IMPACT ASSESSMENT OF AIRPORT ECONOMIC REGULATION AND PRIVATIZATION ON INDIAN AIRPORTS' PERFORMANCE

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द्वारा

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पेट्रोलियम एंव उर्जा अध्ययन का विश्वविद्यालय, देहरादून –248007

डॉक्टर ऑफ फिलॉसफी की डिग्री की आंशिक पूर्ति के लिए प्रस्तुती

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I would like to dedicate this Thesis to

My parents

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DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person or material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

D. P. Singh

Sign: DSingh

Date: 1-7-2016

CERTIFICATE

This is to certify that the thesis entitled "Impact Assessment of Airport Economic Regulation and Privatization on Indian Airport's Performance" submitted by "D. P. Singh" to University of Petroleum and Energy Studies for the award of the degree of Doctor of Philosophy is a bona fide record of the research work carried out by him under our supervision and guidance. The content of the thesis, in full or parts have not been submitted to any other institute or university for the award of any other degree or diploma.

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THESIS COMPLETION CERTIFICATE

This is to certify that the thesis on "**impact assessment of airport economic regulation and privatization on Indian airport's performance**" in Partial completion of the requirements for the award of the Degree of Doctor of Philosophy (Management) is an original work carried out by D. P. Singh under our joint supervision and guidance.

It is certified that the work has not been submitted anywhere else for award of any other Diploma or Degree of this or any other University Institute.

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EXECUTIVE SUMMARY

Global airport economics and management literature revealed that in Europe and Australia lot of research has been undertaken on impact of privatization/ownership and economic regulation/regulatory approach on performance of airports. The privatization and economic regulation in India is of recent origin and there is no study available on the performance of airports in the post privatization and post economic regulation era. In view of above, this research study has been under taken for 17 major (handling more than 1,5 million passenger/year) Indian airports with the following objectives:

i. To give overview of Privatization and economic regulation
ii. To undertake the performance analysis of 17 major Indian airports through efficiency analysis in post privatization and post economic regulation era
iii. In view of efficiency trends to forecast traffic growth , capacity addition in airports and investment required in airport infrastructure for next 20 years
iv. To study the development of low-cost airports to improve air connectivity
v. To study the role development of green field airports in improving environment/sustainability of airports

In view of above objectives the thesis is presented in 10 chapter's viz. Introduction, Survey of Literature. Research Methodology and Scope Of Study, Airport Privatization and Economic Regulation, Performance Analysis of Major Airports In India, Forecasting Investment and Capacity Addition of Indian Airports, Economics of Low Cost Airport and Air Connectivity, Role of Greenfield Airports in Environmental Sustainability, Summary and Conclusion.

The economic regulation in airport infrastructure in India was implemented after privatization which resulted into the adoption of different regulatory approaches for private and public airports. In the first cycle of revision of airport charges by Airport Economic Regulatory Authority (AERA) was undertaken in 2012, the prices has been increased more than four-fold with the result that Indian airports has come in the category of costliest airports of the world i.e. consumer has not been benefited as has happened in case of competitive industry such as

telecommunication. Also the high traffic growth of Indian aviation sector, which started after introduction of low cost airlines in 2003-04, was adversely affected by steep hike in prices by private airport operators. However, the aviation has been benefited out of privatization in terms of creation of adequate capacity and quality of world class infrastructure.

In view of this the efficiency analyses of 17 major Indian airports have been undertaken based on last 3 years data (2011-2012 to 2013-2014). These 17 airports include 6 Joint Venture/Private Airports viz. Delhi Airport, Mumbai Airport, Bangalore Airport, Hyderabad Airport, Cochin Airport & Nagpur Airport. The thesis investigated that whether, Private/JV airports are more efficient than Govt. airports. Prior to adjustment to effect of economies of scale, Delhi and Bombay Airports are most efficient in combined efficiency. Delhi Airport in use of manpower, Bombay Airport in use of operating expenses, Cochin Airport in use of investment and Chennai Airport in use of debt is most efficient.

With respect to overall efficiency the study found that efficiency increases significantly with increase in size of airport i.e. Economies of Scale is most significant factor influencing efficiency. The efficiency decreases significantly with privatization of airport i.e. privatization leads to over consumption of inputs for given outputs. There is no significant difference in efficiency for use of different regulatory approaches individually. With respect to manpower efficiency the study investigated that efficiency increases significantly with the increase in size of airport only. There is no significant difference in efficiency due to private ownership and government ownership. There is no significant difference in efficiency due to difference in regulatory approach also. With respect to operating expenses efficiency it has been found that efficiency increases significantly with the increase in size of airport only. There is no significant difference in efficiency due to private ownership and government ownership. There is no significant difference in efficiency due to difference in regulatory approach also. Investment efficiency increases with size of airport significantly but decreases significantly with the combination of privatization and hybrid till i.e. privatization with hybrid till leads to overinvestment for given outputs. Debt efficiency increases with size of airport and privatization but decreases with the combination of privatization and hybrid till significantly i.e. privatization with hybrid till leads to use of over debt for given outputs. Efficiency increases significantly with government ownership and single till regulation whereas with respect to private ownership combined efficiency decreases significantly with private ownership. Private ownership in combination with hybrid till also decreases investment and debt efficiency significantly.

