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Efficiency of airline industry amid market shocks: Evidence from Indian market

Poonam Dhaliwal[1]
Anupreet Kaur Mavi[2]
Nishi Sharma[3+]

[1]*DES-MDRC, Panjab University, Chandigarh, India.*
[1]*Email: dhaliwal10poonam@gmail.com*
[2]*Faculty, UIAMS, Panjab University, Chandigarh, India.*
[2]*Email: anumavi@pu.ac.in*
[3]*Faculty of Management, South Asian University, Delhi & UIAMS, Panjab University, Chandigarh, India.*
[3]*Email: nishi.uiams@pu.ac.in*

(+ Corresponding author)

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ABSTRACT

The airline industry plays a vital role in the economy, but recently, it has encountered challenges leading to financial instability and even the permanent closure of several well-established airlines. The failure of airline companies creates ripple effects; therefore, it is imperative to measure their efficiency. The present paper analyzes the efficiency of the Indian airline industry from 2003 to 2023 and investigates the impact of the global financial crisis, demonetization, and COVID-19 on efficiency. The results of the Mann-Whitney test proclaim the significant negative impact of demonetization on low-cost carriers and the overall industry. However, full-service carriers are discerned not to be significantly affected by demonetization because they mostly have corporate bookings that use banking channels to transfer funds. The financial crisis and COVID-19 have a profound impact on the efficiency of airlines. The results reveal that efficiency decreased after COVID-19 due to stringent travel restrictions and lockdowns. It is observed that Indian airlines are not operating at an optimal scale of operation, highlighting the need to function in consonance with market demand. The full-service carriers need to diversify their offerings for sustainability. The results are expected to be highly fruitful for the global airline industry, market regulators, and policymakers.

Contribution/ Originality: The paper attempts to investigate the responsiveness of the efficiency of India's airline industry to market shocks, viz., the global financial crisis, demonetization, and Covid-19. An unbalanced panel dataset of 194 observations is analyzed to estimate efficiency from 2003 to 2023. The Mann-Whitney test compares the efficiency scores during the pre- and post-shock periods.

1. INTRODUCTION

In the current globalized environment, the airline industry can be considered indispensable. It plays a vital role in promoting tourism, enabling global connectivity, facilitating cross-border trade with reduced travel time, and generating wider employment opportunities ranging from airline operations to airport management. In recent years, the industry has exhibited strong resilience amid unprecedented challenges. Although it initially experienced significant setbacks, it bounced back impressively, registering a robust recovery across global markets. However, the sector continues to grapple with a range of persistent challenges, including rising fuel prices, geopolitical instability, economic downturns, changing regulatory environments, technological disruptions, safety concerns, infrastructural requirements, and heavy capital expenditure. These factors collectively exert pressure on profitability, keeping the industry constrained by narrow profit margins. Several airlines encountered major setbacks in the past decade, such as Air Berlin-Germany (2017), Monarch Airline-UK (2017), Avianca-Brazil (2019), Thomas Cook-British (2019), Flybe-UK (2020), Trans States Airlines-USA (2020), and Compass Airlines-USA (2020). In the Asian region, prominent examples include Orient Thai-Thailand (2018), Shaanxi Airlines-China (2008), Mandala Airlines-Indonesia (2014), Kingfisher Airlines-India (2012), SpiceJet-India (2014), Jet Airways-India (2019), and Go First-India (2023). Many airlines have struggled financially, such as Biman Bangladesh Airlines, Go Air, Jetstar Japan, Pakistan International Airlines, Thai Airways, and Zest Air. Some of these airlines have shut down, while others have been restructured through mergers, amalgamations, or other strategic alliances. The collapse of an airline can create wider economic instability, leading to direct and indirect job losses, a decline in tourism, disruption of passenger travel and cargo services, reduced connectivity, financial losses, and diminished airport revenues, thereby triggering a ripple effect, especially when financial institutions are involved. Consequently, it is crucial to monitor the performance and financial health of the airline industry closely. Empirical research analyzing the effects of market shocks on airline efficiency in India remains scarce. This study makes a novel contribution by examining the resilience of efficiency in response to major market shocks. Against this backdrop, the present study undertakes a comprehensive evaluation of the efficiency of Indian airlines over a two-decade period from 2003 to 2023 and examines the potential impact of market shocks on their efficiency.

2. INDIAN AIRLINE INDUSTRY- AN OVERVIEW

The historical overview of the Indian airline industry reveals that the first commercial flight took place in 1911 from Allahabad over a distance of 6 miles. However, the distinction of being the country's first regional air carrier goes to Air India, originally founded as Tata Airlines in 1932. After independence, Tata Airlines was nationalized and became the official flag carrier. In 1948, several small regional carriers were merged to form Indian Airlines, which was tasked with operating domestic routes across the country. Gradually, the aviation industry network expanded with the introduction of aircraft like Boeing, Douglas, and Airbus models in the 1960s, followed by significant modernization in the 1980s. The liberalization and privatization policies of the early 1990s marked a turning point, encouraging the entry of private players into the market. This era witnessed the rise of major private airlines like Jet Airways (1993) and Air Sahara (1994), which offered luxury travel experiences, premium seating, and exceptional services. During this period, full-service carriers thrived as India's economy grew, leading to a heightened demand for business and premium travel options. A Full-service carrier (FSC) is an airline that offers comprehensive services, including checked baggage, in-flight meals, premium seating, and loyalty programs, catering to both economy and business-class passengers on domestic and international routes. However, air travel remained largely inaccessible to a significant portion of the population due to high fares. This gap in affordability paved the way for the entry of budget air carriers like Air Deccan (2003), GoAir (2005), SpiceJet (2005), IndiGo (2006). A Low-Cost Carrier (LCC) is one that offers budget-friendly fares by minimizing operating costs and eliminating non-essential services. These carriers typically charge separately for extras like checked baggage, meals, and seat selection to keep base ticket prices low. The entry of these carriers revolutionized air travel and made it more accessible to the public and expanded the connectivity. The Indian airline industry has proven itself to be the world's fastest-growing aviation market. As per the report of the International Air Transport Association, by 2030, the Indian aviation market (encompassing the airline industry) will be the third-largest air passenger market in the world after the US and China. The LCCs have played an instrumental role in stimulating this growth (OAG, 2024). The growth trajectory of the Indian airline industry is also a result of growing airport infrastructure, increased foreign investment, and incentives to boost MRO activities (i.e., maintenance, repair, overhaul) and other activities to ensure safety and efficiency of air transport vehicles.

