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Examining the determinants of Indian airlines' revenues

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ABSTRACT

The Indian aviation sector has undergone remarkable growth, driven by the emergence of low-cost carriers and diverse business models. This has resulted in a surge in passenger numbers and aircraft orders, establishing India as a vibrant global aviation market. However, this rapid expansion is accompanied by significant financial challenges, leading to distress and insolvency among numerous airlines. Despite optimistic growth forecasts, high operating costs and relatively low revenue returns pose substantial hurdles. Motivated by these challenges, this study aims to uncover the key factors influencing revenue generation in the Indian aviation industry by analysing expenditure components and their impacts on costs. The objective of this study is to address the research gap stemming from the lack of previous studies on Indian airlines that address endogeneity issues related to airline expenditures. By utilising data from 2007 to 2022 sourced from the audited annual reports of each airline, we aim to provide essential insights into the revenue dynamics of Indian airlines through the application of various econometric models including instrumental variables (IV) regression and generalised method of moments (GMM) models for improving causality and addressing endogeneity. Our findings reveal a positive correlation between unit revenue and factors such as unit expenditure, staff numbers, and passenger volume, while also highlighting the positive impacts of airline alliances and regional connectivity schemes. This research not only sheds light on industry intricacies but also underscores the imperative to address key variables to enhance the sector's sustainability and resilience in the face of ongoing challenges, offering valuable contributions to both academia and industry stakeholders for informed decision-making and strategic planning.

1. Introduction

The worldwide aviation sector is grappling with significant challenges from various factors, especially the recent COVID-19 pandemic (e.g., Agrawal, 2021; Gandhi & Gandhi, 2020; Jha et al., 2021; Nhamo et al., 2020; Shroff, 2020; Sidhu & Shukla, 2021; Sobieralski, 2020; Sun et al., 2022a). This has led to a phase of economic hardship and decreased productivity, especially in terms of financial self-reliance. Balancing cost reduction with revenue enhancement is a major global challenge for airlines. Additionally, managing passenger preferences, aircraft performance, fuel costs, competition, and unforeseen variables complicates the situation further (e.g., KİRACI & Yaşar, 2020; Mahtani & Garg, 2020; O'Connell et al., 2013; Sun et al., 2024).

India, with its 1.4 billion population and diverse airline business models, is one of the world's most challenging aviation markets. Issues such as rising fuel prices, overcapacity, intense price competition, and prolonged protectionism of Air India exacerbate these challenges (e.g., Asquith, 2019; Saranga & Nagpal, 2016). Despite a rise in passenger numbers, increasing disposable incomes, and government policies promoting foreign direct investment (FDI) in aviation (e.g., Chandrachud et al., 2019; Choudhuri et al., 2013; Vipin, 2012), the entry of new airlines and the impact of COVID-19 pandemic have intensified pressures, leading to financial strains and some companies facing bankruptcy (e.g., Sharma & Gupta, 2019; Shome & Verma, 2020).

However, the Indian aviation sector has shown impressive growth, especially before the pandemic. Since 2004, the industry has expanded remarkably due to transformative Civil Aviation Policies and govern-

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ment interventions. O'Connell et al. (2013) note that a substantial and growing middle class, favourable demographics, rapid economic progress, and higher disposable incomes have driven this growth. This study primarily investigates how airline operational metrics and external factors influence the revenue of six participating airlines, including low-cost, regional, and full-service carriers. Additionally, it addresses a gap in existing research: to our knowledge, no previous studies have examined the endogeneity of operating expenditure in the context of Indian airlines while evaluating their revenue.

The financial struggles and the inability of Indian airlines to weather such challenges, prompt the specific research question: ***"What are the primary factors influencing the revenue of Indian airlines?"*** especially amid the COVID-19 crisis.

The subsequent sections of this research paper are organised as follows. Section 2 provides an overview of the Indian aviation sector, encompassing its historical evolution and current challenges. Section 3 provides an examination of relevant literature. The methodology, variables of interest, and data are presented in Section 4. Section 5 subsequently presents and discusses the empirical results, along with the policy implications and recommendations. Section 6 then concludes the paper.

2. The Indian aviation Industry

2.1. Historical development

The Indian aviation sector has a rich history, marked by significant milestones and rapid growth. The journey began in 1911 with the first commercial flight between Allahabad and Naini (both cities in Uttar Pradesh, India). In 1932, JRD Tata established Tata Air Services, initiating India's airmail service with a flight from Karachi to Mumbai (Hindu, 2021). Post-independence, TATA Airlines lost its majority stake, leading to the nationalisation of Air India by the Indian government in 1953 (Misra, 2021). This resulted in the formation of Indian Airlines and Air India under government control, ensuring a more organised aviation sector. Over time, Air India transitioned from a prestigious national carrier to a financially troubled entity, necessitating the creation of two distinct airlines: Air India for international routes and Indian Airlines for domestic services, which eventually merged in 2007 (Wang et al., 2018). This merger sparked a wave of consolidations in the airline industry, such as Jet Airways acquiring Air Sahara and rebranding it as JetLite in 2007, and Kingfisher Airlines taking over Deccan in 2008 (Yu et al., 2019).

The deregulation of the aviation sector through initiatives like the 1986 Air Taxi Scheme and the Air Corporations Act in the 2000s facilitated the entry of new players such as East-West Airlines, Jet Airways, Damania Airways, and ModiLuft Airlines (Findlay & Goldstein, 2004). Kingfisher Airlines succumbed to financial woes post-2012, exacerbated by its merger with Air Deccan (e.g., Debnath et al., 2020; Panigrahi et al., 2019; Sharma & Gupta, 2019). Jet Airways, once a dominant player, filed for bankruptcy in 2019, unable to withstand competition from low-cost carriers (LCCs) like SpiceJet and IndiGo (Ahmed & Ahmed, 2020). Although Jet Airways and Kingfisher Airlines were renowned for their premium services, they struggled to compete against rivals offering better value for money (Arushi & Drews, 2011). The key milestones of the Indian aviation industry are presented in Table 1 below.

The steady increase in passenger numbers for Indian airlines since 1970 highlights the significant growth of the Indian aviation industry (see Fig. 1), particularly from 2004 onward due to the rise of low-cost carriers. This development has played a crucial role in shaping the aviation sector and has greatly contributed to the flourishing tourism industry.

2.2. Current issues facing the Indian aviation industry

The liberalisation policies of the 1990s transformed the Indian aviation industry, opening skies to private players and low-cost carriers. This led to a surge in passenger volumes, driven by LCCs and government initiatives for infrastructure upgrades and improved connectivity. Despite these favourable conditions, the industry faces challenges like high fuel prices, operational inefficiencies, and stiff competition (Yadav, 2020). O'Connell et al. (2013) noted that bureaucratic policies and state monopolisation historically hindered India's aviation sector. Reforms, including 1990s trade liberalisation and the Naresh Chandra Committee in 2002, aimed to improve air transport services and the competitiveness of state-owned airlines (Ray, 2014). Saranga & Nagpal (2016) highlighted that post-2010 fuel prices in India were 50% higher than in West Asia and Europe, exacerbating overcapacity, intense price competition, and the global financial crisis (GFC 2008-2009). These factors led to ongoing losses, culminating in Kingfisher Airlines' shutdown in 2012. Fig. 2 illustrates the market share of Indian carriers for the year 2022.