This study further explored that there is decrease in efficiency due to privatization i.e. privatization leads to over consumption of inputs for given outputs. Efficiency of manpower utilization is also affected by the size of the airport significantly. There is no significant difference in efficiency due to ownership or regulatory approach. Privatization with hybrid till results in overinvestment and use of over debt significantly. It has been investigated in this thesis that economies of scale are the highly significant factor affecting each category of efficiency and also all the 17 airports under study are very heterogeneous with reference scale i.e. Airport Throughput Unit (ATU). Therefore efficiencies in this study have been compared after bringing all airports on common base by adjustment of scale affect.

Thus privatization of airports has caused over utilization of scarce resources such as investible financial resources, debt, manpower and operating expenses. Privatization in combination with hybrid till has caused the consumption of excess capital resources/use of higher operational leverage and use of more debt/higher financial leverage. Economies of scale are most important factor in minimization of consumption of input resources for given outputs. Government ownership in combination with single till regulation also minimizes use of input resources for given output and needs to be encouraged in airport sector. Then the study brings out relationship between economic growth and air traffic growth, thereafter forecasted capacity addition and Investment in airport infrastructure. To meet the airport infrastructure development plans during the next 20 years, an investment of about Rs. 168578 Crores is envisaged. It has been projected that during next 17-20 years, an additional capacity of about 551.19 MPPA will be required besides the existing capacity of 233 MPPA. During next 17-20 years, 6 million metric tonnes per annum (MMTPA) Cargo Capacity is projected to be added. The supply of available skilled manpower in the aviation industry is much short of actual demand. With passengers and aircraft fleet likely to triple by 2025, the need to induct the more skilled manpower supply is the urgent requirement. Last but not least, aviation industry is typically estimated to generate indirect and induced employment of nearly six times the direct employment. With direct employment across airports and airlines to be more than 140,000 by 2030-31, the aviation sector in India is expected to provide an indirect and induced employment to additional 900,000 people by 2030-31.

In remote, hilly and inaccessible areas of the country, air transport is the quickest and sometimes the only option/ mode of transport. Thus development of regional airports in the Tier-II & III cities is essential to sustain the future aviation growth. AAI has already taken up the development of 35 non-metro airports. While the development of 27 airports has already been completed; development of 4 airports at Ranchi, Raipur, Bhubaneswar and Khajuraho shall be completed soon. Development of 27 other non-metro airports at Tier-III cities has been taken up by AAI. While the development of 15 airports has been already completed; development of 5 other airports at Kadappa, Puducherry, Bikaner, Jaisalmer & Bhatinda is expected to be completed soon. The development of Low-cost Regional Airports would require a separate regulatory framework both for safety and security. The low cost airports are likely to harvest huge untapped industrial and commercial capacities in Tier-II and Tier-III cities and open up the opportunities for investments.

While factors like cargo and passenger traffic and economic growth increases environmental degradation significantly, public policies like economic regulation and privatization try to reduce it significantly at various statistically significant levels through dispersal of traffic in smaller cities. Therefore, more similar kind of policies must be implemented in India in order to reduce environmental degradation to considerable level. Such as initiative of Government of India to development of Greenfield airports, where the intention is diversion of air traffic from existing airports located in urban areas to outskirt of urban city centers. Many of the existing airports are either in saturation stage or will be saturated in near future. Therefore, over burden of traffic will generate pollution along with many other problems and the pollution in the environment will be accumulated leading to problem of climate change. Thus development of Greenfield airports will share air traffics of existing airports and the excess pollution will be shifted to outskirt of urban city centers, where its impact will be very less due to natural environment or creation of such environment through plantation.

The outcome of this research will help aviation planners and policy makers to take appropriate decision on regulatory policies and to adopt the suitable airport structure in India. As of now major airports in India (having annual traffic more than 1.5 million) are regulated by AERA on uniform basis. Thus, the proposed study will also help aviation planners to categorize regulated airports as heavily regulated, lightly regulated and non-regulated airports. The proposed research will also help policy makers to adopt the appropriate approach to privatization and economic regulation.

The proposed impact evaluation study of privatization and regulation of Indian airports on efficiency, capacity generation, output, pricing and quality of service have rarely been observed in the literature of aviation economics, specially Comparison efficiency after eliminating the effect of size of airport, which completely revers the conclusion i.e. efficiency of private airports is lower than the efficiency of Government airports. The marginal efficiency of investment and debt for private airports is negative which leads to over investment and over debt as result of privatization. Government ownership with single till regulation is superior as compared to private ownership with hybrid till. The present study will be unique of its kind by performing impact evaluation of economic regulations and privatizations on Indian airports. Thus, along with contribution to the aviation economics literature the proposed study will have some academic importance.

LIST OF SYMBOLS

θ	: Scalar constants
λ	: Vector of constant
β	: Vector of unknown parameters
μ	: CAGR of passenger traffic
ω	: CAGR of cargo traffic

ABBREVIATIONS

ICAO	: International Civil Aviation Organization
IAAI	: International Airports Authority of India
CAD	: Civil Aviation Department
DGCA	: Directorate general of Civil Aviation
AAI	: Airport Authority of India
BOT	: Built Operate and Transfer
AERA	: Airport Economic Regulatory Authority
DEA	: Data envelopment analysis
SFA	: Stochastic frontier analysis
PPP	: Public Private Partnership
JV	: Joint Venture
ACI-ASQ	: Airport Council International – Airport Service Quality
ANS	: Air navigation services
ACCC	: Australian Competition and Consumer Commission
OMDA	: Operation Management and Development Agreement
BCAS	: Bureau of civil aviation security
CRS	: Constant Returns to Scale
VRS	: Variable Return to Scale
MOCA	: Ministry of Civil Aviation
GOI	: Government of India
DMU	: Decision Making Unit
APAO	: Association of Private Airport Operators
DIAL	: Delhi International Airport Ltd.
MIAL	: Mumbai International Airport Ltd.
BIAL	: Bengaluru International Airport Ltd.
HIAL	: Hyderabad International Airport Ltd.
CIAL	: Cochin International Airport Ltd.
MEHAN	: Company Owning & Managing Nagpur International Airport