The advent of LCCs made air travel affordable to the mass population, but at the same time, it also led to the failure of some airlines as the LCCs began to pose a significant challenge to the FSCs, primarily due to their cost-effective operations and lower ticket prices. Consequently, many FSCs encountered financial struggles stemming from high operating costs, fierce competition from LCCs, and mounting debt, ultimately leading to the closure of prominent airlines like Kingfisher Airlines (2012) and Jet Airways (2019). Recently, Go First filed for voluntary insolvency in May 2023, and the erstwhile national airline, Air India, survived because of a bailout by the Tata Group in 2024. In addition, from being the second-largest domestic airline in 2019, SpiceJet's market share dropped to just 2.3% in 2024.

The paradox of a thriving market coexisting with airline failures underscores the underlying structural challenges, operational inefficiencies, and financial mismanagement that persist within the industry. In spite of rapid expansion in the industry, the growth of Indian carriers has largely been less profitable. Since the efficiency of an organization significantly influences its performance, it is imperative to analyze the efficiency of the airline industry, which has been less explored in comparison to banking, microfinance, and other sectors. In this context, the present study attempts to make a comprehensive analysis of the efficiency of the Indian airline industry and investigates the possible impact (or resilience) of market shocks on efficiency.

3. LITERATURE REVIEW

The review of research on the efficiency of the airline industry reveals that there is a dearth of studies analyzing the Indian airline industry. Existing literature on airline efficiency predominantly focuses on global or regional markets like Inglada, Rey, Rodríguez-Alvarez, and Coto-Millan (2006), which analyzed 20 international air transport companies over the period of 1996-2000 through stochastic frontier approach (SFA) and observed that American and European firms were less efficient than their Asian counterparts. Coli, Nissi, and Rapposelli (2011) used both SFA and DEA to evaluate how efficient an Italian airline was in 2007. The efficiency scores computed through SFA were observed to be higher than those computed through DEA. Assaf (2009) investigated the technical efficiency of 12 airlines in the USA over the period from 2002 to 2007. The study revealed that technical efficiency declined to 69.02% in 2007 owing to the negative impacts of oil prices, inappropriate firm size, airline capacity, and location. Barros and Peypoch (2009) analyzed the efficiency of European airlines during the period 2000 to 2005 through DEA. The study noted that all, except a few, European airlines were operating at a higher level of managerial efficiency. Hong and Zhang (2010) applied DEA to examine 29 airlines from 1998 to 2002. The findings revealed that airlines with a greater proportion of cargo business were considerably more efficient compared to airlines with a lesser cargo business. Zhu (2011) measured the efficiency of 21 airlines for the years 2007 and 2008 using DEA. The results concluded that the majority of the airlines were efficient. Lu, Wang, Hung, and Lu (2012) applied DEA to estimate the efficiency of 30 US airlines for the year 2006. The results revealed that the average production efficiency of airlines was just 63%. Thus, US airlines should focus on improving efficiency in resource allocation during the production stage and then address marketing inefficiencies. It was also observed that LCCs had higher efficiency than FSCs. Pires and Fernandes (2012) measured the financial efficiency of 42 global airlines in 2001 and profitability in 2002 following the September 11 attacks in the USA using DEA. The study underscored that after the attack, many airline firms increased their equity proportion to reduce financial risk. This resulted in better profitability for 64% of the studied airlines.

Rai (2013) applied DEA to study the technical efficiency of 10 US airlines from 1985 to 1995. The study reported that only six airlines were efficient, while the remaining four were inefficient. Wu, He, and Cao (2013) measured the efficiency of 12 Chinese and non-Chinese airlines for the period 2006 to 2010 using a DEA model. The average efficiency score was found to be 0.950, indicating that most airlines were close to the maximum efficiency level. Lee and Worthington (2014) compared the performance of 42 airlines in 2006, after Europe's deregulation policies. The findings showed that six airlines were operating at a technically efficient level, while only three of them had scale efficiency. It was observed that among the firms exhibiting decreasing returns to scale, almost all European airlines were too large and needed to downsize their operations. Also, major airlines did not benefit from the deregulation measures. Tavassoli, Faramarzi, and Saen (2014) followed network DEA approach to examine technical efficiency of

