolia.

| Ranking | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Beijing (1693) | Beijing (1635) | Beijing (1607) | Beijing (1646) | Beijing (1664) | Seoul (1804) | Seoul (406) | Seoul (345) | Seoul (1650) | Seoul (3078) |
| 2 | Seoul (1415) | Seoul (1419) | Seoul (1478) | Seoul (1492) | Seoul (1591) | Beijing (1768) | Hohhot (244) | Tokyo (66) | Istanbul (501) | Beijing (991) |
| 3 | Moscow (671) | Moscow (669) | Moscow (691) | Moscow (692) | Moscow (694) | Hong Kong (828) | Irkutsk (228) | Istanbul (47) | Tokyo (458) | Tokyo (756) |
| 4 | Hong Kong (635) | Hohhot (440) | Hong Kong (452) | Manzhouli (462) | Tokyo (542) | Moscow (740) | Manzhouli (214) | Beijing (24) | Beijing (353) | Istanbul (625) |
| 5 | Hohhot (474) | Hong Kong (398) | Tokyo (412) | Hong Kong (454) | Irkutsk (520) | Tokyo (604) | Hong Kong (151) | Busan (19) | Frankfurt (242) | Hong Kong (498) |
| 6 | Tokyo (398) | Tokyo (362) | Hohhot (400) | Tokyo (448) | Hong Kong (514) | Busan (486) | Hailar (144) | Hong Kong (18) | Busan (161) | Busan (468) |
| 7 | Bishkek (312) | Bishkek (314) | Manzhouli (332) | Hohhot (342) | Busan (426) | Irkutsk (473) | Ulan-Ude (144) | Frankfurt (16) | Irkutsk (132) | Irkutsk (379) |
| 8 | Irkutsk (268) | Manzhouli (258) | Bishkek (314) | Irkutsk (333) | Bishkek (312) | Bishkek (312) | Moscow (138) | Yekaterinburg (10) | Guangzhou (88) | Frankfurt (363) |
| 9 | Manzhouli (194) | Irkutsk (256) | Irkutsk (256) | Busan (321) | Manzhouli (282) | Hohhot (218) | Tokyo (127) | Hanoi (6) | Almaty (70) | Ulan-Ude (256) |
| 10 | Bangkok (121) | Hailar (196) | Hailar (160) | Bishkek (312) | Hohhot (156) | Ulan-Ude (206) | Beijing (118) | n/a | Bishkek (68) | Hohhot (174) |

*Remarks*: Flight numbers are indicated in parentheses. Data sourced from the Cirium Aviation Database.

**Table 3**
Top 10 international cities with the highest passenger numbers to and from Mongolia.

| Ranking | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Seoul (265,462) | Seoul (294,816) | Seoul (301,507) | Seoul (333,113) | Seoul (358,221) | Seoul (383,882) | Seoul (57,511) | Seoul (24,341) | Seoul (285,982) | Seoul (552,328) |
| 2 | Beijing (209,618) | Beijing (188,204) | Beijing (189,119) | Beijing (201,450) | Beijing (210,376) | Beijing (212,627) | Beijing (13,498) | Istanbul (13,075) | Istanbul (108,029) | Istanbul (138,922) |
| 3 | Hong Kong (68,873) | Moscow (66,702) | Moscow (73,352) | Moscow (74,916) | Moscow (80,258) | Hong Kong (103,325) | Istanbul (12,720) | Tokyo (3203) | Frankfurt (48,634) | Beijing (110,974) |
| 4 | Moscow (62,273) | Hong Kong (54,078) | Hong Kong (56,218) | Tokyo (61,856) | Tokyo (69,795) | Moscow (10,0719) | Hong Kong (11,868) | Frankfurt (930) | Tokyo (46,861) | Tokyo (93,557) |
| 5 | Tokyo (48,609) | Tokyo (49,282) | Tokyo (55,212) | Hong Kong (59,471) | Hong Kong (68,384) | Tokyo (78,762) | Tokyo (11,750) | Yekaterinburg (408) | Busan (19,107) | Frankfurt (75,983) |
| 6 | Istanbul (27,097) | Istanbul (27,568) | Istanbul (26,579) | Busan (36,031) | Busan (44,827) | Busan (60,202) | Moscow (10,957) | Beijing (212) | Beijing (7628) | Busan (68,755) |
| 7 | Hohhot (17,412) | Hohhot (15,848) | Busan (15,422) | Istanbul (30,336) | Istanbul (33,335) | Istanbul (34,687) | Ulan-Ude (7358) | Hanoi (174) | Irkutsk (6228) | Hong Kong (64,371) |
| 8 | Bishkek (13,219) | Bishkek (11,040) | Hohhot (15,284) | Manzhouli (23,552) | Irkutsk (25,307) | Irkutsk (17,600) | Busan (6952) | Hong Kong (109) | Guangzhou (4553) | Hohhot (19811) |
| 9 | Berlin (10,929) | Manzhouli (9859) | Manzhouli (13,808) | Irkutsk (15,247) | Manzhouli (14,993) | Guangzhou (13,686) | Irkutsk (6358) | Busan (97) | Bangkok (3968) | Bangkok (17,975) |
| 10 | Irkutsk (10,722) | Irkutsk (9838) | Irkutsk (12,158) | Hohhot (13,159) | Bangkok (13,019) | Nur-Sultan (11,307) | Manzhouli (5797) | Phuket (19) | Almaty (3731) | Irkutsk (17,346) |