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CHAPTER 1
INTRODUCTION

1.0 Introduction

Before formation of International Airports Authority of India (IAAI) in April 1972 all Indian airports were owned developed and managed by Civil Aviation Department (CAD) of Directorate general of Civil Aviation (DGCA). There are total 463 airstrips, which were constructed during World War II for defense use and 133 of them were converted into civilian airports after the war was over. Four metro international airports viz. Delhi, Mumbai, Chennai and Kolkata were corporatized on 1st April 1972 by Government of India through International Airports Authority of India (IAAI) act of 1972 and were transferred to IAAI for development, management and control. Impressed by performance of IAAI, National Airports Authority of India (NAAI) was formed in 1986 for construction, development and management of domestic airports in India. The NAAI was loss making organization and could not generate adequate funds for development of airports. The Govt. of India on 1st April 1995 formed Airport Authority of India (AAI) by merger of IAAI and NAAI for smooth functioning, improved coordination and balanced development of all Indian airports. In 2000 the process of privatization begun with the formation of Cochin International Airport Limited (CIAL) for development of first Greenfield Airport at Cochin. Govt. of Kerala contributed 26% in equity of CIAL by providing land for development of Airport; the remaining 74% equity was contributed by Non Resident Indians (NRI's) and other private investors. In May 2006, Mumbai and Delhi airport were also transferred to Mumbai International Airport Limited (MIAL) and Delhi International Airport Limited (DIAL) on Built Operate and Transfer (BOT) basis initially for 30 years, further extendable by another 30 years for development and management. AAI also contributed 26% in the equity of DIAL and MIAL each. In 2008 Bangalore and Hyderabad Green Field Airports were also transferred by respective state Governments to Bangalore International Airport Limited (BIAL) and Hyderabad International Airport Limited (HIAL) with 13% equity by respective state governments and 13% equity by AAI. The existing airports of Bangalore, Hyderabad and Cochin were closed for operation with commissioning of Greenfield Airports at these cities.

Subsequently, Nagpur Airport was also transferred to Multi-modal International Cargo Hub and Airport at Nagpur (MIHAN) for its construction development and management with 49% equity of AAI. Another 10 Airports are on the way to privatization and the remaining major airports will be transferred to private operators for development, construction and management subsequently.

Airports are designed and developed to support and provide infrastructure facilities to airlines. Since many decades, the airports remained as natural and public monopolies with large economies of scale. Only recently and after the corporatization and privatization, airports come under economic regulation. Particularly, during last few decades the nature of the airport industry has undergone a drastic change. The business and commercial objective with profit/ revenue maximization in a corporate frame work have been adopted by almost all airports worldwide including Indian airports in particular. Regulating the profit maximization objective and increasing the efficiency, various effective regulation and different types of privatization have been dynamically encouraged by public authority with the informed and planned aim of increasing social welfare. Thus majority of privatized airports come under economic regulation with the objective of improving efficiency and augmenting social welfare during recent decades.

With the privatization of airport the need for economic regulation was felt by Govt. of India and subsequently Airport Economic Regulatory Authority (AERA) was formed by Act no. 27 of 2008 dated 5th December 2008. As per section 13(1) of AERA act, the regulator performs various functions in respect to major airports[1], namely:-

(a) Determination of aeronautical services based on the following considerations

i. Capital expenditure
ii. Quality of service
iii. Cost of bringing in improvement in efficiency
iv. Cost effective and viable operation
v. Revenue from other sources
vi. Agreements signed by GoI

[1] Major airports are those airports which handle more than 1.5 million passenger traffic per year.

vii. Other factors not covered above

viii. Tariff may vary from airport to airport based on the cost structure and the factors mentioned above

(b) Determination of development fees;

(c) Determination of passengers service fee;

(d) Monitoring of performance standard;

(e) Other information necessary to determine the tariff

(f) Any other function assigned by central govt.

Airports worldwide had been state owned entities to provide infrastructure for airlines industry. They were monopolies in nature involving large scale of economies. In the late 1980s privatization of airport started in UK and expanded worldwide. Due to their monopolistic nature govt. of different countries felt the necessity of economic regulation to prevent the tendency of profit maximization. (Gillen D. , 2010). India is not exception to the above trend and the major six airports viz. Mumbai, Delhi, Bangalore, Hyderabad, Cochin and Nagpur have been privatized under PPP mode from 2000 to 2009. With the onset of privatization, Airport Economic Regulatory Authority (AERA) was established by an act of Parliament in 2008 for economic regulation of Indian Airports. Thus with the hypothesis that privatization and regulation have positive impact on social welfare, an effort has been bade to measure the efficiency of major Indian airports. Computing efficiency of major airports requires estimation of unknown production frontier with the help of independent input factors. Thus the objective of this study was to identify input and output factors in order to compute efficiency of major Indian airports and to estimate unknown production frontier with the help of input factors (Gillen D. , 2010).