11 airlines of Iran for the year 2010. The findings revealed that, on average, technical efficiency was 75.99%, and that cargo planes used proportionately more labor than passenger planes, which implied that cargo planes used comparatively more inputs to generate the same output. Mallikarjun (2015) implemented DEA to examine the efficiency of 27 airlines in the USA. The results showed that major airlines were more efficient compared to national airlines, but the efficiency ratios were not substantially different. Zhu and Yang (2015) measured the efficiency of six Chinese airlines through SFA. The study noted an overall increasing trend in technical efficiency from 2001 to 2013. Furthermore, the technical efficiency was observed to depend on the size of the firm. Scotti and Volta (2017) applied a stochastic frontier approach to an unbalanced data set of 53 international air carriers covering the period from 1983 to 2010, including North American, European, Asia-Pacific, Latin American, Middle Eastern, and African airlines. The study found that average cost efficiency increased from 0.67 to 0.73. Zhang et al. (2017) estimated and compared the efficiency of the top 10 airlines of China and the USA for the period 2011-2014. The results revealed that Chinese airlines were less efficient than those in the USA, and the efficiency gap widened over the studied period. Yu, Zhang, Zhang, Wang, and Cui (2019) used a DEA approach to analyze the efficiency of major air carriers in China and India from 2008 to 2015. The findings revealed that two low-cost carriers, specifically China's Spring Airlines and India's SpiceJet, emerged as the most efficient operators. Huang, Hsu, and Collar (2021) employed a network data envelopment model to assess the performance of nine U.S.-based airlines from 2015 to 2019, as well as performed regression analysis aiming to identify the factors contributing to inefficiency. The results revealed that airlines utilizing a low-cost business model demonstrated higher efficiency scores compared to those operating under a full-service model. Additionally, while the size of an airline, as indicated by total assets, positively impacted efficiency, a greater number of full-time employee equivalents negatively affected the level of efficiency. Lin and Hong (2020) applied a network DEA model to eight airlines operating in Taiwan and China. The findings indicated that Chinese airlines exhibited significantly higher cost efficiency and cost-effectiveness compared to their Taiwanese counterparts, primarily due to the effective cost control measures implemented by Chinese airlines. Law (2022) used DEA to assess the efficiency of five airlines in Thailand over a nine-year period from 2011 to 2019. The findings revealed that budget airlines were not inherently more efficient than full-service carriers. Additionally, private airlines outperformed state-owned ones, and small to medium-sized airlines demonstrated greater efficiency compared to their larger counterparts.

In the context of Indian airlines, Singh (2011) evaluated 11 airlines of India using the DEA framework to identify performers and underperformers. The results indicated that Indigo was at the maximum relative efficiency level, while Alliance Air had the lowest relative efficiency score. Jain and Natarajan (2015) examined the technical and scale efficiency of 12 airlines in India for the period 2006 to 2010. The study observed that most budget airlines were efficient. Furthermore, private-owned small airlines were noted to be more efficient than larger airlines. Saranga and Nagpal (2016) conducted a two-stage empirical study to estimate operational efficiencies of the Indian airline industry and to determine the drivers of performance using DEA and regression, respectively. The period of study was 2005 to 2012. It was found that Jet Airways, Air India Express, and Paramount Airways were the most technically efficient airlines. Air India remained technically efficient from 2005 to 2007 but declined in later years. The study noted a significant impact of average stage length, international RPK, and yield on efficiency. Chowdhary, Ghosh, Bandhopadhyay, and Mukhopadhyay (2018) assessed the efficiency of low-cost airlines in India through DEA. The findings revealed that Jetlite achieved technical and overall efficiency, while Indigo was the most inefficient airline. Sakthidharan and Sivaraman (2018) evaluated the technical and scale efficiency of major domestic airlines in India for 2013-2014 using input-oriented DEA. The empirical findings indicated that technical efficiency ranged from 71% to 89%. The study revealed that LCCs demonstrated superior scale efficiency compared to FSCs in India. Seth, Saxena, and Arora (2024) applied window DEA to estimate the efficiency of Indian airlines from 2014 to 2019. The findings revealed that Air India Express was the only airline that was relatively efficient. Additionally, Air India and Alliance

Air showed a decline in performance, whereas Indigo, SpiceJet, and Vistara showed an upward trend in their performance.

The review underscores a pronounced dearth of studies aiming to analyze the impact of market shocks on the efficiency of the airline industry. The review indicates the presence of only a few studies that examine the impact of market shocks on efficiency, such as Duygun, Prior, Shaban, and Tortosa-Ausina (2016), which analyzed comprehensive data of 87 airlines from 23 European countries from 2000 to 2010 through DEA. Their study divided the results into two parts: the pre-crisis period (2000-07) and the post-crisis period (2008-10). On average, the findings of the present research are similar. Efficiency dropped marginally after the crisis. This study observes that LCCs performed better than FSCs in the pre-crisis period, and the gap increased significantly during the crisis years. The facts indicate that low-cost airlines were quicker in adapting to the economic downturn, and much of the inefficiency was generated by full-service airlines.

Such studies are indispensable for maintaining the sustainability of the airline industry, which is the lifeblood to ensure connectivity of the markets. Furthermore, since low-cost airlines may perform differently from full-service airlines, it is essential to comprehend and compare the responsiveness (or immunity) of the two segments towards various shocks. Additionally, since the Indian airline industry has recently undergone major changes, it is crucial to analyze its efficiency trend so that appropriate regulatory measures can be implemented. In this context, the present study attempts to demystify the efficiency of Indian low-cost as well as full-service carriers over a period of two decades.

4. RESEARCH METHODOLOGY

As per the International Air Transport Association, the Indian airline industry is viewed as the world's fastest-growing aviation market and is expected to be the world's third-largest air passenger market after the US and China by 2030 (Moisejenko, 2024). The present study aims to estimate the efficiency of the Indian airline industry and investigate the impact of major shocks on the efficiency estimates. It analyzes the efficiency of FSCs and LCCs, independently as well as collectively, over a period of two decades from 2003-04 to 2022-23. The period has been chosen with the intention to observe the impact of national shocks (like demonetization) as well as international shocks (like the global financial crisis, Covid-19) on the efficiency.