Table 1
Evolution of the Indian aviation industry.

Year	Major milestones
1932	JRD Tata founded Tata Airline.
1948	The Indian government established Air India International Limited in collaboration with Tata Airline (as a joint stock company), leading to the first flight on the Mumbai-London air route.
1953	Nine airlines existed, including Air India and Indian Airlines.
1953	Nationalisation of all private airlines through the Air Corporations Act.
1986	Private carriers are permitted to operate as air taxi operators.
1994	Air Corporation Act was repealed; Private carriers were allowed to operate scheduled flight services.
1995	Jet Airways, Air Sahara, Modiluft Airlines, Damania Airways, and East-West Airlines were granted their scheduled carrier status.
1997	4 out of 6 carriers shut down; Jet Airways and Air Sahara continued to operate.
2001	Aviation turbine fuel (ATF) prices are decontrolled.
2003	Air Deccan started operations as India's first LCC.
2004	Air India Express started operations.
2005	Kingfisher, SpiceJet, IndiGo, GoAir, and Paramount Airways started operations.
2007	Indian airline industry consolidated; Jet Airways acquired Air Sahara; Kingfisher acquired Air Deccan.
2010	SpiceJet started international flight operations
2011	IndiGo started international flight operations; Kingfisher exited the LCC segment. The merger between Air India and Indian Airlines was completed.
2012	The Indian Government allowed direct ATF imports, FDI proposal for allowing foreign carriers to pick up to a 49 per cent stake of Indian carriers under consideration. Kingfisher bankrupted.
2014	Falling international crude prices led to sharp cuts in the price of ATF. Debt-ridden SpiceJet cancelled flight services, cut a third of its aircraft fleet and sought help from the Indian government.
2019	Jet Airways ceased flight operations.
2022	Acquisition of debt-ridden national flag carrier Air India by TATA group.

Source: Jain & Natarajan (2015), (DGCA, 2021).

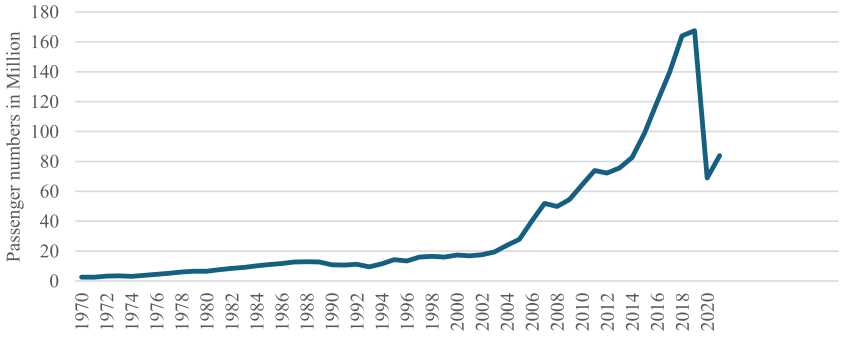

Fig. 1. Passenger growth of Indian airlines (1970–2020).

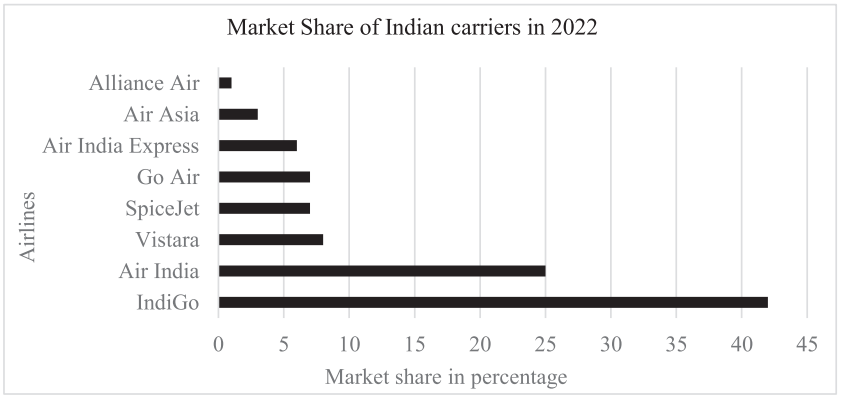

Fig. 2. Market share of Indian airlines in 2022.

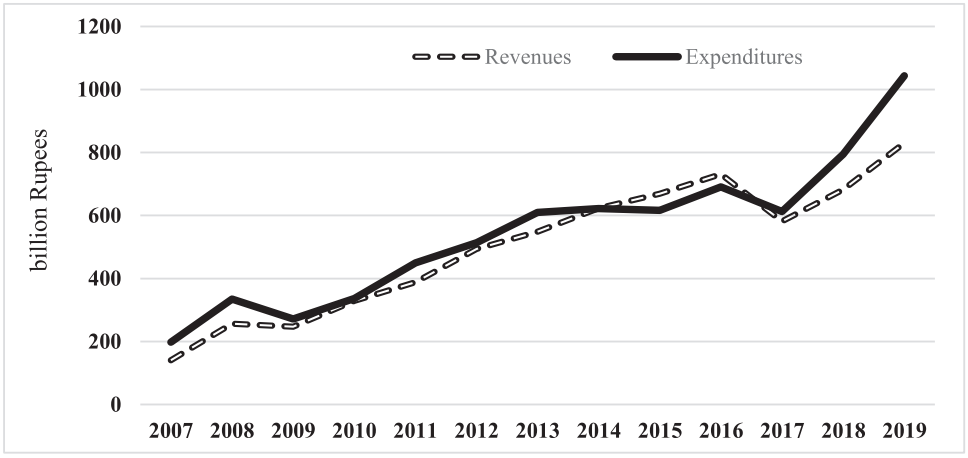

Fig. 3. Financial performance of the Indian airlines (2007–2019).

IndiGo leads with the largest market share in the domestic aviation market, followed by other airlines. The disparity in market share among the carriers is quite prominent.

Sakthidharan and Sivaraman (2018) observed that Air India had the highest inefficiency in managing non-fuel operating costs, becoming a significant state liability. In October 2020, Civil Aviation Minister Hardeep Singh Puri announced bids for Air India would be accepted based on enterprise value, aiming to optimise operations and reduce costs (e.g., Misra, 2021;Mohan, 2021). Air India's disinvestment sought to reduce the government's daily loss of Rs 20 crore (USD 2.7 million), amounting to an annual loss of Rs 7,300 crore (USD 986 million) (Misra, 2021). Challenges persist, such as a shortage of maintenance, repair, and overhaul (MRO) centres, leading to financial losses (IANS, 2021). Ahmed and Ahmed (2020), stated that airlines like Jet Airways continue to struggle financially amid competition and rising operational costs. As shown in Fig. 3, from 2007 to 2019, Indian airlines struggled to balance revenues and expenditures, compounded by factors like LCC competition and price wars (e.g., Agrawal, 2021; Jain & Natarajan, 2015; O'Connell et al., 2013; Sakthidharan & Sivaraman, 2018; Saranga & Nagpal, 2016; Singh et al., 2019; Wang et al., 2018).