Unlike Europe and US, the deregulation of India airports has blocked the competition with the closure of existing airports and restriction of development of green filed airports within 150kms. Former military airports have opened to serve low cost carriers within the catchment area of existing airports, substantially changing the downstream airline market and potentially impacting the airport market too.

Military airports developed during world war II were transferred for civil aviation use to serve the low cost airline in the hinter land of major commercial airports. The non-aeronautical sources of revenue were developed to augment the aeronautical sources of revenue (Zhang A. a., 2010). In case of India this has not happened. In fact the Indian airports ranking has changed from 211 to 6 thus making them the costliest airport of the world after privatization and regulation. Privatization of airports which increase the interest of govt. in benchmarking of airports with the result that IATA and ACI started AETRA survey for bench marking which was later on exclusively under taken by ACI and named as ACI-ASQ survey, which increased the airports business complexity and competition between airports (Graham A. , 2005).

With the result a number of studies were under by researcher of different countries to major the efficiency of airports through DEA and SFA technique. Also the impact of privatization of airlines on airports needs to be studied by researcher worldwide.

Efficiency estimation may be used for different purposes as brought out by Oum (1992). Productivity/ efficiency of different airports or different airport companies may be majored to help in identification of best practices. Also panel data can be used for assessing the change in level of productivity over the time. In majority of the cases the efficiency and productivity of public vis-a vis private airports have been measured (Caves, 1982), However, the measurement of factor productivity require quantitative measure of input and output. SFA technique/ regression analysis may be used to separate the impact of privatization ane economic regulation (Aigner, 1977). The DEA analysis mainly involves application of LPP techniques using software such as SPSS, STATA etc. No study on Indian airports have been undertake in this regards, however the regulatory approach, ownership and public policies contribute to airport efficiencies (Gillen D. a., 1997).

With the advent of economic liberalization during 1991 there has been increase in the economic activities and with the resultant economic boom, disposable income of individuals has reached the new peak. The real GDP per capita of India which was growing at a compound annual growth rate (CAGR) of 3.9% during 1992-2001, started growing at an accelerated CAGR of over 6% during 2014-2015. Even during the recent global meltdown, India's economy was least affected and then recovered very fast than any other economy which explains the strong economic fundamentals of India. The recent trend in economic growth reveals that India is expected to be on the high growth trajectory during the next 20 years and Indian aviation sector will be no exception to it. Thus along with growth of economy we need to develop our aviation infrastructure in order to accommodate growing needs of the future. Empirical evidence suggests that there is a direct correlation between economic development and air travel. Therefore as economy grows, Civil Aviation is

expected to grow significantly. With the increasing real GDP per capita and with the associated value of time or leisure time, demand for air travel is on rise in India. Airports facilitate business tourism, medical tourism, educational tourism, ethnic tourism, leisure tourism etc. Manufacturing and service sector activities get escalated with development of airports. In a nutshell, modern airport infrastructures are engine for economic growth and development of the nation (Domodaran, K.2015).

Before economic liberalization and introduction of open sky policy in 1991, aviation was traditionally viewed as an elite activity. The two government airlines Air India (long haul international) and Indian Airlines (domestic and short haul international) were the only Indian carriers. With the advent of open sky policy, private airlines entered into the Indian sky, first as air taxi operators and then as scheduled operators. Indian aviation sector witnessed an unprecedented change and the resultant growth after 2003. During this period, the importance of aviation for the development of business, trade and tourism was recognized and the industry saw dramatic reforms across the aviation value chain (Domodaran, K.2015).

In 2003, there were just 3 private carriers viz., Jet Airways, Air Sahara and Air Deccan, all operating full service models. The private carriers in those days were limited to operating domestic routes only. In 2015, there are 5 private carriers viz., Jet Airways, Kingfisher, Spice Jet, Indigo and Go Air are operating under 9 brand names and 3 of them are permitted to operate on international routes (Domodaran, K.2015).

During the XI Plan Period, domestic carriers embraced to the Low Cost Carrier (LCC) model. The market share of LCC during 2014-15 has crossed 40% of the total domestic traffic. As a result, Indian carriers catered to 70 million on board domestic passengers and 50 million (all international carriers) on board international passengers during 2014-15 (190 million passengers handled at airports) and earned a total revenues of around Rs. 47,800 crores.

During the XII Plan period, the domestic traffic for Indian carriers is growing at a healthy average annual rate of around 9%. The traffic growth has resulted in increased capacity utilization of domestic carriers with average passenger load factor having reached the new peak of over 76% mark during 2014-15. To cater need of the increasing demand, the domestic carriers have doubled their fleet size from around 200 to 450 during the XII plan period (Domodaran, K.2015).

Economic activity and trade are closely connected and interlinked and therefore the fruits of India's impressive growth in international and domestic trade during the XII plan have been well reaped by the Indian air-cargo industry (Domodaran, K.2015).

Total cargo traffic handled by Indian airports increased at a CAGR of 6.2% in last five years to reach 2.53 Million Metric Ton (MMT) per annum by 2014-15. International cargo, which accounts for two-thirds of the total cargo handled, is mainly concentrated at metro airports like Mumbai, Delhi, Chennai, Kolkata, Bangalore and Hyderabad. During the XII Plan period, these international airports witnessed entry of global players/ cargo handlers such as Celebi, Cargo Service Centre India Pvt. Ltd. (CSC), Menzies[2], etc. as cargo terminal operators.