The term efficiency implies performing or functioning in the best possible manner with the least wastage of time and effort. It can be explained as a firm's ability to produce the maximum possible outcome with a given set of inputs (Farrell, 1957). Efficiency analysis is primarily conducted using two approaches: parametric and non-parametric methods. The parametric methods rely on a priori information, such as the functional form of the production function (Svitalkova, 2014) whereas non-parametric methods make no such assumptions, the present study applies the non-parametric method Data Envelopment Analysis (DEA), which is one of the most popular methods for estimating efficiency (Karlsson, Häggqvist, & Hedberg, 2021; Nguyen & Pham, 2020; Saroy, Jain, Awasthy, & Dhal, 2023; Singh & Thaker, 2020; Yesmine et al., 2023). Modern efficiency measurement traces its origins to Farrell (1957), who built upon the earlier work of Debreu (1951) and Koopmans (1951) to develop a simple technique to estimate efficiency that could accommodate multiple inputs. Charnes, Cooper, and Rhodes (1978) drew upon the theoretical framework of Farrell (1957) and proposed DEA. DEA is a linear programming technique used to estimate the relative efficiency of a decision-making unit (DMU) in converting inputs into outputs. It creates a nonparametric, piecewise frontier, and DMUs located on the frontier are regarded as best practice or efficient units, with efficiency values equal to one. DMUs with efficiency values of less than one are deemed inefficient units, implying that they can increase their efficiency in order to reach the efficient frontier by either increasing or decreasing their present input levels. The basic model, also called the CCR model, operates under the assumption of constant returns to scale, which presumes that there is no significant relation between size and efficiency, implying that an increase in inputs leads to a proportionate increase in outputs. Later, Banker, Charnes, and Cooper (BCC 1984) extended it to develop a model of variable returns to scale, also called the BCC model, which acknowledges that an increase in inputs does not necessarily lead to a proportionate increase in outputs. The CCR model analyzes overall efficiency, in which pure technical efficiency and scale efficiency are summed up into a single value, whereas the BCC model analyzes just pure technical efficiency. Assuming there are n airlines, i.e., $j = 1,2,\dots,n$ where, each airline uses *m* inputs to produce *s* outputs. The vectors $x_{ij} = (i = 1,2 \dots m)$ and $y_{rj} = (1,2 \dots s)$ are m-inputs and s-outputs vectors. The following input-oriented models, as proposed by Charnes et al. (1978) and Banker, Charnes, and Cooper (1984), are used to get the efficiency scores of airlines.

CCR Model

$$\begin{aligned} & \theta^* = \min \theta \\ \text{s.t.} \quad & \sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{ik}, \quad i = 1,2,\dots,m \\ & \sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{rk}, \quad r = 1,2,\dots,s \\ & \lambda_j \geq 0, \quad j = 1,2,\dots,n \end{aligned} \tag{1}$$

BCC Model

$$\begin{aligned} & \phi^* = \min \phi \\ \text{s.t.} \quad & \sum_{j=1}^{n} \lambda_j x_{ij} \leq \phi x_{ik}, \quad i = 1,2,\dots,m \\ & \sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{rk}, \quad r = 1,2,\dots,s \\ & \sum_{j=1}^{n} \lambda_j = 1 \\ & \lambda_j \geq 0, \quad j = 1,2,\dots,n \end{aligned} \tag{2}$$

Where θ^* and ϕ^* represent efficiency scores under CRS and VRS, respectively, for DMU under consideration, x_{ik} represents input *i* for DMU *k*, y_{rk} represents output *r* for DMU *k* and λ_j represents weights. Input-oriented approach is adopted since airlines have greater influence over inputs in comparison to outputs (Saranga & Nagpal, 2016).

On the basis of previous literature, the following variables have been selected to proxy inputs and outputs.

- Input 1: Total operating expense (Bansal, Srivastava, & Aggarwal, 2023; Choi, 2017; Chowdhary et al., 2018; Kumaran et al., 2019; Law, 2022; Lin & Hong, 2020; Seth et al., 2024).
- Input 2: Number of employees (Bansal et al., 2023; Choi, 2017; Chowdhary et al., 2018; Kumaran et al., 2019; Law, 2022; Lin & Hong, 2020; Seth et al., 2024).
- Output: Total operating revenue (Bansal et al., 2023; Choi, 2017; Chowdhary et al., 2018; Kumaran et al., 2019; Law, 2022; Lin & Hong, 2020; Seth et al., 2024).

To sum up, in the present study, input-oriented DEA has been used to measure three efficiency estimates: pure technical efficiency (which focuses solely on the managerial aspect of utilizing resources in the production process to generate outputs), scale efficiency (which is associated with the operating scale of operation), and overall technical efficiency, which measures the efficiency of the DMU due to the input/output configuration, i.e., managerial efficiency as well as scale efficiency (Jagwani, 2012). The data has been obtained from the official website of the airlines and the Directorate General of Civil Aviation (DGCA). The dataset includes only those airlines that remained operational in the industry for at least four years to establish a competitive position in the market, and for which data is available. There were 16 airlines that met this criterion. However, due to the intermediary entry and exit of companies, the data forms an unbalanced panel with a total of 194 observations across the study period. It is important to note that regarding the minimum number of selected units for DEA, there are two criteria. The first states that the number of selected units must be ≥ twice the sum of the number of inputs and outputs. The second specifies that the number of selected units should be ≥ twice the multiple of the number of inputs and outputs. Since there are two inputs and one output, at least six airlines must be operating each year. The selected sample size meets these criteria.