*Remarks*: Passenger numbers are indicated in parentheses. Data sourced from the Cirium Aviation Database.

intensifying airline competition and potentially lowering yield. However, the high-yield routes generate greater revenues per passenger, enhancing route profitability for airlines and motivating them to increase flight frequencies to capture more high-revenue air travel demand (e.g., Vaze & Barnhart, 2012; Wang et al., 2014; Zhang et al., 2017). Yet, the yield-flight frequency relationship is complex, as more airline seat supply and greater airline competition generally suppress yield, which can ultimately lead to flight frequency reductions by airlines.

Additional explanations for the explanatory variables are included in the 3SLS equations:

- Passenger numbers: A proxy for air travel demand, expected to influence flight frequencies positively.
- Flight distance: Anticipated to have a negative effect on both yield and flight frequencies due to higher fuel costs over longer flying times.
- Herfindahl–Hirschman Index (HHI): Reflects market concentration based on passenger counts per carrier at an airport, capturing the market power effects of airlines (Grosche et al., 2020; Wandelt et al., 2024)
- Bilateral economic mass: Calculated by multiplying Mongolia's GDP by GDP of the partner country or region, representing the combined economic size of origin and destination.
- Route characteristics: Factors such as the number of airlines operating a route, the presence of Mongolian airlines for a route, the routes exclusively operated by Mongolian carriers, and the share of flight frequencies operated by Mongolian airlines, capturing the unique characteristics of Mongolia's international aviation markets.
- COVID-19 Pandemic Dummy: Controls for the 2020–2021 period, when Mongolia was most affected by the pandemic.

## 5. Empirical analysis

To prepare the two equations for estimation via 3SLS, we first tested the correlation among all selected explanatory variables to determine the likelihood of multicollinearity (Wooldridge, 2016). Additionally, to avoid issues of spurious correlation, it was essential to ensure that both dependent and explanatory variables were stationary, as recommended

**Table 4**
Top 5 countries and cities with highest quarterly flight frequencies to and from Mongolia (2014, 2019, 2023).

| | | | | | | |
|---|---|---|---|---|---|---|
| **Country-pair routes** | | | | | | |
| 2014 | Q1 | China (543) | South Korea (310) | Russian Federation (199) | Hong Kong (SAR) (154) | Kyrgyzstan (76) |
| | Q2 | China (591) | South Korea (328) | Russian Federation (253) | Hong Kong (SAR) (164) | Kyrgyzstan (78) |
| | Q3 | China (800) | South Korea (463) | Russian Federation (296) | Japan (232) | Hong Kong (SAR) (192) |
| | Q4 | China (658) | South Korea (314) | Russian Federation (191) | Hong Kong (SAR) (125) | Kyrgyzstan (78) |
| 2019 | Q1 | China (547) | South Korea (424) | Russian Federation (284) | Hong Kong (SAR) (128) | Japan (128) |
| | Q2 | China (594) | South Korea (505) | Russian Federation (357) | Hong Kong (SAR) (200) | Japan (144) |
| | Q3 | South Korea (838) | China (670) | Russian Federation (482) | Hong Kong (SAR) (264) | Japan (237) |
| | Q4 | China (635) | South Korea (555) | Russian Federation (296) | Hong Kong (SAR) (236) | Japan (130) |
| 2023 | Q1 | South Korea (590) | Russian Federation (216) | Japan (164) | China (149) | Turkey (136) |
| | Q2 | South Korea (786) | China (346) | Japan (190) | Turkey (152) | Russian Federation (148) |
| | Q3 | South Korea (1473) | China (452) | Japan (260) | Russian Federation (215) | Turkey (184) |
| | Q4 | South Korea (769) | China (516) | Japan (178) | Russian Federation (155) | Turkey (153) |
| **City-pair routes** | | | | | | |
| 2014 | Q1 | Beijing (360) | Seoul (310) | Hong Kong (154) | Hohhot (128) | Moscow (123) |
| | Q2 | Beijing (379) | Seoul (328) | Moscow (179) | Hong Kong (164) | Hohhot (122) |
| | Q3 | Beijing (566) | Seoul (463) | Moscow (230) | Tokyo (196) | Hong Kong (192) |
| | Q4 | Beijing (388) | Seoul (314) | Moscow (139) | Hong Kong (125) | Hohhot (106) |
| 2019 | Q1 | Beijing (342) | Seoul (318) | Moscow (129) | Hong Kong (128) | Tokyo (128) |
| | Q2 | Beijing (452) | Seoul (377) | Hong Kong (200) | Moscow (180) | Tokyo (144) |
| | Q3 | Seoul (666) | Beijing (601) | Moscow (272) | Hong Kong (264) | Tokyo (202) |
| | Q4 | Seoul (443) | Beijing (373) | Hong Kong (236) | Moscow (159) | Tokyo (130) |
| 2023 | Q1 | Seoul (538) | Tokyo (164) | Istanbul (136) | Ulan-Ude (128) | Beijing (99) |
| | Q2 | Seoul (687) | Beijing (256) | Tokyo (190) | Istanbul (152) | Hong Kong (120) |
| | Q3 | Seoul (1181) | Beijing (296) | Busan (226) | Tokyo (224) | Istanbul (184) |
| | Q4 | Seoul (672) | Beijing (340) | Tokyo (178) | Istanbul (153) | Hong Kong (142) |