Ground handling business at Indian airports has grown to reach a size of approximately over Rs.2,000 crores. This segment also witnessed increased participation of private players such as SATS, Celebi, Bird Group, Menzies[3], etc. In Joint Ventures (JVs), AIR India SATS (AISATS) is a JV between national carrier Air India and Singapore Air Transport Services. In 2011, Ministry of Civil Aviation (MOCA) announced a new ground handling policy under which only three ground handlers were allowed at each of the six metro airports in the country. One was an Air India subsidiary, the other a subsidiary of the airport operator and the third one, an entity selected through competitive bidding.

Airports Authority of India (AAI) continued its leadership in creating air connectivity across the country by incurring expenditure to the tune of Rs. 12,500 crores during the XI Plan period and Rs.70,000 crores was planned for the XII Plan period. AAI has upgraded and

[2] Celebi, CSC, and Menzies are global companies in cargo handling.

[3] SATS, Celebi, Bird Group, Menzies are global cargo handling companies.

modernized 35 non-metro airports in the country, at an estimated cost of about Rs. 4,500 crores. AAI is enhancing air connectivity in the northeast by way of Greenfield airports at Pakyong (Sikkim), Itanagar (Arunachal Pradesh) and Cheitu (Nagaland).

The private sector played a major role during the XI Five Year Plan in the development of airports through Public Private Partnership (PPP) model. These include development of Greenfield International airports at Bangalore and Hyderabad and modernization of Delhi and Mumbai international airports. Total investment made by private airport operators in the last five years being about Rs.30,000 crores, which includes investment of Rs.12,857 crores for commissioning of the 34 Million Passenger per annum capacity Terminal 3 (T3) at the Delhi International Airport and Terminal 2 (T2) of Mumbai airport at the cost of over Rs. 5000 crores.

India has become the 9th largest civil aviation market in the world. The passenger handling capacity has grown from 73 million during 2005-06 to 190 million during 2014-15, resulting more than twofold increase. The cargo handling capacity has also grown from 1.4 million MT during 2005-06 to 3.3 million MT during 2014-15 i.e. more than 2.3 fold increase. Connectivity to north eastern region has gone up from 87 flights per week to over 300 flights per week indicating a 3 fold increase. Government of India has formed Airport Regulatory Authority of India (AERA) to safeguard the interests of the users and service providers at Indian airports.

1.1 Existing Regulatory Practices at Indian Airports

The details of existing regulatory practices are described below.

1.1.1 Regulatory Approaches Adopted in India

In the context of statutory functions of AERA under the Act and regulatory objectives & principles for regulatory process, the regulatory approach on a number of important aspects are discussed below. The regulatory approaches adopted by AERA are also discussed here in the context of international examples, the context of Indian airports and air navigation services.

1.1.2 Price Cap Regulation

Price cap regulation is now a common way of setting prices in a wide range of monopoly or near-monopoly situations. Typically, the formulae for determining prices under such a cap incorporate terms that automatically reflect inflation (e.g. CPI) and it is commonly known as 'CPI-X regulation' or in exceptional situation CPI-X+Y. The 'X' factor principally takes into account the expected changes in business parameters pertaining to investments, depreciation, & cost implication of increased level of service on one hand and anticipated efficiency improvements (through reduced operating costs), and growth in volumes on the other and the benefit of Y factor is given to the airport operator if the huge investment has been undertaken recently and more investment is also required.

The formulae under such a form of regulation reflect the maximum possible percentage increase in prices over certain base parameter(s). The base parameter(s) itself can be (i) an aggregate term like yield per passenger or (ii) individual tariffs. This works with reference to a given level of base parameters at the initial year (T=0) of the regulatory cycle. These parameters are allowed to increase by the given formula. The increase (over the base parameters) is structured to give a reasonable rate of return (on investments or equity) to the investors in airport infrastructure (AERA, Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services,, 2009-10).

While the initial concept works best for firms with easy to measure unit costs, the form of regulation has evolved to account for investing and service performance as well as operating expenditure. However, in case of qualitative service parameters it is not possible to measure precisely and this has been implemented through Airport Council International – Airport Service Quality (ACI-ASQ) survey. This survey is executed by the local consultant to be appointed by the airport operator and possibility influence by the airport operator cannot be ruled out. ACI undertakes survey design, data processing and report preparation. It has been observed that overall rating is higher than all the 33 parameters included in the survey which is not feasible if the survey is executed scientifically.

In the same way as for operating expenditure, it provides incentives for an airport to develop commercial revenues (AERA, Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services,, 2009-10). Price Cap Regulation was originally proposed for economic regulation of monopoly utilities as a way of encouraging incremental improvements in performance[9] and, initially in the telecoms sector, to provide a route to eventual deregulation. Regulators in a number of countries have evolved the methods of Price Cap Regulation to address a wide range of circumstances. In the United Kingdom, CPI-X (or its UK equivalent, RPI-X) has been used in the regulation of designated airports since the privatization of British Airport Authority (BAA) in 1987 (AERA, Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services,, 2009-10). In India price cap regulation has been implemented for Airport charges that is landing, parking, housing charges (Aircraft related charges) and passenger service fees, security charges etc.

1.1.3 Rate of Return Regulation

Rate of Return Regulation is the name for a form of regulation that permits the regulated firm to set prices at such a level that it recovers its costs, including a rate of return on an appropriately defined value of capital employed.