Concurrently, the unpredictable fluctuations in global fuel prices posed a persistent financial risk, further complicating the financial stability of airlines. This necessitated prioritising operational efficiency and adaptability to navigate the aviation industry's complexities. The Indian government has been proactive in launching aviation-related initiatives that have evolved into policies aimed at nurturing the sector. Key initiatives include the regional connectivity scheme (RCS), UDAN (in Hindi *Ude Desh ka Aam Nagarik*, which translates to "*Let the common citizens of the country fly*" in English), infrastructure investments, and regulatory reforms. The UDAN scheme enhances regional connectivity by making air travel affordable and operationalising underserved airports through subsidies and financial incentives to airlines (e.g., Das et al., 2020; Iyer & Thomas, 2020). Infrastructure investments aimed at expanding and modernising airports, with significant projects involving new airports and upgrading existing ones. Additionally, regulatory reforms have eased the operational environment for airlines, including

simplifying new route approvals and reducing aviation fuel taxes. The National Civil Aviation Policy (NCAP) contributed by reducing Aviation Turbine Fuel (ATF) taxes and removing Foreign Direct Investment (FDI) restrictions (MoCA, 2019). A notable milestone was the abolition of the 5/20 rule in 2016, allowing airlines to operate internationally without extensive domestic experience (Chandra, 2018). Amid prolonged financial difficulties, Air India, struggling financially, was taken over by the Tata Group in 2022, marking a significant development in Indian aviation.

Among various challenges, the COVID-19 pandemic had been the most impactful. Dube (2022) cited India as the source of the highly contagious Delta variant, exacerbating the situation. Sun et al. (2022b) highlighted the pandemic's profound impact on aviation, causing irregular flight bans and complicating assessments of aviation stakeholders. Jackson et al. (2021) identified India and Brazil as viral hotspots by April 2021, leading to stringent restrictions on airlines. Grounded flights caused a steep decline in passenger traffic, resulting in substantial revenue losses estimated at up to US$113 billion (Mohapatra et al., 2021). Despite achieving a robust Compound Annual Growth Rate (CAGR) of 14.5% in domestic passenger traffic from 2014-15 to 2019-20 (MoCA, 2023), the industry saw a sharp downturn due to the pandemic. Dube et al. (2021) underscored the severity, noting significant revenue losses for individual airports, impacting the financial stability of both airports and air navigation companies.

The Indian aviation sector stands at a unique juncture, characterised by rapid growth driven by a burgeoning middle class and increasing urbanisation. While global aviation focuses on technological advancements and sustainability, India faces challenges like infrastructure constraints and a complex regulatory environment. Nath and Upadhyay (2024) highlight bureaucratic red tape, outdated infrastructure, and inefficient customs procedures at Indian air cargo terminals. They suggest streamlining customs, adopting artificial intelligence (AI), upgrading infrastructure, and coordinated stakeholder efforts to enhance efficiency and competitiveness. Cost sensitivity among Indian consumers shapes airline strategies, favouring low-cost carriers that dominate the market. Wang et al. (2014) suggest that airport concentration in India could yield cost efficiencies, potentially reducing airfares. Supported by favorable policies, initiatives like UDAN aim to strengthen regional connectivity, integrating remote areas into the economic mainstream.

The inclusion of new startup carriers, such as the launch of Akasa Air in 2021, underscores these efforts in shaping Indian aviation. Molewijk (2023) posits that startups foster innovation, risk-taking, and strategic collaborations with established organisations. PTI (2024) forecasts that Indian airlines will achieve a 50 percent market share in international passenger traffic by FY 2027–2028, presenting opportunities for new startups. Sun et al. (2022a) observed that the pandemic created a unique environment for airline startups, characterised by significant challenges and opportunities. Technological leapfrogging is evident with India embracing digitalization and sustainable aviation fuels to address environmental impacts, while developing skilled manpower remains a priority amidst global shortages.

3. Literature review

3.1. Airline revenue and its determinants

Most studies consider revenue a key indicator of financial performance, which is strongly influenced by the airline's expenditure or costs (e.g., Barnhart et al., 2009; Dunleavy & Phillips, 2009).

Oum and Yu (1998) conducted a comprehensive analysis of the cost competitiveness of 22 major airlines from 1986 to 1993. They employed a translog variable cost function to break down unit cost differentials into input prices, network and output attributes, and efficiency. This detailed decomposition, along with the innovative use of a multilateral index procedure, highlights the study's methodological strengths. Their key findings indicate that Asian carriers (excluding Japanese) exhibited higher cost competitiveness compared to their U.S. and European counterparts. Despite potential data inconsistencies and assumptions about capital input equilibrium, the study significantly enhanced understanding of cost drivers in the airline industry and provided insights for policymakers and management, aligning with findings that higher unit expenditure can boost revenue. Future research should broaden the range of airlines, include recent data, and offer detailed regional analyses.

An extensive analysis of prominent airlines by Windle (1991), used total factor productivity (TFP) to examine their response to post-deregulation dynamics. The study found that deregulation compelled airlines to enhance productivity, leading to cost reductions, with employee expenditure being a key variable. The strength of TFP lies in its holistic approach, considering multiple inputs—labour, fuel, flight equipment, ground property and equipment (GPE), and materials—which provides a thorough understanding of productivity changes. However, reliance on the translog multilateral index procedure may introduce complexity and potential inaccuracies in measurement, which could affect the reliability of the findings. Despite this, the study's robust input selection and comprehensive analysis offer valuable insights into how even less efficient airlines managed to increase productivity by lowering prices and improving customer services in response to deregulation challenges. The detailed focus on key variables strengthens the study's conclusions, although potential methodological limitations should be considered when interpreting the results. Notably, the study highlighted that airlines with lower efficiency during that period succeeded in augmenting their productivity by lowering prices and enhancing customer services in response to these challenges.

Merkert and Hensher (2011) employed a two-stage Data Envelopment Analysis (DEA) to evaluate airline efficiency, focusing on factors such as airline size, fleet composition, and aircraft variety to manage costs. This comprehensive approach assesses technical, allocative, and cost efficiency, providing nuanced insights into performance. The use of an input-oriented function highlights airlines' control over inputs, acknowledging external economic and contractual influences on outputs. Despite DEA's limitations, such as sensitivity to input/output selection and relative efficiency scores, the study's robust findings reveal that fleet age does not significantly impact technical efficiency but positively affects allocative and cost efficiency. Higher fuel costs, as noted, can drive up consumer prices and increase airline revenue, supported by Sibdari et al. (2018). As these findings have significant implications for airline management, Camilleri (2018) also highlights profitability factors like sector length, aircraft utilization, fleet size, and labour costs, with corroborating results found by Chang and Shao (2011), Bitzan and Peoples (2016), and O'Connell et al. (2020).