*Remarks*: Flight numbers are indicated in parentheses. Data sourced from the Cirium Aviation Database.

**Table 5**
Key international hub airports connecting to Mongolia (economic and aviation data comparisons).

| Year | Western hubs | Flights | Air passengers | Average airfare (USD) | Country GDP (Billion, USD) | Export trade value (USD) | Eastern hubs | Flights | Air passengers | Average airfare (USD) | Country GDP (Billion, USD) | Export trade value (USD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2014** | Frankfurt | 52 | 7311 | 316 | 3,890 | 158,425,572 | Beijing | 1693 | 209,618 | 113 | 10,480 | 2,216,381,986 |
| | Istanbul | 116 | 27,097 | 270 | 939 | 37,046,079 | Soul | 1415 | 265,462 | 164 | 1,480 | 346,863,273 |
| | Moscow | 671 | 62,273 | 252 | 2,060 | 1,460,431,424 | Tokyo | 398 | 48,609 | 262 | 4,900 | 326,439,996 |
| **2019** | Frankfurt | 64 | 10,750 | 298 | 3,890 | 169,858,069 | Beijing | 1768 | 212,627 | 93 | 14,280 | 1,826,589,978 |
| | Istanbul | 156 | 34,687 | 220 | 761 | 41,647,780 | Soul | 1804 | 383,882 | 150 | 1,650 | 291,073,437 |
| | Moscow | 740 | 100,719 | 209 | 1,690 | 1,734,488,084 | Tokyo | 604 | 78,762 | 297 | 5,120 | 583,299,578 |
| **2023** | Frankfurt | 363 | 75,983 | 339 | 4,460 | 193,840,764 | Beijing | 991 | 110,974 | 125 | 17,790 | 3,470,407,580 |
| | Istanbul | 624 | 138,922 | 294 | 1,100 | 105,576,785 | Soul | 3078 | 552,328 | 167 | 1,710 | N/A |
| | Moscow | N/A | N/A | N/A | 2,020 | N/A | Tokyo | 756 | 93,557 | 293 | 4,210 | 771,219,564 |

*Remarks*: Data on flights, air passenger numbers, and average airfares were sourced from the Cirium Aviation Database. GDP figures were sourced from the World Bank. Export trade values for each country trading with Mongolia were retrieved from the United Nations Comtrade Database. Note that 2023 export trade data for South Korea and the Russian Federation were not available in the database.

in prior studies (e.g., Chow et al., 2021; Tsui et al., 2021a,b; Wooldridge, 2016). Panel unit root tests (i.e., augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests) were conducted to confirm stationarity across all the variables of interest (see Table 8). The tests revealed that certain variables, such as $\ln(Distance)_i$, $\ln(GDP\_bothcountries)_{it}$, and $Flight\_share\_Mongolian_{it}$ were non-stationary. To address this, first-differencing was applied to these variables, converting them into stationary series suitable for robust analysis.

Table 9 presents the estimation results for the $\ln(Yield)_{it}$ in Equation (1) and $\ln(Frequency)_{it}$ in Equation (2). The coefficient for $\ln(Frequency)_{it}$ in the yield equation is statistically significant and negative, indicating that an increase in flight frequencies connecting Mongolia is associated with reduced airfares. The elasticity of −0.115 suggests that a 1 % increase in flight frequencies leads to a modest 0.115 % decrease in yield. This reflects that adding flights on a route raises total seat capacity, and if passenger demand does not keep pace, airlines may lower ticket prices to maintain seat occupancy or load factors, thus reducing yield from ticket sale. Higher flight frequencies scheduled by airlines, especially on popular routes, often intensify competition among airlines, leading to competitive pricing that drives airfares and yields down (Ng et al., 2023). Both $\ln(Distance)_i$ and the $COVID_t$ variable show their respective significant negative relationships with yield, as expected. While increasing flying distance links Mongolia's airports with major hubs, which often attract intense competition among multiple airlines due to higher passenger demand, thus putting downward pressure on ticket prices and yield (Zhang & Zhang, 2018). For the $COVID_t$ variable, travel restrictions and health concerns during the COVID-19 pandemic reduced passenger numbers travelling to and from Mongolia (e.g., Czerny et al., 2021; Gallego & Font, 2021; Li et al., 2021). These negative associations highlight the need for interpreting yield as reflective of both reduced passenger demand and increased operating costs for airlines, and in particular, revealing the operational and economic challenges that the COVID-19 pandemic posed to airline operations and cross-border air travel (Agrawal, 2021; Amankwah-Amoah, 2020).