The study period is marked by the occurrence of three major market shocks, viz. the global financial crisis, demonetization, and the outbreak of COVID-19. The first shock, i.e., the Global Financial Crisis (GFC), which originated in the US, was triggered in late 2007, and by 2009, it spread its contagious effect to various economies. In the context of India, most sectors remained relatively resilient, yet the impact became visible in 2008-09. Therefore, the period from 2003-04 to 2007-08 has been taken as the pre-period, and the matching five-year period from 2008-09 to 2012-13 has been taken as the post-event period. The next market shock (or change), i.e., demonetization, occurred on 8th November 2016, wherein the government banned the accreditation of currency notes of ₹ 500 and ₹ 1000 as legal tender money to discourage illegitimate revenue. This affected air travel bookings and ticket prices (Sinha, 2016). But soon, as per the data released by DGCA, the air passengers flown during December 2016 increased by 23.91% with respect to last year. Thus, it will be interesting to note whether demonetization has affected the efficiency of the Indian aviation industry or not. The period from 2016-17 to 2022-23, i.e., seven years, has been taken as the post-period, and the matching seven years till 2015-16 have been taken as the pre-period. The third shock, i.e., Covid-19 (coronavirus), brought unprecedented disruptions all over the world. In India, though the first case of Covid infection was reported on 30th January 2020 (i.e., the year 2019-20), yet its contagious effect came out from April 2020, i.e., the year 2020-21. Therefore, the three-year period from 2020-21 to 2022-23 has been taken as the post-period, whereas the matching three years prior to April 2020 have been taken as the pre-period. The possible impact of these shocks has been examined through comparing the efficiency scores of pre- and post-periods through the Mann-Whitney test. The test examines the following three null hypotheses:

H_{01}: There is no significant impact of GFC on the efficiency of the Indian airline industry.

H_{02}: There is no significant impact of demonetization on the efficiency of the Indian airline industry.

H_{03}: There is no significant impact of COVID-19 on the efficiency of the Indian airline industry.

To assess the validity of the null hypothesis, the computed test statistic is compared to the critical value. The null hypothesis is accepted if the computed statistic is less than the critical value. However, if the probability is lower, the null hypothesis is not accepted, which implies that the relevant shock has a considerable effect on the efficiency of the Indian airline industry.

5. RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics, i.e., the average, standard deviation, coefficient of variation, maximum and minimum value for the selected six input and output variables.

Table 1. Descriptive statistics.

Variables	Mean	Standard deviation	Coefficient of variation	Minimum	Maximum
Operating revenue	60087.62	80437.1	133.866	544464.5	144.2
Operating cost	64773.3	84141.4	129.901	500832.1	321.9
Employees	6012.951	6811.96	113.288	32397	214

The selected variables, as displayed in Table 1, have been used to compute the overall technical efficiency (OTE), pure technical efficiency (PTE), and scale efficiency (SE) of the selected airlines. The average efficiency scores of all full-service carriers (FSCs), low-cost carriers (LCCs), and the overall airline industry for the entire study period of 20 years have been depicted in Table 2.

As revealed from Table 2, the comparative analysis of average efficiency estimates of FSC and LCC demonstrates that FSCs are less efficient than their competitive segment. The overall technical average (OTE) is 79.9%, implying 20.1% inefficiency in making optimal use of resources, whereas the same for LCC is 82.7%, indicating inefficiency of 17.3%. The lower efficiency of FSCs may be linked to the entry of multiple LCCs into the industry, due to which FSCs were forced to discount their fares by around 60–70% to maintain a competitive edge. Although the competitive pricing tactics of LCCs expanded and deepened air travel demand, reaching into non-metro towns and Tier-II cities, it adversely affected the profits of LCCs and diminished revenues, margins, and market share of FSCs (Jain & Natarajan, 2015).

Table 2. Average efficiency estimates of Indian airline industry (2003-04 to 2022-23).

Years	FSCs			LCCs			Overall		
	OTE	PTE	SE	OTE	PTE	SE	OTE	PTE	SE
2003-04	0.939	0.989	0.95	0.977	1.000	0.977	0.952	0.993	0.959
2004-05	0.891	0.963	0.926	0.897	1.000	0.897	0.893	0.975	0.916
2005-06	0.776	0.903	0.869	0.759	0.809	0.917	0.768	0.86	0.891
2006-07	0.829	0.889	0.934	0.744	0.822	0.900	0.786	0.855	0.917
2007-08	0.818	0.942	0.869	0.734	0.757	0.968	0.764	0.824	0.932
2008-09	0.867	0.928	0.939	0.829	0.863	0.963	0.843	0.886	0.954
2009-10	0.806	0.940	0.86	0.905	0.948	0.954	0.865	0.945	0.916
2010-11	0.906	0.986	0.918	0.897	0.957	0.939	0.901	0.969	0.930
2011-12	0.907	0.920	0.985	0.914	0.980	0.934	0.911	0.96	0.951
2012-13	0.862	0.896	0.961	0.899	0.980	0.919	0.886	0.952	0.933
2013-14	0.820	1.000	0.820	0.854	0.940	0.912	0.845	0.955	0.889
2014-15	0.594	1.000	0.594	0.808	0.962	0.843	0.744	0.974	0.768
2015-16	0.684	0.840	0.83	0.749	0.874	0.865	0.731	0.865	0.855
2016-17	0.756	0.868	0.881	0.799	0.933	0.859	0.787	0.915	0.865
2017-18	0.766	0.901	0.863	0.843	0.923	0.870	0.822	0.917	0.868
2018-19	0.763	1.000	0.842	0.865	0.801	0.896	0.837	0.855	0.882
2019-20	0.535	0.969	0.972	0.851	0.928	0.920	0.765	0.939	0.934
2020-21	0.710	0.778	0.924	0.672	0.894	0.828	0.68	0.868	0.849
2021-22	0.863	1.000	0.81	0.703	0.863	0.833	0.739	0.893	0.828
2022-23	0.890	0.931	0.811	0.838	0.869	0.966	0.851	0.884	0.927
Mean	0.799	0.932	0.878	0.827	0.905	0.908	0.819	0.914	0.898

The results of SE (87.8% for FSCs and 90.8% for LCCs) also depict a similar scenario, which calls for immediate intervention to bring changes in the scale of operations. The results align with the findings of previous researchers (Huang et al., 2021; Jain & Natarajan, 2015; Sakthidharan & Sivaraman, 2018; Yu et al., 2019). It is interesting to note that in terms of PTE, i.e., managerial efficiency, FSCs score better (93.2%) than LCCs (90.5%), which underscores managerial challenges in LCCs in satisfying customer needs (Deeppa, Ganapathi, & Dwivedi, 2017) and the intense competition due to the entry of FSCs into Tier 2 cities (Jain and Natarajan, 2015). The analysis of the overall industry highlights that the average PTE (91.4%) is comparatively better than OTE (81.9%). The airlines were found to operate at a sub-optimal scale of operations. IATA (2013) noted that during the 2012 economic meltdown, when the overall demand for air travel dropped by 4.9% compared to the previous year, airlines were operating at a larger scale, which needed to be brought down to more realistic levels.