Sibdari et al. (2018) examined endogeneity in airline expenditure, focusing on how passenger demand, cost per gallon, and unemployment rate affect capacity decisions, including flight frequency, aircraft size, and load factor. The study spotlights on significant correlations between these factors and operational adjustments. Recognising bidirectional causality is crucial, as airlines' strategic decisions can influence economic conditions like fuel costs and unemployment rates, adding complexity to causality attribution. Addressing endogeneity not only strengthens empirical findings but also sheds light on how airlines adapt to diverse economic environments.

In summary, there is evidence that the financial performance (i.e., revenue) of an airline is influenced by its expenditure. However, existing literature often overlooks the potential endogeneity bias, where airline expenditure could be influenced by other factors, such as the number of aircraft. Therefore, our study is the first to address this endogeneity issue from an Indian perspective.

3.2. Efficiency and performance of Indian airlines

Research on Indian airlines, particularly in terms of expenditure and revenue, has been a subject of growing interest in recent years.

Jain and Natarajan (2015) found that the influx of LCCs, including government-backed Air India Express and private LCCs like GoAir, IndiGo, and SpiceJet, improved competitiveness in the Indian market, emphasising the significance of ownership. This study utilised DEA and noted that aggressive capacity expansion and inability to control costs led to mounting losses, impacting revenue and potentially causing bankruptcy or acquisition. Similarly, O'Connell et al. (2013) stated that the issues on restrictions on foreign ownership, the outdated regulatory policies, over taxed fuel and the industry-wide overcapacity were the major contributing factors towards ailing aviation scenario in India.

Saranga and Nagpal (2016) analysed the determinants influencing the market performance of the Indian airline industry from 2005 to 2012. Using a two-way random effects GLS regression and Tobit model, they uncovered that structural and regulatory factors negatively impacted performance, while operational efficiencies within the low-cost segment were notable. Their findings highlighted that technical efficiency, particularly through enhanced pricing power, played a pivotal role in improving market performance and revenue. The study also revealed that load factor, representing the ratio of revenue passenger kilometer (RPK) to available seat kilometer (ASK), positively impacted operational efficiencies. Furthermore, the choice of aircraft fleet operated by Indian airlines was found to be a pertinent factor. While the methods used addressed unobserved heterogeneity and censored data, their complexity may challenge interpretation for non-specialists.

A comparative study of Indian airlines by Wang et al. (2018) stated that Air India's performance could be deteriorating because of two essential aspects: competition from other private airlines and LCCs. Their study employed log-linear demand and supply equations to model pricing dynamics and passenger demand within the airline industry. They found that the presence of an operating LCC on specific routes reduced costs, lowered airfares, and boosted demand for air travel in India. The study also indicated that high airport concentration in India could enhance passenger travel and connectivity. Despite methodological strengths, such as modelling pricing dynamics and demand, the log-linear approach's assumptions about constant elasticities of demand may overlook nonlinear consumer responses. Ganesh (2011) observed that pilots accounted for around 34% of the total manpower costs for scheduled Indian carriers during the 2008-2009 period, despite constituting only 7% of the workforce. This high expense could be linked to additional costs associated with introducing new aircraft, leading to potential shortages of trained instructors and related training expenses.

A panel data analysis by Singh et al. (2019) examined the impacts of different factors on the operational expenditure of Indian airlines. Key variables included available seats per kilometer, payload, average fuel price, flight duration, and ownership. Their multiple regression analysis revealed that operating larger aircraft and increasing payload significantly improved cost efficiency, reducing expenses per Revenue Passenger Kilometer (RPK). They suggested mergers and code-sharing arrangements as potential strategies to enhance efficiency from an Indian perspective. Additionally, the study identified aviation fuel costs as the most crucial factor contributing to rising operational expenditures. The chosen methodology effectively controls for unobserved heterogeneity across different airlines and over time, enhancing the robustness and reliability of the findings.

Similarly, Mahtani and Garg (2020) applied a logistic regression model to analyse Indian airline data from 2006 to 2017, covering seven prominent airlines. They confirmed that fluctuations in fuel prices influenced revenue and profits, impacting key variables such as load factor, fleet size, operating revenues per revenue passenger kilometer (RPKM), operating expenses per RPKM, labour costs, and various financial ratios. The logistic regression model is suitable for examining the impact of multiple factors on discrete outcomes like profitability. However, it assumes a linear relationship between the log-odds of the dependent and independent variables, which may not fully capture complex data interactions, necessitating careful variable specification and addressing issues like multicollinearity to ensure accurate results.

Sakthidharan and Sivaraman (2018) examined major domestic carriers in India using DEA, finding their technical efficiency ranged from 71% to 89% for the period of 2013–2014. DEA inputs included revenue passenger kilometer (RPKM) and freight tonne kilometer (FTKM), while outputs covered available tonne kilometer (ATKM), cost per available seat kilometer, fuel costs (with and without) per ASK, maintenance costs per ASK, ownership costs per ASK, and the number of employees. Their analysis indicated that LCC models contribute to cost reduction by maintaining a younger fleet, particularly in terms of maintenance.

An exception is a recent study by Shome and Verma (2020) using bankruptcy prediction models to examine the financial performance of Indian airlines. Their results showed that the Indian airline industry was problematic with one airline facing bankruptcy every five years. It triggered us to further examine the financial performance, i.e., revenues, of Indian airlines more carefully.

3.3. Impact of external factors

In light of decreasing profit margins, Garg and Agrawal (2023) utilized a fuzzy-based Analytic Hierarchy Process (AHP) framework to assess key performance indicators (KPIs) of Indian airlines. Their analysis highlighted safety and security as primary focus areas, followed by operational, marketing, customer relations, and financial factors. This model offers a method for evaluating KPIs crucial for Indian airlines.

Using a multi-criteria decision-making (MCDM) approach, Mahtani and Garg (2018) found that LCCs generally exhibited higher efficiency in ownership structures, while government carriers benefited from privileges, aligning with global trends. Key factors included fuel prices, inflation, GDP growth, and passenger traffic. Das et al. (2020) cited political influence through government ownership as significant, suggesting state-owned airlines balance commercial and social obligations amid competition from efficient LCCs.

Sidhu and Shukla (2021) conducted a comprehensive analysis of airline parameters from 2019 and 2020, using a correlation matrix to assess significant impacts on the Indian aviation industry. Their study focused on metrics such as passenger load factor (PLF) and revenue performance, revealing the severe effects of COVID-19 on industry volatility and preparedness. Unlike studies limited to single airlines, this research examined the pandemic's effects on the entire industry, offering insights into flight performance and financial endurance. They emphasised the need for robust sustainability protocols to ensure airline survival in unpredictable scenarios, as supported by Dube et al. (2021), Nhamo et al. (2020) and Sun et al. (2023). Furthermore, Barik et al. (2021) observed a significant decline in stock prices of Indian airline companies immediately following the first reported COVID-19 case.