In the $\ln(Frequency)_{it}$ equation, the coefficient for $\ln(Yield)_{it}$ is also statistically significant and negative, highlighting an inverse relationship where higher revenue per revenue passenger-mile correlates with fewer flights on the route. This suggests that airlines serving Mongolia's international markets may prioritise revenue maximisation on their

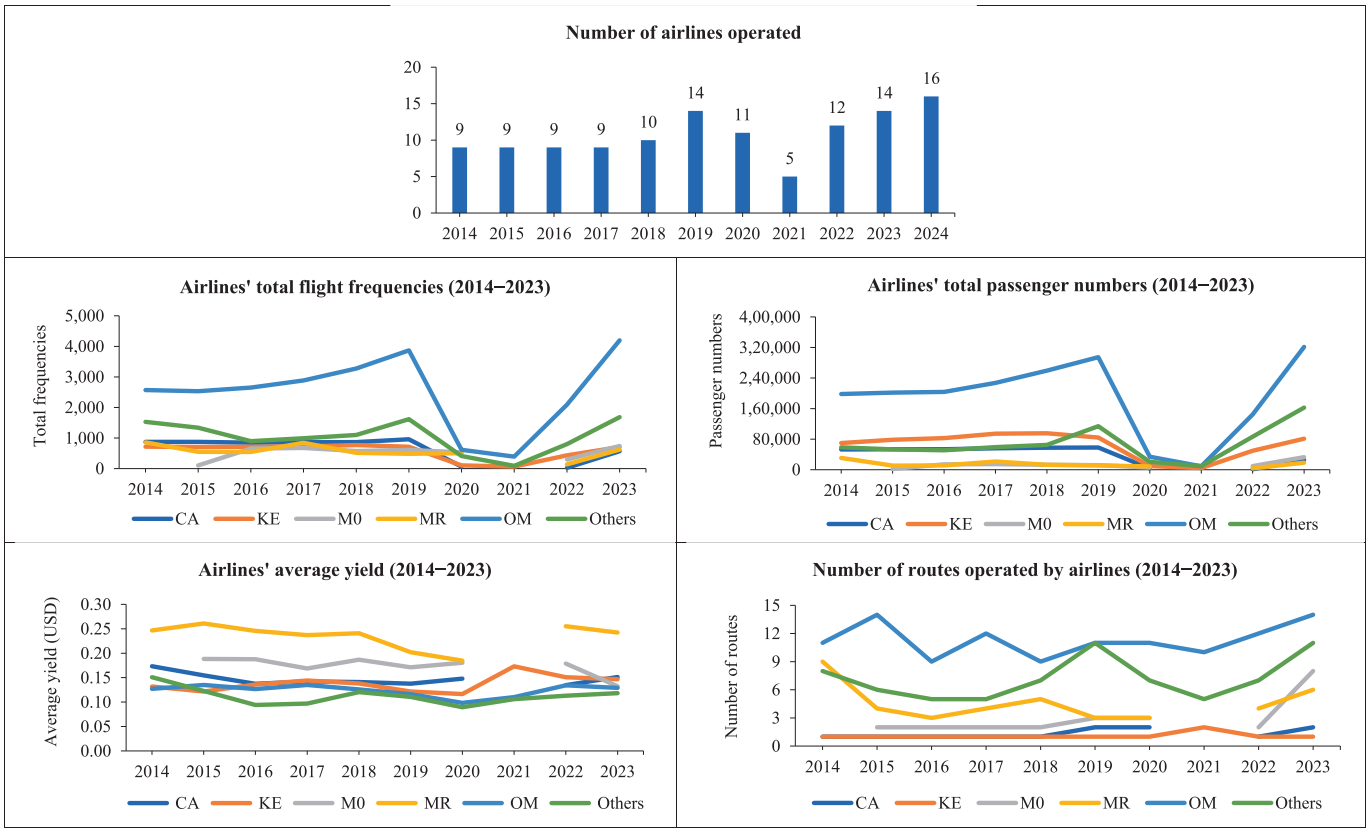


**Fig. 3.** Key airlines operated in the Mongolia international aviation markets. *Remarks*: Two key international airlines operated routes to and from Mongolia during the study period: Air China (CA) and Korean Air (KE). Three Mongolian airlines operated international routes: Aero Mongolia (M0), Hunnu Air (MR), and MIAT Mongolian Airlines (OM). Others refer to other international airlines operating routes to and from Mongolia.