The analysis of efficiency underscores notable fluctuations in the efficiency estimates over different years, such as a decline in overall technical efficiency of FSCs, LCCs, and the overall industry observed in 2005-06. This decline is due to the entry of two FSCs, namely Kingfisher and Paramount, registering very low efficiency scores in their first year of operations (viz., 58.4% and 40.6%, respectively). Similarly, in 2014-15, overall efficiency declined due to the low efficiency (just 22%) of the new entrant full-service airline Vistara, and budget airline AirAsia (renamed as AIX Connect), reporting 46% efficiency in its commencing year. In 2008, efficiency dropped owing to industry consolidation, the global financial crisis, the Mumbai terrorist attack, and the outbreak of H1N1 virus. Further, another fluctuation was observed in 2019-20 when Jet Airways and its low-cost subsidiary Jet Lite closed down due to financial distress. Additionally, in 2020-21, the outbreak of coronavirus and subsequent lockdown, travel restrictions, and suspension of all domestic and international flights led to significant financial losses for airlines, which had to bear costs such as aircraft maintenance, employee salaries, and lease payments without any incoming revenue. Flights remained grounded for two months, with domestic travel resuming in May 2020 under strict guidelines. The average efficiency estimates of selected airlines have been depicted in Table 3.

Table 3 depicts that in terms of OTE, one of the LCCs, Air India Express, is the most efficient airline. The results align with the findings of previous studies, including Jain and Natarajan (2015) and Seth et al. (2024). The analysis of individual airline scores reveals that this airline has been on the efficiency frontier from 2013-14 to 2022-23. It is followed by another LCC, IndiGo, with 90% efficiency, and one FSC, Air Sahara, with an average efficiency estimate of 87%. TrueJet, which is a LCC, is observed to be the lowest performer with an average efficiency of 57%, followed by Vistara with an efficiency estimate of just 61%. In terms of PTE, FSCs perform better, with both Paramount Airways and Air Sahara achieving 100% efficiency estimates. The lowest performers are Air Deccan, a LCC, and Kingfisher, a FSC, with 79.5% and 80% pure technical efficiency, respectively. In terms of SE, Jet Airways, followed by Air India Express, exhibits better efficiency, attaining 98% and 97% efficiency, respectively. The airlines with the lowest SE are Alliance Air (81%) and Paramount (86.5%). The frequency distribution of airlines across different efficiency ranges has been reported in Table 4.

Table 4 depicts that, on average, 36% of the airlines demonstrate strong OTE, with efficiency scores ranging between 0.90 and 1.00. The efficiency of all airlines was found to be more than 0.80 in 2003-04, but there was a significant drop in the OTE in 2004-05, due to which 17% of the airlines were able to secure an average efficiency in the range of 0.70 to 0.80. This result may be attributed to increased competition in the industry following the entry of LCC segment airlines into the market. During the year 2020-21, many airlines (56%) exhibited less than 0.70 efficiency, but this was soon stabilized. In terms of managerial and scale efficiency, on average, 69% and 65% of the airlines secured an efficiency score within the range of 0.90 to 1.0. Less than 10% of airlines (7% for PTE and 8% for SE) had an efficiency estimate of less than 0.70. The years 2020-21 (for PTE) and 2021-22 (for SE) could be regarded as the least performing years, with efficiency falling into the lower range. The reason for this may be attributed to the immediate impact of the outbreak of COVID-19.

Table 3. Average efficiency estimates of different airline companies (2003-04 to 2022-23).

Segment	Airline	OTE				PTE				SE			
		Rank	Average	Min.	Max.	Rank	Average	Min.	Max.	Rank	Average	Min.	Max.
FSC	AI	8	0.83	0.74	1.00	4	0.97	0.78	1.00	11	0.87	0.76	1.00
	IA	6	0.86	0.75	0.92	8	0.92	0.82	1.00	6	0.9	0.90	1.00
	JA	7	0.85	0.12	1.00	10	0.89	0.78	0.96	1	0.98	0.96	1.00
	AS	3	0.87	0.75	0.96	2	1.00	0.98	1.00	10	0.90	0.69	1.00
	KF	12	0.76	0.58	0.98	14	0.80	0.61	0.99	4	0.95	0.87	0.99
	PM	5	0.87	0.41	1.00	1	1.00	1.00	1.00	12	0.87	0.41	1.00
	VT	15	0.61	0.22	0.91	13	0.82	0.52	1.00	15	0.79	0.22	0.97
LCC	AIE	1	0.99	0.89	1.00	3	0.97	0.80	1.00	2	0.97	0.76	1.00
	AA	11	0.76	0.56	1.00	6	0.94	0.48	1.00	14	0.81	0.56	1.00
	JL	4	0.87	0.70	1.00	7	0.92	0.74	1.00	5	0.94	0.83	1.00
	AD	13	0.73	0.49	0.95	15	0.80	0.52	1.00	8	0.93	0.79	1.00
	GA	9	0.83	0.36	1.00	12	0.85	0.56	1.00	9	0.91	0.41	1.00
	IG	2	0.90	0.50	1.00	9	0.91	0.50	1.00	3	0.96	0.84	1.00
	SJ	10	0.81	0.69	0.91	11	0.87	0.76	1.00	7	0.93	0.41	1.00
	TJ	16	0.57	0.41	0.84	5	0.94	0.65	1.00	16	0.77	0.43	1.00
	AAs	14	0.61	0.46	0.79	16	0.77	0.15	1.00	13	0.86	0.46	1.00

Note: AI=Air India, IA= Indian airlines, JA= Jet airways, AS= Air Sahara, KF = Kingfisher, PM= Paramount, VT-Vistara, AIE= Air India express, AA= Alliance air, JL= Jet lite, AD= Air Deccan, GA= Go Air renamed as Go First, IG= Indigo, SJ= SpiceJet, TJ= True jet, AAs= Air Asia renamed as AIX connect.