The literature review underscores a complex interplay between operational efficiency, market performance, and external factors in shaping airline revenue. Effective cost management, particularly concerning labour and fuel costs, strategic operational adjustments, and efficient fleet management are critical for revenue enhancement. Additionally, market conditions, regulatory policies, and economic factors significantly influence revenue outcomes. Addressing endogeneity and examining these relationships across varied economic scenarios, including crises like the global financial crisis (GFC) and COVID-19 pandemic, is vital for understanding revenue determinants in the Indian aviation context. Despite valuable insights from existing studies, gaps remain in addressing internal biases, such as endogeneity in expenditure determinants and the impacts of initiatives like the regional connectivity scheme on operational costs, particularly regarding fleet size optimization. Existing research often lacks comprehensive evaluations across different economic scenarios and detailed financial analyses during significant crises. This study aims to bridge these gaps, enhancing the understanding of Indian airlines' operational efficiency and financial resilience. Future research should focus on filling these methodological gaps to support effective management strategies within India's aviation industry.

4. Methodology

4.1. Empirical models

In our research on the revenue dynamics of Indian airlines, we observed endogeneity issues due to the expenditure variable, which is significantly influenced by the number of aircraft. To address this, we employed instrumental variables (IV) regression and generalised method of moments (GMM) estimation. IV regression helps mitigate endogeneity by using instruments correlated with expenditure but uncorrelated with the error term, ensuring unbiased and consistent estimates. GMM extends this approach, offering a flexible and efficient framework, particularly useful for handling multiple endogenous variables and accommodating heteroskedasticity and autocorrelation in panel data (e.g., Ngo et al., 2022; Ullah et al., 2018). By leveraging these econometric methods, we aim to obtain robust and reliable results, isolating the true impact of expenditure on airline revenue and enhancing the credibility of our findings. This methodological approach is essential for deriving meaningful insights and informing strategic decisions in the aviation industry. As previously mentioned, the objective of this study is to address the research gap stemming from the lack of previous studies on Indian airlines that address endogeneity issues related to airline expenditures.

While econometric results can provide valuable insights into causal relationships, ignoring endogeneity can produce biased estimations and limit research applicability (e.g., Gretz & Malshe, 2019; Maung et al., 2022; Saranga & Nagpal, 2016; Ullah et al., 2018). Our study utilised both fixed effects (FE) and random effects (RE) IV regressions to further enhance the robustness of our findings.

The number of aircraft in an airline's fleet is an endogenous factor in airline expenditure because it is influenced by both the demand for air travel and the airline's profitability, creating a feedback loop (e.g., Pitfield et al., 2010; Sibdari et al., 2018; Vasigh & Azadian, 2022). When airlines experience high demand, they may increase their flight capacity to capture additional sales, leading to higher profits. These increased profits enable airlines to expand their fleets, thereby offering more flights, creating a bidirectional effect. Thus, the fleet size is both a result of and a factor in the airline's financial performance and operational decisions.

The dependent variable of this study is the financial performance, i.e., revenue, of Indian airlines. To account for the differences across the airlines due to their sizes and scope of operations, instead of using total revenue, we employ the unit revenue (*UREV*, defined as total revenues divided by total stage length) as a 'fair' measure of the financial performance of the airlines. Regarding the determinants of revenue, as discussed earlier, our main focus is the airline's expenditure – similarly proxied by unit expenditure (*UEXP*). In this study, operating expenditure encompasses all essential costs associated with airline operations. This includes staff expenses, fuel costs, maintenance and repair expenditures, and airport fees. However, *UEXP* needs to be instrumented by the number of aircraft (*AC*), among other IVs, to account for potential endogeneity bias. As discussed in Section 3.1 above, *AC* significantly affects the airline's expenditure, and expenditure influences revenue (e.g., Camilleri, 2018b; Merkert & Hensher, 2011; Sibdari et al., 2018). We, therefore, apply the two-stage approach of Tsui (2017) and Ngo et al., (2022), among others, to account for this endogeneity issue.

Theoretically, the positive correlation between unit expenditure (*UEXP*) and unit revenue (*UREV*) observed in the Indian airline industry can be justified through the concept of cost-quality trade-offs. Increased expenditure on modernising fleet, expanding seating capacity, and improving operational efficiency allows airlines to provide better services, which in turn attracts more passengers willing to pay higher fares. This aligns with findings from Wojahn (2012) and Alamdari & Morrell (1997) suggesting that strategic investments in operational enhancements and service improvements are key drivers of revenue growth in the inherently cyclical airline industry.

Specifically, in the first stage, *UEXP* is regressed against *AC* and other exogenous variables using Equation (1):

$$\begin{aligned} UEXP_{it} = {} & \alpha_0 + \alpha_1 AC_{it} + \alpha_2 PAX_{it} + \alpha_3 STAFF_{it} + \alpha_4 ALLIANCE_{it} \\ & + \alpha_5 LCC_{it} + \alpha_6 GFC_t + \alpha_7 COVID_t + \alpha_8 OWNERSHIP_{it} \\ & + \alpha_9 UDANRCS_{it} + \varepsilon_{it} \end{aligned} \tag{1}$$

where i and t denote the airline and year, respectively.

Then, in the second stage of Equation (2), the predicted value of *UEXP* (accounted for *AC* already) is used as the key independent variable of *UREV*. Including lagged variables in a model helps address autocorrelation and omitted variable bias by incorporating the effects of past periods into the current period's analysis (Ullah et al., 2018). This helps to mitigate autocorrelation by accounting for the influence of previous observations on current observations, thus capturing temporal dependencies. Additionally, it reduces omitted variable bias by considering past information that could affect current outcomes, leading to more accurate and unbiased estimates of the model's coefficients.

Hence we have included the 1-year lagged value of *UREV* to account for other potentially omitted variables – this is a popular practice of the generalised method of moments (GMM) (e.g., Roodman, 2009; Ullah et al., 2018):

$$\begin{aligned} UREV_{it} = {} & \gamma_0 + \gamma_1 UREV_{it-1} + \gamma_2 \widehat{UEXP}_{it} + \gamma_3 PAX_{it} + \gamma_4 STAFF_{it} \\ & + \gamma_5 ALLIANCE_{it} + \gamma_6 LCC_{it} + \gamma_7 GFC_t + \gamma_8 COVID_t \\ & + \gamma_9 OWNERSHIP_{it} + \gamma_{10} UDANRCS_{it} + \mu_{it} \end{aligned} \tag{2}$$

The selection of our variables closely follows the literature, as outlined in Table 2.