routes by focusing on fewer, more profitable flights rather than increasing flight frequencies as more flights may reduce yield. By limiting the seat supply for the routes, airlines can sell and maintain higher airfares on those routes with premium passenger demand or constrained seat capacity, optimising yield and profitability (e.g., Hsu & Wen, 2003; Ng et al., 2023; Vaze & Barnhart, 2012). The significant negative coefficient for $\ln(Distance)_i$ aligns with expectations (Pai, 2010), while the combined economic size of origin and destination, $\ln(GDP\_bothcoutnries)_{it}$, shows a significant positive relationship with flight frequencies. This positive correlation indicates that economic growth in both countries stimulates air travel demand, encouraging airlines to expand their flight frequencies and seat capacity for Mongolia (Doganis, 2009; Zhang & Zhang, 2018). It also means that when GDP for Mongolia and its trading partners arise, it may lead to increased business activities, trade, tourism, and infrastructure investment, prompting airlines to respond with higher flight frequencies and more seat capacities to meet the increasing air travel needs travelling between Mongolia and its trading partners.

## 6. Conclusions and discussions

This study uses the 3SLS model to estimate airline yield and flight frequencies serving Mongolia's international aviation markets from 2014 to 2023. It also provides an overview of the growth and dynamics of Mongolia's air transport sector, revealing two primary connectivity corridors: eastern hubs (e.g., Beijing, Seoul, Tokyo) and western hubs (e.g., Frankfurt, Istanbul, Moscow). Mongolia, as a landlocked developing country, faces inherited air connectivity challenges, and its air passenger traffic relies heavily on eastern hubs to access Southeast Asia, North America, and the South Pacific. While air connectivity to western hubs has grown, it remains limited, constraining Mongolia's interaction with the Middle Eastern and European markets. Enhancing these connections could broaden Mongolia's access to the global economy and facilitate international trade, tourism, and cultural exchange. Additional few points are worthwhile to discuss as below.

A key insight from this study is the role of cultural tourism in driving air traffic to Mongolia. Air passenger numbers and flight frequencies peaked during the annual Naadam Festival, Mongolia's largest cultural celebration, attracting regional and international tourists. This highlights an opportunity for the Mongolian government and aviation authorities to leverage cultural tourism as a strategic asset to boost inbound travel (Eldev-Ochir, 2016). By intensifying international marketing efforts around such festivals, Mongolia could enhance its visibility as a unique tourist destination, potentially attracting more visitors from overseas markets and strengthening the tourism sector's contribution to the economy. For an LLDC like Mongolia, with limited direct access to global trade and tourism, developing tourism-focused aviation strategies is essential for both economic resilience and growth. However, Mongolia's landlocked geography creates significant logistical hurdles. Therefore, Mongolia is often isolated from beneficial flows of trade, tourism, and knowledge transfer that coastal nations enjoy, limiting economic diversification (Tsui & Wu, 2022). In this context, air connectivity and affordability are crucial for Mongolia, as they facilitate not only tourism but also essential business interactions, access to international healthcare and education, and greater social benefits. Prior studies also supported the importance of robust air connectivity in promoting trade, tourism, and development in LLDCs, particularly in isolated or resource-scarce regions (Borchert et al., 2012; Rana & Karmacharya, 2014).

Another insight is the limited presence of LCCs in Mongolia's international aviation markets. Currently, most of flight routes connecting to Mongolia are dominated by FSCs, and arguably these carriers

**Table 6**
Definitions and sources of variables.

| Variables | Definitions | Sources |
|---|---|---|
| $\ln(Yield)_{it}$ | The natural logarithm of the average yield of airlines on route *i* at time *t*. | Cirium Aviation Database |
| $\ln(Frequency)_{it}$ | The natural logarithm of total bi-directional number of flights on route *i* at time *t*. | Cirium Aviation Database |
| $\ln(Passenger)_{it}$ | The natural logarithm of total bi-directional number of air passengers on route *i* at time *t*. | Cirium Aviation Database |
| $\ln(Distance)_{i}$ | The great circle distance of route *i*. | Cirium Aviation Database |
| $\ln(HHI\_pax)_{it}$ | The natural logarithm of airline HHI on route *i* at time *t*, which is measured by the number of passengers. | Author's own calculation, Cirium Aviation Database |
| $\ln(GDP\_bothcountries)_{it}$ | The natural logarithm of Mongolia's GDP multiplied by partner country/region's GDP at time *t*. | The World bank |
| $Number\_airline_{it}$ | The number of airlines operating on route *i* at time *t*. | Cirium Aviation Database |
| $Mongolian\_air_{it}$ | The number of Mongolian airlines operating on route *i* at time *t*. | Author's own calculation, Cirium Aviation Database |
| $Mongolianair\_only_{it}$ | A dummy variable that takes 1 if only Mongolian airlines operate on route *i* at time *t* and 0 otherwise. | Author's own calculation, Cirium Aviation Database |
| $Flight\_share\_Mongolian_{it}$ | The percentage of flights operated by Mongolian airlines on route *i* at time *t*. | Author's own calculation, Cirium Aviation Database |
| $COVID_{t}$ | A dummy variable that takes 1 for the year of COVID-19 pandemic in 2020 and 2021 and 0 otherwise. | Author's own calculations |
| *Yearly dummies* | The dummy variable for each year of the study. | Authors' own calculations |