The predominant consideration under such a form of regulation would be determination of nature of return and the appropriate base / value of capital employed. Rate of return regulation is extensively used in the US across regulated sectors and is also used at certain airports in Europe. Traditionally, this form of regulation has been primarily used for publicly owned entities. In India rate of return regulation has been implemented for air navigation services (ANS) with a view that investment in up-gradation technology is undertaken liberally and safety is not compromised.

1.1.4 Light Touch Regulation

A number of academic commentators have argued that the intrusive process of regulation itself creates distortions that can be worse than the effects of monopoly abuse (Gillen D. , 2007) and that light touch regulatory approaches can deliver better performing sectors than formal price control (AERA, Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services,, 2009-10) in competitive and non-substantial services. In this case threat of regulation restrains the airport operator for abuse of monopoly power.

Commentators and the regulatory authorities point out that an important component of light touch approaches is meaningful price monitoring and a realistic long term commitment to intruding regulation in the event of unacceptable outcomes. The light touch regulation is suitable for the services which are provided on mutually negotiated term or competitive bidding basis. These may include the firm setting prices at unacceptable levels, earning profits deemed excessive, reducing quality beyond some point or some other behavior or outcome considered a clear abuse of monopoly.

Light touch regulatory approaches in the airports sector have been adopted in New Zealand and Australia, and arguably wherever airports are free to set their own charges, subject for example to competition law constraints. Australia had a system of incentive regulation for its airports, which encountered problems, and was replaced by a loosely specified monitoring system. New Zealand has operated with no explicit regulation, but the threat of regulation exists in case performance is unsatisfactory.

In India light touch approach has been adopted for ground handling services, cargo services and oil refueling services etc. AERA has also defined the competitive services are those services where two or more service provider are operating. AERA has also defined non substantial services where the numbers of aircrafts movement are less than a pre-defined limit.

The price cap regime for airport regulation in Australia moved to price monitoring in 2002. In 2006, the Productivity Commission [10] reviewed airport performance under the new regime. Generally, airports supported the current arrangements, while airlines argued that it did not sufficiently restrain the use of market power. The Australian Competition and Consumer Commission (ACCC) was also critical of current arrangements, agreeing with the airlines that restraints on the use of market power, were unspecific and too weak.

New Zealand took a different approach to light handed regulation, sometimes referred to as Shadow Regulation. Instead of an explicit review/sanction mechanism, the New Zealand approach involved a general provision in the relevant legislation to enable a review of pricing in industries such as airports to be initiated by the Minister at any time. Though they are not formally regulated, they are subject to the threat of price controls (AERA, Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services,, 2009-10).

Academic commentators have pointed out that the assessment of light handed regulation depends on what it is expected to achieve. From a broad efficiency perspective, it has performed well, though it has not been without problems, especially those associated with investment. If the objective is to keep prices close to cost, and minimize the use of market power, the system may be seen as less successful (AERA, Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services,, 2009-10). It is also not clear whether and to what extent light touch approaches depend on the commercial, governance and regulatory traditions of a country.

Light touch approach has been used in case of cargo services, ground handling services and Aircraft refueling services where either the services are competitive or they are not substantial in nature. In case the services are non-competitive and substantial in nature then price cap regulation will be applied for the above services also. The competitive and substantial services have been defined by AERA in the revision of respective charges.

1.1.5 Single Till and Dual Till Approaches

It is a generally accepted principle, endorsed by ICAO, that airport users should pay their full and fair share of the cost of providing the airport. However, a modern airport is engaged in a complex mix of aeronautical activities (handling passengers and aircraft) and non-aeronautical activities (retail, catering, car parking, and property rents). A critical question is whether, and to what extent, non-aeronautical activities should be taken into account in determining that fair share.

One approach is to adopt the 'single till' principle, where all airport related assets and costs are taken into account in determining allowed tariff rates or return or a general price cap, after considering all revenues from non-aeronautical services (AERA, Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services,, 2009-10).

Single till approach does not make any distinction between aeronautical and non-aeronautical services at an airport and treats an airport as an integrated business and helps set airport charges so that the airport as a whole can generate appropriate returns for its investors. As a first step, total assets (aeronautical and non-aeronautical) are considered for allowing a certain return. The return is then adjusted for allowed depreciation and efficient operating expenditure (aeronautical and non-aeronautical). The adjusted return so obtained is then subsidized by the total non-aeronautical revenues to arrive at the net revenue required by the airport from aeronautical charges.

Effectively, single till uses profits from non-aeronautical activities at an airport to offset the aeronautical cost base for determining airport charges. Under this approach the allocation of costs between aeronautical and non-aeronautical services is less significant, given that the allowable revenue figure is based on total costs.

An alternative approach is to adopt a 'dual till', in which the revenues, costs and assets of an airport are allocated between two heads - aeronautical and non-aeronautical. In a pure dual till, the 'regulatory till' is made up of revenues, costs and assets (and thus the costs of financing those assets) that are solely associated with aeronautical activities plus a share of the common

costs and assets that support both aeronautical and non-aeronautical activities (AERA, Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services,, 2009-10).

Variants of the pure dual till include hybrid approaches that reflect some of the revenues, costs and assets directly associated with non-aeronautical activities in the cost base for airport charges. It is generally supposed that, under conventional cost allocation methods, non-aeronautical activities generate a higher rate of return on their assets than the airport's cost of capital. As such, a dual till approach (pure or hybrid) may tend to lead to a higher computation of required airport charges.