Table 4. Frequency distribution of efficiency of industry (In %).

Year	OTE				PTE				SE			
	< 0.70	0.7-0.8	0.8-0.9	0.9-1	< 0.70	0.7-0.8	0.8-0.9	0.9-1	< 0.70	0.7-0.8	0.8-0.9	0.9-1
2003-04	-	-	17	83	-	-	-	100	-	-	17	83
2004-05	-	17	33	50	-	-	-	100	-	17	17	67
2005-06	27	18	27	27	18	9	18	55	18	-	9	73
2006-07	17	42	17	25	17	17	25	42	-	-	42	58
2007-08	27	45	9	18	18	36	9	36	-	9	18	73
2008-09	9	36	9	45	-	27	9	64	-	9	9	82
2009-10	10	20	40	30	-	10	20	70	-	20	20	60
2010-11	-	10	40	50	-	0	10	90	-	-	30	70
2011-12	-	22	11	67	-	11	11	78	-	11	-	89
2012-13	11	11	22	56	-	-	33	67	11	-	-	89
2013-14	13	13	38	38	-	-	25	75	13	-	25	63

Year	OTE				PTE				SE			
	< 0.70	0.7-0.8	0.8-0.9	0.9-1	< 0.70	0.7-0.8	0.8-0.9	0.9-1	< 0.70	0.7-0.8	0.8-0.9	0.9-1
2014-15	30	30	-	40	-	-	10	90	30	20	10	40
2015-16	36	18	27	18	18	-	36	45	9	18	9	64
2016-17	27	9	36	27	9	9	9	73	18	-	18	64
2017-18	27	18	18	36	-	18	18	64	9	9	45	36
2018-19	-	27	55	18	18	9	-	73	9	9	36	45
2019-20	18	9	45	27	-	9	18	73	-	-	27	73
2020-21	56	11	22	11	22	-	11	67	11	22	11	56
2021-22	33	33	11	22	11	11	11	67	22	-	33	44
2022-23	25	25	25	38	13	13	25	50	13	-	13	75
Average	18	21	25	36	7	9	15	69	8	7	19	65

6. IMPACT OF GLOBAL FINANCIAL CRISIS, DEMONETIZATION AND COVID-19 ON EFFICIENCY

The present study has conducted a comprehensive analysis of the efficiency of the Indian airline industry over a period of 20 years from 2003-04 to 2022-23. The study period has been characterized by the occurrence of some prominent events. The literature review reveals that some previous studies have stated that efficiency levels can be influenced by various shocks (changes/incidences/events) experienced by the market (Akhtar, Alam, Khan, & Shamshad, 2023; Alsharif, 2024; Boubaker, Le Tu, & Ngo, 2023; Gulati, Charles, Hassan, & Kumar, 2023; Riani, 2022; Tanwar, Seth, Vaish, & Rao, 2020). Since the trend analysis exposes certain swings in the efficiency scores, it is pertinent to investigate the possible impact of major events on the efficiency level. Accordingly, the impact of the three major events, viz. the Global Financial Crisis (GFC), Demonetization, and Covid-19, has been analyzed in the present study. The period from the year in which the event occurred has been classified as the post-period, whereas the matching period prior to the event occurrence year has been classified as the pre-period (Alsharif, 2024; Maity & Ganguly, 2019; Qadri et al., 2023; Rawat & Sharma, 2023). As mentioned in the methodology, the following durations have been considered for the pre-period and the post-period.

Table 5. Duration of pre-crisis and post-crisis periods for Mann-Whitney test.

Market Shocks	Number of years	Time period
• GFC	± 5 Years	Pre-period: 2003-04 to 2007-08 Post-period: 2008-09 to 2012-13
• Demonetization	± 7 Years	Pre-period: 2009-10 to 2015-16 Post-period: 2016-17 to 2022-23
• COVID-19	± 3 Years	Pre-period: 2017-18 to 2019-20 Post-period: 2020-21 to 2022-23

Table 5 presents the time duration considered according to the requisites of the Mann-Whitney test to analyze the impact of market shocks on airline efficiency. To scrutinize the possible impact of the selected market shocks on efficiency, three null hypotheses asserting no significant impact of market shocks on efficiency have been examined through the Mann-Whitney test, and the results have been reported in Table 6.

Table 6. Impact of market shocks on efficiency of airlines.

Particulars	Pre period		Post period		Z value	Probability
	Average	Standard deviation	Average	Standard deviation		
Impact of GFC						
FSC	0.881	0.082	0.874	0.111	0.072	0.471
LCC	0.768	0.189	0.881	0.119	-2.400	0.008***
Overall industry	0.812	0.164	0.880	0.116	-1.894	0.029**
Impact of demonetization						
FSC	0.778	0.194	0.744	0.194	0.535	0.296
LCC	0.856	0.148	0.798	0.161	1.966	0.025**
Overall industry	0.837	0.162	0.784	0.171	2.053	0.020**
Impact of COVID-19						
FSC	0.687	0.226	0.824	0.164	-1.707	0.044**
LCC	0.853	0.105	0.732	0.193	2.397	0.008***
Overall industry	0.808	0.162	0.753	0.188	1.330	0.092*

Note: *Null hypothesis cannot be accepted at 10% and ** at 5% and *** at 1% level of significance.