4.2. Data

Our data for this study has been meticulously sourced from the Directorate General of Civil Aviation (DGCA, 2021) India and the annual reports of each airline. Airlines include Air India, Air India Express, IndiGo, SpiceJet, Alliance Air and Jet Airways (Jet Airways suspended operation since 2019). By obtaining data directly from these authoritative sources, we ensure the highest level of accuracy and reliability, thereby enhancing the credibility and robustness of our research findings.

The selected sample size and period spanning from 2007 to 2022 can be considered appropriate for several reasons. Firstly, this 16-year timeframe provides ample scope for conducting a systematic analysis of long-term trends and patterns within the Indian aviation industry. Secondly, it encompasses various economic cycles and significant events such as global financial crises (GFC), economic reforms, shifts in aviation policies, and notably, the impact of the COVID-19 pandemic. These events are critical for understanding industry dynamics and resilience. Lastly, spanning over a decade and a half ensures the dataset's robustness in capturing both stable periods and volatile economic conditions, thereby offering a balanced perspective for conducting meaningful analysis and deriving policy implications.

It is important to note that post-2020, comprehensive and reliable information for many Indian airlines became unavailable due to the disruptions caused by the COVID-19 pandemic. Additionally, the schedules of numerous Indian airlines were severely affected, leading to a significant decline in revenue generation. Therefore, we ended up using an unbalanced panel data considering six airlines in 15 years (2007-2022), yielding a total of 79 observations. Table 3 offers a descriptive overview of the key variables under investigation within this study and Table 5 presents key insights derived from these descriptive statistics. In brief, the typical Indian airline exhibits a unit expenditure of approximately INR 25.01 billion per kilometer while being capable of generating approximately INR 24.96 billion per kilometer in total revenue thanks to an average of 15.7 million passengers travelled. We have applied consumer price index deflation to remove the effects of inflation,

Table 2
Variable definitions and their expected relationship with airline revenue.

Variables	Definitions	Expected Relationship	References
Unit Revenue *UREV*	The ratio between operating revenue and stage length of airline *i* at year *t*	-	Singh et al. (2019)
Unit Expenditure *UEXP*	The ratio between operating expenditure and stage length of airline *i* at year *t*	A positive correlation between expenditure and revenue exists, as increased spending often leads to higher earnings.	Singh et al. (2019)
No. of Staff *STAFF*	The total staff of airline *i* at year *t*	More staff tends to reduce revenues	Singh et al. (2021)
No. of passengers *PAX*	The number of passengers carried by airline *i* at year *t*	Expected to reduce expenditure and improve revenues	Kiraci and Yaşar (2020); (Shao & Sun, 2016); Singh et al. (2019)
No. of aircraft *AC*	The total number of aircraft of each airline *i* at year *t*	Expected to improve revenue	(Pitfield et al., 2010; Sibdari et al., 2018)
Member of any airline alliance *ALLIANCE*	This binary variable takes the value of 1 when airline *i* joined alliance membership at year *t*, 0 otherwise	Tends to have a positive impact on airlines from both expenditure and revenues	Barros and Peypoch (2009); Yu et al. (2017)
Global financial crisis time period *GFC*	This binary variable takes the value of 1 during the global financial crisis (2008 and 2009), 0 otherwise.	GFC has a negative impact on both expenditure and revenues	Merkert and Hensher (2011)
Low-cost carrier business model *LCC*	This binary variable takes the value of 1 when airline *i* is a low-cost carrier at year *t*, 0 otherwise	LCCs are better in cost management and may be better in revenue generation	Wang et al. (2018); (Saranga & Nagpal, 2016)
COVID-19 pandemic time period *COVID*	This binary variable takes the value of 1 during COVID-19 pandemic (2020-2022), 0 otherwise;	COVID has a negative impact on both expenditure and revenue	Dube (2022); Maung et al. (2022); Sidhu and Shukla (2021); Sun et al. (2023)
Ownership of the airline (government or private) *OWNERSHIP*	This binary variable takes the value of 1 when airline *i* at year *t* is state owned, 0 otherwise	Non-governmental airlines tend to perform better in terms of expenditure and revenues	Singh et al. (2019); Wang et al. (2018)
Participant in *RCS-UDAN UDANRCS*	This binary variable takes the value of 1 when airline *i* is member of UDAN scheme at year *t*, 0 otherwise	Regional connectivity schemes tend to have a positive impact in revenue	Iyer and Thomas (2020)

Table 3
Descriptive statistics of variables of interest.

Variables	Obs	Mean	Std. dev.	Min	Max
UREV	79	24.96	1.59	21.54	27.77
UEXP	79	25.09	1.50	21.71	27.76
STAFF	79	10458	9595.17	455	32407
PAX	79	13.5	15.8	0.31	87
AC	79	80	70	8.0	304
ALLIANCE	79	0.11	0.32	0.00	1.00
LCC	79	0.68	0.47	0.00	1.00
GFC	79	0.10	0.30	0.00	1.00
COVID	79	0.16	0.37	0.00	1.00
OWNERSHIP	79	0.49	0.50	0.00	1.00
UDANRCS	79	0.30	0.46	0.00	1.00

Notes: UREV and UEXP (both are in billion rupees per km) have been deflated using the consumer price index. The natural log of UREV, UEXP is taken, while STAFF, PAX and AC is measured without transformation. SATFF is in number of employees, PAX is measured in million and AC is measure in number.
Source: Annual reports of the sampled airlines.

enabling accurate analysis of variables like income or costs in terms of their actual value relative to the years.

However, the study acknowledges certain limitation in data accessibility. Data beyond 2007 was not equally accessible for all airlines, potentially affecting robustness. On the other hand, data from 2007-2022 has been validated by the DGCA, and annual reports are audited by reputable firms, providing credibility. Primary data from airlines' websites presents constraints due to discontinuations or unavailability, including those influenced by the COVID-19 pandemic.

The use of GMM, supported by Sargan tests, ensures methodological robustness and validity; it effectively addresses endogeneity concerns and supporting reliable inference and interpretation of our empirical findings.

5. Empirical results and discussions

5.1. Model Selection

The Sargan test (Coef=0.156, p-value=0.028) strengthens our argument in the previous section that endogeneity is present in our data, and that *AC* and *UEXP* are valid instruments for our analysis

Table 4
Hausman's test results.

Test	Hausman test statistic	Conclusion
RE vs FE	0.999	RE is not better than FE
GMM vs RE	17.88**	GMM is statically better than RE
GMM vs FE	24.40***	GMM is statistically better than FE

(Roodman, 2009). We also use the Hausman test to see if the fixed-effect (FE), random-effect (RE), or generalised method of moments (GMM) is more appropriate for our analysis. Note that the null hypothesis of the Hausman test assumes that there is no difference between the results of the two models being examined; a statistical result for the Hausman test, therefore, suggests that the first model is better than the second one. Accordingly, the results reported in Table 4 show that GMM is the best model among the three. Note that the GMM approach effectively corrected for potential biases and provided more reliable parameter estimates, making it the preferred method in our analysis.