AERA has adopted single till approach in India however for Delhi International Airport Ltd. (DIAL) and Mumbai International Airport Ltd. (MIAL) the Operation Management and Development Agreement (OMDA) was signed before establishment of AERA and in the OMDA it was one of the condition that hybrid till with 30:70% will be applied i.e., 30% of non-aeronautical revenue will be counted towards fixation of aeronautical charges and 70% will be retained by the airport operator. In view of the above hybrid till has been applied for Delhi and Mumbai Airport, subsequently BIAL also approached AERA for the hybrid till on the pattern of Mumbai and Delhi airport.

While BIAL's letter dated 30th July 2013 indicated a request for review of proposal under what it calls as Hybrid Till, the Authority had noted, from the submissions made by BIAL that it had considered Shared Revenue Till model wherein 30% of Gross Revenues from Non-Aeronautical Services had been set off from the Aggregate Revenue Requirements computed for the Aeronautical Services, without taking into account the costs associated with providing these Non-Aeronautical services (AERA, In the matter of Determination ofAeronautical Tariffs in respect ofKempegowda International Airport (Earlier Bengaluru International Airport). , 2014.order 08/2014-14.).

A Shared Revenue till of 40% would strike an appropriate balance between the needs of expansion of the airport as well as passenger interest, in terms of keeping the user charges at reasonable level. Therefore, 40% of gross revenue generated by BIAL from Non Aeronautical Services may be reckoned towards subsidizing Aeronautical charges and User Development Fees (UDF) (AERA, In the matter of Determination ofAeronautical Tariffs in respect ofKempegowda International Airport (Earlier Bengaluru International Airport). , 2014.order 08/2014-14.). However AERA accepted Hybrid till with 40:60 ratios. At remaining 14 airports single till approach has been adopted.

The remaining part of the thesis is as follows. The chapter 2 describes survey of literature of airport and aviation sector followed by research methodology and scope of study in chapter 3. Airport privatization and economic regulation is explained in chapter 4. Performance analysis of major airports are presented in chapter 5 followed by forecasting investment and capacity addition of Indian airports in chapter 6. While economics of low cost airport and air connectivity is described in chapter 7, role of Greenfield airports in environmental sustainability is explained in chapter 8. Finally, the summary and conclusion of the thesis is given in chapter 9.

CHAPTER 2
SURVEY OF LITERATURE

2.0 Brief Literature Review

In order to identify the business problems, to detect research problems, to find out research gaps, to formulate research objectives and to adopt research methodologies for the present study a brief literature review was conducted as described below.

2.1 Regulation and Competition in Airports Sector

The neoclassical theory of the firm states that competition leads to increased productive and allocative efficiency as a result of lower prices and higher outputs. In the case of indivisibilities, as typically occurs in the provision of infrastructure based services and utilities, one large firm might be able to produce at lower costs leading to monopolistic conditions. In this case, in order to encourage efficiency and avoid abuse of market power, the natural monopolist should be subject to economic regulation (Lipczynski, 2009).

In Europe, airport charges have traditionally been regulated according to a rate of return or cost-plus principle (Reinhold, 2010). Such regulation permits airports to generate sufficient revenue to cover total expenditures, including the depreciation of capital and an expected rate of return on capital. However, according to Johnson (1962), this form of regulation may lead to overcapitalization, which does not engender productive efficiency. To solve the problem of overinvestment, Littlechild (1983) proposes an incentive based price-cap regulation. Price-caps are generally set over a regulatory period of five years according to the RPI-X formula where RPI represents the retail price index and X is the efficiency improvement that the regulators consider reasonable within the timeframe. If the airport management achieves greater cost reductions over the five year period, the gains are enjoyed by the company. In the case of airports, the single till principle is applied in the UK, in which case both aeronautical and non-aeronautical revenues are constrained. Over the years, price-cap regulation has been emulated by other European authorities. Compared to traditional rate of return regulation, Gillen (2008) provided a comprehensive overview of the current economic regulation at European airports.

Price-cap creates incentives for cost savings hence encourages efficiency, however it equally may lead to underinvestment on the part of firms with heavy infrastructure sunk costs. Consequently, it may be necessary to regulate in order to ensure a reasonable level of quality with respect to the products or services offered. Another approach to stimulate efficiency is yardstick competition originally proposed by Shleifer (1985). This form of regulation implies virtual competition amongst regulated firms by comparing their cost levels and determining the permitted price based on an average level. Common approaches utilized to assess appropriate cost levels for regulated firms, which include frontier techniques such as DEA and SFA. In addition, the cost function must be corrected to take into account external heterogeneities. Factors, such as geographical constraints, may affect airport costs but are considered to be beyond the control of the airport management. Whereas yardstick competition evolved to a standardized approach in the British water and railway industries, it is yet to be applied to airports. To the best of our knowledge, the Dublin Airport Authority (DAA) is the only European example that attempted to implement yardstick competition in 2001. However, it was highly criticized by airport management for identifying inappropriate peer airports Reinhold (2010) and was discontinued. The British CAA argued that the heterogeneous character of airports and the challenge to obtain appropriate data contribute to their reluctance to apply this type of economic regulation (British Civil Aviation Authority, 2000) .