maintained essential connections, they are often not optimised for affordability or accessibility. While LCCs have been instrumental worldwide in lowering travel costs, improving access to smaller regional airports, and driving both tourism and mobility growth (Henama, 2013). For Mongolia, a stronger LCC presence may diversify its route offerings, reduce travel costs, and attract more tourists and business travellers alike. Therefore, promoting the LCC model can prove advantageous to Mongolia's international aviation markets, where low-cost travel options are currently scarce.

Additionally, our empirical analysis of Mongolia's aviation market suggests a negative impact of flight frequencies (and thus seat capacity) on airline yield. As demand from international passengers to and from Mongolia often could not rise proportionally as airline seat capacity growth, airlines would generally have to reduce airfares to fill seats, ultimately lowering yield. In those popular routes connecting Mongolia to key international hubs and cities such as Beijing, Istanbul, Seoul, and Tokyo, higher flight frequencies could intensify competition among airlines serving the routes. Increased competition and aggressive pricing strategies would push airfares and reduce yield. There was an inverse relationship between airline yield and flight frequencies, where higher revenue per passenger mile correlates with fewer flights on a given route. This explains that airlines' limited motivation in expanding flight services (e.g., increased flight frequencies and seat availability) as they are more interest in improving yield and prioritising profitability by operating fewer flights even on certain high-demand routes. By improving the yield from seat capacity scheduled, airlines sell and uphold higher fare levels on the routes where passenger demand is strong, or seat supply is limited, thus optimising ticket revenues and yield for their routes (e.g., Hsu & Wen, 2003; Ng et al., 2023; Vaze & Barnhart, 2012). Mongolia's international aviation markets are currently dominated by many FSCs, which are not likely to schedule more flights but maintain higher airfares due to their relatively high operating costs compared with LCCs. The introduction of LCCs can bring significant change to the Mongolia's international aviation markets, fostering competitive pricing and expanding cheaper air travel options for tourists and travellers.

An additional insight is the critical importance of economic partnerships for the growth of Mongolia's aviation sector. Our findings show that bilateral GDP (Mongolia and its trading partners) has a positive impact on route capacity (measured by flight frequencies), underscoring how economic growths and expansions in Mongolia and its trade partners support increased airline activities to and from Mongolia (Eldev-Ochir, 2016). Recognising that air connectivity plays an essential role in the economic development of LLDCs, international organisations, such as the United Nations, have implemented initiatives to support transport infrastructure and connectivity for LLDCs (Tsui & Wu, 2022). Improved aviation connectivity with economic partners can further promote Mongolia's ability to participate in international trade, attract foreign investment, and support its growing tourism industry.

Mongolia's most comprehensive aviation frameworks is outlined in

**Table 8**
Summary of panel unit root tests for variables.

| Variables | Level | | First-differencing | |
|---|---|---|---|---|
| | ADF | PP | ADF | PP |
| $\ln(Yield)_{it}$ | 0.0000*** | 0.0000*** | 0.0000*** | 0.0000*** |
| $\ln(Frequency)_{it}$ | 0.0477 | 0.0477 | 0.0366 | 0.0366 |
| $\ln(Passenger)_{it}$ | 0.0000*** | 0.0000*** | 0.0000*** | 0.0000*** |
| $\ln(Distance)_{i}$ | 0.9998 | 0.9998 | 0.0000*** | 0.0000*** |
| $\ln(HHI\_pax)_{it}$ | 0.0000*** | 0.0000*** | 0.0000*** | 0.0000*** |
| $\ln(GDP\_bothcountries)_{t}$ | 1.0000 | 1.0000 | 0.0000*** | 0.0000*** |
| $Flight\_share\_Mongolian_{it}$ | 0.3977 | 0.3977 | 0.0004*** | 0.0004*** |

*Remarks*: The values indicate *p*-values. The test is shown for the constant only. *** indicate the rejection of the null hypothesis ($H_0$) that the variable has a panel unit root at 1% significance level. ADF, augmented Dickey–Fuller; PP, Phillips–Perron.