5.2. Estimation results interpretation and discussions

Table 5 presents the estimated results derived from the IV regressions incorporating FE, RE and GMM models. Some important findings and their relevant discussions, which are based on the GMM results as the best model, are presented below.

In GMM, the unit expenditure (*UEXP*) is found to be statistically positively correlated to the Indian airline's unit revenue (*UREV*), with a 1% increase in unit expenditure associated with a 0.458% increase in unit revenue. Given the inherently cyclical nature of the airline industry, this finding is in line with the results of Wojahn's (2012) and Alamdari and Morrell (1997). It also aligns with the airlines' increased expenditure on various events, thereby leveraging them to generate higher revenue (Gibson & Morrell, 2004; Singh et al., 2019).

This aligns with the expected causality of variables presented in Table 2. As unit expenditure is defined as the ratio of total expenditure by stage length, it thus suggests that Indian airlines should focus on acquiring new-generation aircraft with higher fuel efficiency, increasing seating capacity, and extended range capabilities (e.g., Das et al., 2020; Walters, 2018; West & Bradley, 2008). In the Indian airline industry, higher expenditure on marketing, expanding routes, and improving

Table 5
Estimation results of IV regressions.

	FE	RE	GMM
$UREV_{t-1}$	–	–	0.163**
			(0.081)
UEXP	1.704*	1.491***	0.458***
	(1.022)	(0.346)	(0.065)
STAFF	-0.248	-0.294	0.202**
	(0.546)	(0.179)	(0.088)
PAX	-0.263	-0.176	0.122**
	(0.377)	(0.194)	(0.043)
ALLIANCE	-0.003	-0.090	0.335**
	(0.612)	(0.260)	(0.147)
LCC	–	0.022	–
		(0.203)	
GFC	0.360	0.238	-0.192**
	(0.553)	(0.280)	(0.093)
COVID	0.034	0.044	-0.063
	(0.236)	(0.187)	(0.084)
OWNERSHIP	-0.564	-0.632**	-0.441**
	(0.520)	(0.193)	(0.167)
UDANRCS	-0.776	-0.579**	0.148*
	(0.853)	(0.226)	(0.090)
Constant	-11.082	-6.722	5.976
	(15.480)	(4.597)	(1.423)
χ^2	156201.74***	859.98***	856.66***

Notes: ***, **, and * denote the significance levels at 1%, 5%, and 10%, respectively. LCC was omitted from RE and GMM models due to the multicollinearity issue. Standard errors are presented inside the brackets.

services can attract more passengers, leading to higher ticket sales and increased revenue. While there is a complex interplay between factors influencing airline competition and the pandemic's impact on industry dynamics, Sun et al. (2024) emphasised the growing importance of ancillary services and differentiated pricing strategies. Additionally, investments in technology and infrastructure can enhance operational efficiency, further boosting profitability.

The relationship between expenditure and revenue varies across industries, with some studies supporting the notion that higher expenditure leads to increased revenue, while others contradict this finding. For instance, in the textiles and clothing industry, Dunford et al. (2016) found that higher expenses related to design and marketing can lead to increased revenue by targeting premium market segments. Similarly, Hudáková and Bajus (2017) observed that in agriculture, high expenditure can yield high revenue. Schütz et al. (2020) demonstrated that for a European multinational utility company, strong expertise in purchasing can lead to cost savings and increased revenue. Additionally, Eller and Moreira (2014) showed that effective purchasing functions and supplier relationships across various industries in Latin America, specifically in a sample of 278 Chilean companies, play a crucial role in enhancing productivity and innovation, thus boosting revenue.

Conversely, higher expenditure does not always correlate with increased revenue. Zaharco et al. (2021) indicated that while optimising expenditure and improving operational efficiency are crucial for increasing sales revenue in agricultural enterprises, higher expenditure alone does not necessarily lead to higher revenue. In the oil and gas industry, Ogolo (2021) noted that higher expenditure raises the breakeven price required to achieve profitability, without directly increasing revenue. Similarly, Zwanziger and Mooney (2005) observed that in the healthcare sector, higher expenditure often results in slower growth rather than increased revenue. Notteboom and Vernimmen (2009) found that in the shipping industry, higher expenditure on bunker costs suggests that increased expenditure can lead to lower revenue. These observations underscore the complex relationship between expenditure and revenue across different industries, highlighting the need for strategic spending and operational efficiency to drive profitability.

Airline staff, denoted as *STAFF*, and unit revenue show a positive correlation, contrary to the expected causality of variables presented in Table 2. This suggests that airlines effectively aligning their staffing levels with operational needs tend to maintain positive revenue trends. According to the estimation results, a unit percentage increase in *STAFF* is associated with a 0.202% increase in unit revenue for operating airlines. Throughout the study period from 2007 to 2022, numerous Indian airlines underwent notable growth, prompting expansions in their routes and networks, evidently resulting in increased revenue. Naturally, this expansion necessitated greater staff involvement to accommodate the rising number of passengers and efficient operations. This is in alignment with the observations of Barbot et al., (2008) and Ginieis et al., (2020). Singh et al. (2019) pointed out that lower employee productivity, reduced ratios of in-flight personnel to total personnel along with lower aircraft utilisation also hinder the performance of state-owned airlines in the Indian context.

Passenger numbers, denoted by *PAX*, exhibit a positive correlation with the financial performance of the Indian airline industry. A one percent increase in passenger numbers typically results in a corresponding rise in unit revenue of approximately 0.122%. This is consistent with the anticipated causal relationships among the variables outlined in Table 2. Noted that passenger numbers have significantly increased in India since 2004, as evidenced by the data in Fig. 1. Increasing passenger numbers drive revenue in the Indian airline industry through several key factors: market demand, competition, and service quality. Higher passenger numbers indicate strong market demand, enabling airlines to fill more seats per flight, thus maximising ticket sales and overall revenue (Sibdari et al., 2018). High demand also allows airlines to maintain or increase ticket prices without losing customers. In a competitive market, airlines that attract more passengers gain a larger market share, leading to economies of scale where the cost per passenger decreases, improving profitability (Alamdari & Morrell, 1997). Enhancing service quality (Camilleri, 2018), such as better in-flight experiences and customer service, attracts and retains passengers. More passengers also mean higher revenue from ancillary services like baggage fees, seat selection, in-flight sales, and loyalty programs. Additionally, increasing passenger numbers can justify expanding flight routes and frequencies, making travel more convenient and attracting even more passengers. Urbanisation further fuels this trend, as urban areas typically exhibit heightened demand for air travel due to increased business activities, tourism, and connectivity with other regions. Moreover, the growth of tourism has significantly contributed to the expansion of passenger volumes, consequently bolstering airlines' revenue streams (e.g., Dash et al., 2021; Iyer & Thomas, 2021).