As revealed from Table 6, the GFC has a significant positive impact on the efficiency of LCCs as well as the overall airline industry of India. The results are aligned to the findings of Pires and Fernandes (2012). The GFC caused a drastic reduction in traffic, thereby necessitating the optimization of resources. Therefore, airlines strategically realigned their flight networks to concentrate on high-demand routes, with a renewed focus on routespecific profitability. The successful rescheduling, lean management practices, better planning, and turnaround resulted in a significant rise in efficiency estimates. The rise of LCCs in India is no surprise given the domestic market's leadership in overall air travel. During the ten-year period from 2009 onwards, international traffic from India increased by a cumulative 75.9%, wherein the LCCs expanded total seats by 239.9%, and mainline FSCs expanded by 53.6% (DGT, 2019). India's LCCs like IndiGo and GoAir expanded their operations by pursuing flights of Airbus A320 planes into Tier 2 cities. In addition, SpiceJet used Bombardier's Q400 turboprops with a huge success (Benny, 2012). Duygun et al. (2016) also noted that low-cost airlines were quicker in adapting to economic downturn.

The demonetization of heavily denominated currency is seen to have a significant negative impact on the efficiency of LCCs as well as the airline industry of India as a whole. The individual travelers using LCCs were initially pushed into an inconvenient situation owing to the withdrawal of high-denomination currency; however, later the launch of mobile wallets, UPI payment systems, and digital payment platforms resumed normalcy. However, with reference to FSCs, no significant impact has been noted. This is perhaps due to the adaptability of digital payment systems by the airlines. The airlines quickly integrated ticket booking and payment for onboard services with digital payment platforms. This reduced the dependency of the industry on cash, reducing the impact of demonetization. Also, the business travelers using FSCs were shielded because most of the corporate bookings take place through corporate accounts via bank transfers.

The outbreak of coronavirus has had a profound negative impact on the transportation industry due to the strict restrictions imposed on travel, border closures, and lockdowns. According to the International Air Transport Association (IATA), the estimated global loss for airlines in 2020 alone was approximately $118 billion. India's air traffic decreased by 60% in 2020 compared to pre-pandemic levels. The air transportation sector was crippled with enormous losses, amounting to billions of dollars for each carrier. Additionally, the grounding of aircraft increased maintenance costs for airlines. This is clearly reflected in the significant impact of COVID-19 on the efficiency of the Indian airline industry. Interestingly, the efficiency of full-service carriers (FSCs) improved during the post-COVID period; however, this improvement cannot be solely attributed to the pandemic, as only two FSCs were operating during this period. Jet Airways ceased operations in April 2019, and its exit likely prevented a further decline in the segment's average efficiency. Furthermore, changes in operational strategies, such as focusing on domestic routes, cargo operations, and maintaining safety protocols, contributed positively to FSCs.

7. POLICY IMPLICATIONS

The recent few years expose the paradox of a thriving of airline industry across the globe and Indian airline industry is no exception to it. The growing airport infrastructure, increased foreign investment, and incentives to boost MRO activities (i.e., maintenance, repair, overhaul, and other activities to ensure the safety and efficiency of air transport vehicles) contributed to the growth trajectory of the Indian airline industry, but at the same time, high operating costs, fierce competition, and mounting debt led to the insolvency and permanent closure of some prominent airlines. The conflicting situation calls for immediate attention to analyze the efficiency of the airline industry, which is underexplored. In this context, the findings of this study are anticipated to provide valuable insights for managerial decision-making, such as devising cost-cutting strategies and ensuring the optimal allocation of resources. The results are useful for market regulators and policymakers to understand market dynamics and improve the overall performance of the industry.

8. LIMITATIONS AND FUTURE RECOMMENDATIONS

The present study estimates the efficiency of the Indian airline industry over a period of 20 years from 2003-04 to 2022-23. Further, the impact of three major shocks has also been analyzed in the study. However, the scope of the study is subject to the limitations of data availability. A comprehensive international comparison can enhance the value of the results. Additionally, the study has not explored the potential causes of efficiency (or inefficiency) among different airlines, which may be an interesting aspect to explore in the future.

9. CONCLUSION

The Indian aviation market is the world's fastest-growing market and is on track to become the world's third-largest air passenger market, yet it continues to face persistent challenges in achieving sustained efficiency. Efficiency can be influenced by various potential shocks (Akhtar et al., 2023; Alsharif, 2024; Boubaker et al., 2023; Gulati et al., 2023; Riani, 2022; Tanwar et al., 2020). Therefore, it is essential to examine the responsiveness of the industry towards various market shocks. In light of this, the current study has analyzed the efficiency of the Indian airline industry comprising full-service carriers and low-cost carriers over a period of two decades from 2003-04 to 2022-23. The study period is characterized by the occurrence of three major shocks, viz., Global Financial Crisis (GFC), Demonetization, and Covid-19, on the efficiency estimates. The results indicate that LCCs perform better than FSCs. The findings are in consensus with previous studies (Huang et al., 2021; Jain & Natarajan, 2015; Sakthidharan & Sivaraman, 2018; Yu et al., 2019). The results of the Mann-Whitney test indicate the significant negative impact of GFC and demonetization on the efficiency of LCC airlines as well as the airline industry of India. However, with reference to FSC, no significant impact has been noted since the business travelers using FSCs were shielded, as most of the corporate bookings took place through corporate accounts via bank transfers and thus reduced the dependency on cash. The outbreak of coronavirus has had a profound impact on all companies owing to the strict restrictions on travel, border closures, and lockdown. The results are aligned with the previous studies conducted by Pires and Fernandes (2012) and Duygun et al. (2016).

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