**Table 7**
Descriptive statistics of variables.

| Variables | Unit | Obs. | Mean | Std. | Min | Max |
|---|---|---|---|---|---|---|
| $Yield_{it}$ | USD per mile | 198 | 0.15 | 0.07 | 0.05 | 0.66 |
| $Frequency_{it}$ | Number | 198 | 287.50 | 454.20 | – | 3,078 |
| $Passenger_{it}$ | Number | 198 | 36,814.97 | 77,511.59 | 2 | 552,328 |
| $Distance_{i}$ | Miles | 198 | 1,665.63 | 1,192.45 | 158 | 4,377 |
| $HHI\_pax_{it}$ | Number | 198 | 8,786.71 | 2,107.41 | 2,732 | 10,000 |
| $GDP\_bothcountries_{t}$ | Billion (USD) | 198 | 72,557.38 | 88,894.43 | 76.14 | 353,487.30 |
| $Number\_airline_{it}$ | Number | 198 | 1.33 | 0.66 | 1 | 6 |
| $Mongolian\_air_{it}$ | Number | 198 | 0.84 | 0.36 | 0 | 1 |
| $Mongolianair\_only_{it}$ | Dummy | 198 | 0.03 | 0.16 | 0 | 1 |
| $Flight\_share\_Mongolian_{it}$ | Percentage | 198 | 0.68 | 0.40 | 0 | 1 |
| $COVID_{t}$ | Dummy | 198 | 0.20 | 0.40 | 0 | 1 |

**Table 9**
3SLS estimation results of Mongolia international aviation market (2014–2023).

| Dependent variables | EQ (1) $\ln(Yield)_{it}$ | EQ (2) $\ln(Frequency)_{it}$ |
|---|---|---|
| **Explanatory variables** | | |
| $\ln(Yield)_{it}$ | | −5.621** (2.596) |
| $\ln(Frequency)_{it}$ | −0.115** (0.049) | |
| $\ln(Passenger)_{it}$ | | 0.236 (0.299) |
| $\ln(Distance)_{i}$ | −46.311* (25.263) | −289.339*** (121.154) |
| $\ln(HHI\_pax)_{it}$ | 0.004 (0.162) | |
| $\ln(GDP\_bothcountries)_{it}$ | 0.737 (0.487) | 4.486* (2.696) |
| $Number\_airline_{it}$ | | 0.049 (0.234) |
| $Mongolian\_air_{it}$ | −0.006 (0.136) | −0.153 (0.552) |
| $Mongolianair\_only_{it}$ | 0.055 (0.210) | 0.423 (0.824) |
| $Flight\_share\_Mongolian_{it}$ | | −0.177 (0.351) |
| $COVID_{t}$ | −0.513** (0.204) | −2.697 (0.351) |
| *Year*2014 | | |
| *Year*2015 | 0.415* (0.213) | 2.555* (1.442) |
| *Year*2016 | 0.294 (0.199) | 1.932* (1.169) |
| *Year*2017 | 0.114 (0.168) | 0.817 (0.743) |
| *Year*2018 | 0.053 (0.153) | 0.355 (0.643) |
| *Year*2019 | −0.049 (0.158) | −0.189 (0.622) |
| *Year*2020 | 0.473* (0.243) | 2.649 (1.723) |
| *Year*2021 | | |
| *Year*2022 | −0.213 (0.230) | −1.234 (0.992) |
| *Year*2023 | | |
| Constant | −1.495 (1.652) | −8.728** (3.390) |
| $R^2$ | 0.20 | 0.49 |
| No. of observations | 112 | 112 |

*Remarks*: *, ** and *** indicate the explanatory variable is significant at the 0.10, 0.05 and 0.01 significance levels, respectively. Standard errors are in parentheses.

the Government Action Programme 2016–2020 (Government of Mongolia, 2016), supported by the foundational Civil Aviation Law of 1999. These documents emphasize its alignment with ICAO standards, expansion of air connectivity, and modernization of aviation infrastructure (most notably through the construction of Chinggis Khaan International Airport). The policy framework also promotes Mongolia's participation in open skies agreements, which aim to increase the number of international and domestic flights and seek to reduce airfares and tariffs by fostering competition within the international airline market. While these measures have established a baseline for institutional governance and aviation infrastructure investment, Mongolia currently lacks an updated national aviation strategy that articulates long-term objectives related to market liberalization and regional integration. This gap is particularly significant given UNESCAP's recommendations that LLDCs should integrate their aviation policies into broader transport and trade facilitation strategies to improve competitiveness (UNESCAP, 2022). In view of the findings of this study and the practical aviation market dynamics in Mongolia, the Mongolian government and its aviation sector may explore the below options to promote the development and growth of its aviation and tourism sectors:

- Enhancing efficiency in the aviation sector to reduce operational costs of aviation operators. Lower operational costs would allow airlines to stimulate air traffic volume with reduced airfare, thereby enhancing service quality and further reducing average costs by exploiting "economies of traffic density" benefits. In addition to better management of airlines and airports, measures facilitating cost reduction may include reducing/removing tax and charges on airport services, aviation fuel, aircraft/airport financing costs, duties on aircraft components and airport operational equipment. In light of its robust development to access international aviation markets, securing slots at major hub airports can be difficult and costly. The Mongolian government, together with international organisations such as The International Think Tank for LLDC (https://land-locked.org/) may work with international aviation organizations and foreign governments (e.g., International Civil Aviation Organization (ICAO), Organisation for Economic Co-operation and Development (OECD), etc.) to promote relevant cooperation.
- The limited aviation market size and high seasonality in Mongolia's market imply that it is difficult and costly to maintain good air connectivity and develop large flight networks by Mongolian airlines only. However, the nation's carrier shall also cooperate and learn from leading international airlines through synergy, cooperation, and improved management. Additionally, the Mongolian government shall facilitate its airlines to form strategic alliances or route-based cooperations with foreign airlines.
- The Mongolia's aviation sector may consider more flexible regulations and policies, which facilitate airlines, possibly with their partners, to more dynamically adjust their operations (e.g., frequency, aircraft type and seat offering, route and network choices, code sharing and operations by the partner (overseas) airlines). This would allow the Mongolia's aviation sector to better align supply with air travel demands during the peak seasons.
- Mongolia's aviation sector may facilitate LCC growth in domestic and regional routes, not just attracting international LCC operators. LCCs typically use smaller aircraft to serve short- to medium-distance routes with lower costs, thereby maintaining acceptable profitability even with reduced yield. On the other hand, LCCs typically do not offer connecting services. Increased market shares by LCCs may limit FSCs and/or flag carriers' ability to operate the hub-and-spoke networks, which are essential for Mongolia's long-distance or intercontinental connectivity. Therefore, the Mongolian government may provide additional support to its flag carrier to create a low-cost subsidiary. This may help the flag carrier to follow the success airline-within-airline strategies of Qantas–Jetstar and Singapore Airlines–Scoot in operating "dual brands". With lower costs and increased (passenger and cargo) capacity, Mongolia may promote international tourism and e-commerce in conjunction, addressing the air connectivity issue from both the supply and demand sides.

Although this study focuses on Mongolia, the challenges it faces, such as limited international air service, outdated aviation policies, and weak institutional coordination, are widely shared among LLDCs. These countries face systemic barriers to air connectivity due to their geographic isolation, small and underdeveloped domestic markets, and fragmented regulatory frameworks (Tsui & Wu, 2022). As a result, LLDCs often lack the economies of scale needed to attract international carriers and maintain international air services, leading to a heavy reliance on external financial assistance and foreign partnerships for aviation infrastructure development. One viable path moves forward for LLDCs, like Mongolia, is to align their air transport development with broader regional strategies, such as the Belt and Road Initiative (Czerny et al., 2022; Mendee, 2022). This approach involves more than just investing in aviation infrastructure and projects such as airports and air navigation systems. It also calls for coordinated policy actions, including the establishment of regional safety oversight frameworks, the alignment of air service agreements across countries, and collaborative efforts to develop and sustain international air routes. Mongolia's aviation experience reflects these broader dynamics and can be viewed as a representative example of the challenges and opportunities faced by LLDCs. Therefore, the findings of this study offer a foundation for more generalizable policy insights that may be applicable to other LLDCs, particularly those in Central Asia and Sub-Saharan Africa.

While this study sheds light on key aspects of Mongolia's aviation sector, further studies on specific regulations and related issues (e.g., foreign direct investment, tourism development, and seasonal economic patterns) are expected to further enhance our understanding of the challenges facing Mongolia's aviation sector. Analysing quarterly or monthly data could capture the effects of seasonal demand fluctuations more precisely, offering a clearer picture of peak and off-peak dynamics. Evaluating the impact of promising airline development strategies on popular routes, such as Ulaanbaatar–Tokyo or Ulaanbaatar–Seoul, on

Mongolia's transit and connectivity landscape can provide targeted insights. These avenues of research can offer practical recommendations to policymakers seeking to strengthen Mongolia's air connectivity, driving both economic growth and social benefits for this strategically positioned but geographically isolated nation. Furthermore, future research could expand on this study by incorporating international airports from other Asian LLDC countries to enable cross-country benchmarking. Such comparative analysis would provide broader regional insights and help contextualize Mongolia's aviation development within the wider landscape of landlocked or emerging economies.

## CRediT authorship contribution statement

**Odbayar Erdenetsogt:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Xiaowen Fu:** Writing – review & editing, Supervision, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Hanjun Wu:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Wai Hong Kan Tsui:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization.

## Declaration of competing interest

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

## Acknowledgements

Financial support from the Hong Kong RCDTT (project #P0051275) is gratefully acknowledged.

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