The lagged variable of $UREV_{t-1}$ exhibits a positive correlation, suggesting that Indian carriers as a whole have shown a persistent increase in revenue over time. This could indeed be a valid explanation for the ongoing growth of the industry, where the financial performance of the previous year contributes to the success of the current year's performance. However, this situation may also be attributed to the rise of low-cost carriers, with low fares serving as the primary driver for sustained growth due to heightened competition in the country (e.g., Wang et al., 2018). Further, this underscores the importance of strategic investments in infrastructure, technology, and workforce development to sustain this upward trajectory.

Among the six dummy variables, *ALLIANCE, GFC, OWNERSHIP*, and *UDANRCS* emerged as statistically significant exhibiting influence over unit revenue. The partnerships reflecting via alliances, and connectivity schemes like UDAN, helped steered Indian airlines towards a more favourable revenue trajectory (e.g., Das et al., 2020; Douglas & Tan, 2017). The importance of airline cooperation, particularly within alliances, is strongly notable due to its positive correlation with unit revenue. It's worth noting that at the time of this research, only the national carrier Air India was a member of the Star Alliance. Nevertheless, past evidences have consistently shown that joining such alliances leads to increased productivity, reduced fares, and boosted revenue (e.g., Douglas & Tan, 2017). Air India's revenue is derived not solely from domestic routes, but predominantly from international routes, where it boasts a

more diverse network than any other carrier in India. Alliances contribute to market stability by reducing cutthroat competition, fostering sustainable pricing strategies, and driving industry innovation through the establishment of common standards. Meanwhile, the regional connectivity scheme, UDAN, demonstrates a notable inclination towards boosting unit revenue, highlighting the significance of the initiative. By facilitating the formation of air routes between tier-2 and tier-3 cities, connecting them to tier-1 cities, the scheme encourages airlines to cater to regional passengers. Government subsidies backing flights to non-metro areas signify a promising prospect for countries with abundant non-metro cities, unlocking substantial potential for heightened passenger traffic. Additionally, the development of infrastructure could open up opportunities for tourism growth and increased commerce. Significance of *ALLIANCE* and *UDANRCS* corresponds to the anticipated causal relationship of variables outlined in Table 2.

The dummy variable *OWNERSHIP* indicates that private airlines are statistically more likely to be effective in revenue generation. This aligns with observations of Singh et al. (2019) and Zhang et al. (2017). Private airlines, particularly the low-cost carriers, have experienced rapid network expansion due to factors such as appealing to price-sensitive passengers. Given that most Indian airlines are privately owned, there's a tendency for revenue generation to be a dominant feature of their ownership structure. This corresponds to the anticipated causal relationships among the variables outlined in Table 2. Furthermore, private airlines face less obstacles in accessing capital markets for investment and modernisation. And, as expected, the exogenous variables *GFC,* and *COVID* have had negative impacts on the financial performance of the airlines.

5.3. Policy implications and recommendations

The positive correlation between unit expenditure *UEXP* and unit *UREV* underscores the potential for revenue growth through investments in advanced technologies and efficient aircraft. Policymakers should incentivise Indian airlines to acquire new-generation aircraft with higher fuel efficiency, increased seating capacity, and extended range through tax incentives, subsidies or favourable financing options. These investments will enhance operational efficiency and environmental sustainability. Further, Sun et al. (2022a) emphasised that modern technologies such as data science and artificial intelligence (AI) can address critical challenges, especially during crises like a pandemic. Supporting technological investments, research and development in AI, and facilitating partnerships between technology firms and airlines are crucial steps. Robust human resource strategies are necessary, as indicated by the correlation between *STAFF* and *UREV*. Funding training programs and facilitating labour market flexibility can enable airlines to adjust their workforce according to demand changes. Increasing passenger volumes, highlighted by the correlation between *PAX* and *UREV*, requires policies promoting air travel, improving airport infrastructure, reducing air ticket taxes and enhancing urban-rural connectivity. Marketing campaigns to boost tourism and business travel can further increase passenger numbers (e.g., Das et al., 2020; Fageda et al., 2018).

Collaborative strategies among airlines supported by policies facilitating global alliances, bilateral agreements, code-sharing, and joint ventures, can enhance financial performance. While low-cost carriers typically don't join alliances, India's airline industry lacks a major full-service carrier comparable to Air India. Most other airlines in India operate as low-cost. Government support for the *UDANRCS* initiative is crucial for regional connectivity, including subsidies for non-metro flights and improving tier-2 and tier-3 city infrastructure. Promoting private sector participation and competition in the airline industry should be maintained, ensuring a level playing field, reducing bureaucratic barriers, and facilitating access to capital markets. Policymakers should develop contingency plans and financial support mechanisms to help airlines withstand economic shocks like the *GFC* and *COVID*, such as an aviation relief fund, temporary tax relief, and low-interest loans during distress periods. Integrating findings into policy through data-driven decisions, stakeholder engagement, and monitoring and evaluation is crucial for ensuring the sustainable growth and resilience of the industry.

6. Conclusion

This research empirically investigated the influence of key drivers on the financial performance (proxied via unit revenue) of six Indian carriers from 2007–2022. This period encompasses significant phases in Indian aviation: expansion, turbulence (GFC 2008-2009 and COVID-19 pandemic in 2020), the insolvency of Jet Airways, and the privatisation of Air India in 2022. Using IV regression and GMM models, the study examined relationships between variables such as airline unit expenditure, staff numbers, passenger numbers, regional connectivity, alliance participation, ownership structure, and exogenous shocks including global financial crisis and the COVID-19 pandemic. The findings indicate a positive correlation between *UEXP, STAFF, PAX, ALLIANCE*, and *UDAN* with *UREV*. Conversely, *GFC* and *OWNERSHIP* exhibit a negative correlation with *UREV*. The study yields several noteworthy findings. Essentially, it's crucial to establish robust protective and supportive framework to ensure fair and equitable growth for all airlines in India, whether government-owned or private.

Although GMM has been used to address endogeneity, some issues may still remain; we recognise this limitation and recommend further investigation in future research. In addition, since this study aims on fair comparison between Indian airlines, we focused more on the unit expenditure and unit revenue of the airlines; future studies extending to the total expenditure/revenue may contribute to a wider picture of the Indian aviation market. Further research should leverage and expand upon this study's methodologies and findings, incorporating new variables like technology adoption and digital transformation, alongside deeper investigations into factors like alliance participation and policy support. Extending the study period beyond 2022 will capture ongoing impacts, particularly the post-COVID-19 recovery phases, providing critical insights into industry resilience and adaptation strategies. Studies on other developing markets (e.g., Thailand or Vietnam) could also contribute to the literature.

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.

CRediT authorship contribution statement

Ajai Jayathilakan: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Conceptualization. **Thanh Ngo:** Writing – review & editing, Visualization, Validation, Software, Methodology, Conceptualization. **Wai Hong Kan Tsui:** Writing – review & editing, Validation, Supervision, Software, Methodology, Conceptualization. **Nives Botica Redmayne:** Writing – review & editing, Supervision. **Faruk Balli:** Writing – review & editing, Supervision, Methodology. **Xiaowen Fu:** Writing – review & editing, Supervision.

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