In the theoretical literature, the debate as to the necessity for and type of airport regulation seems to be rather controversial. Gillen (2008) argued in favor of price-cap regulation but also that commercial and ground handling activities might be disciplined to some extent by potential competition, hence the dual till price-cap approach was preferable. Czerny (2006) argued that market power exists in both the aeronautical and commercial spheres of activity. For non-congested airports, he suggested that the single till outperforms dual till price-cap regulation in maximizing social welfare. For large, congested airports, Beesley (1999) argued that the single till is inappropriate because increasing concession profits would lead to lower airport charges over time. In addition, Starkie (2002) found no evidence of economies of scale for airports with large throughput and argued that demand complementarities across aeronautical and terminal activities will prevent airports from abusing market power, obviating the need for any regulation. In particular, airports generating additional revenues from non-aeronautical activities are likely to lower their charges and cross-subsidize using commercial revenues in order to attract both passengers and airlines (Zhang, 2010).

To the best of our knowledge, the impact of regulation on efficiency and airport pricing has been empirically investigated by very few scholars. Marques (2008) incorporated a dummy variable defining cost-plus or price-cap regulation in order to assess a worldwide set of airports from 2003 to 2004, estimating a heterogeneous cost frontier utilizing stochastic frontier analysis. They found that regulatory procedures contribute to cost savings. Oum (2004) collected data on worldwide airports for the years 1999 and 2000, and applied gross endogenous-weighted total factor productivity to study various forms of regulation including single and dual till concepts. The results indicated that airports under dual till price-cap regulation tend to have higher levels of gross total factor productivity than those with a single till price-cap or those that operate under the single till rate of return regulation. Furthermore, dual till approaches together with rate of return regulation appear to provide incentives to improve efficiency but are very complex to estimate. Bel (2010) examined the impact of privatization, regulation and regional and intermodal competition on airport charges at European airports in 2007. Utilizing regression analysis, they revealed that competition with nearby airports and other transport modes is likely to decrease the potential to abuse market power. Furthermore, private unregulated airports charge higher prices than public and regulated airports thereby supporting the analytical findings of (Oum, 2004). Dender (2007) assessed the US market between 1998 and 2002 utilizing an econometric approach and similarly found that airports under regional competition charge lower fees. He also argued that slot-constrained airports are likely to charge higher aeronautical fees, which are explained by the airport management's ability to capture scarcity rents.

2.2 Privatization and Ownership of Airports

With the stated aim of reducing government involvement, minimizing costs and maximizing productivity, a wave of airport privatizations began in the late eighties in UK. Due to successful initial public offerings and increasing share prices, many European countries began to partially privatize their airports in the mid-nineties (Gillen, 2008). Reviewing the theoretical literature on privatization, its effects seem to be somewhat controversial. Sappington and Stiglitz (1987) argued that the transaction costs of government intervention are lower under public ownership. In a similar vein, (Shapiro, 1990) had a view that the government is better informed and more capable of regulating state-owned firms. Opponents of this point-of-view sought evidence to demonstrate that state intervention leads to inefficiency. Shleifer (1994) for example opined that the relationship between politicians and managers is governed by incomplete contracts leading to inefficient incentives. In addition, the emergence of partially privatized models complicates the debate as to the effects of ownership on productivity. Vining (1989) reviewed the effects of mixed ownership structures based on theoretical arguments and empirical studies. He found that large, industrial, partly privatized and state-owned companies perform in a less productive and profitable manner than their fully private counterparts, which might be caused by the public and private shareholders' differing objectives. Considering the issue to be more complex, Yarrow (1991) remarked that privatization is not a universal solution to the agency problem in the public sector and should not be separated from the economics of competition and regulation which are all determinants of corporate incentives.

Over the past two decades, there has been a trend of privatization of ownership and management of airports. Regional patterns in ownership forms have emerged largely. Privatized airports are common in Australia and New Zealand, while partial privatization is more common in Europe. In many cases, an airport may be owned by one entity and operated by another. In the event that an airport is publicly owned and operated or publicly owned and operated by a not-for-profit organization, is highly likely that the airport will pursue non-monetary objectives in addition to earning a return for shareholders (Productivity Commission 2011, 14 December 2011).

2.3 Efficiency and Ownership of Airports

Parker (1999) employing DEA technique to estimate the technical efficiency opined that British Airport Authority (BAA) remains subject to economic regulation and hence incentives to operate more efficiently are distorted as a result of government intervention. There are several tasks to be performed to analyze airport regulation. One of these is to observe the ownership and regulatory pattern in a city or country, and seek to explain it in terms of efficiency and other objectives. Another task is to outline which approaches to airport ownership and regulation are most likely to be conducive in efficient operation of airports-have some countries implemented promising models, and are the approaches taken by others flawed? Finally, there is the task of assessing what ownership and regulatory frameworks can best promote efficiency while recognizing the constraints imposed by the non-efficiency objectives imposed by governments- does a particular framework represent a good compromise between objectives and is it possible to meet the non-economic objectives at less cost in terms of efficiency (Gillen, 2007)?

Empirical studies that attempted to assess the effects of ownership on the efficiency of airports are so far rather inconclusive. Parker (1999) employed DEA technique to estimate the technical efficiency of the BAA airports between 1979 and 1996 covering pre and post privatization period. He did not found any evidence in support of complete privatization leading to improved technical efficiency. He advocated that the UK government's golden share limits the impact of capital market pressures. Furthermore, he opined that BAA remains subject to economic regulation and hence incentives to operate more efficiently are distorted as a result of government intervention. In contrast, Yokomi (2005) analyzed the technical and efficiency change of six BAA airports from 1975 to 2001 by utilizing Malmquist DEA. As opposed to Parker, Yokomi found that the BAA airports exhibit positive changes in efficiency and technology as a result of the privatization. It should be noted that commercial growth after privatization was substantial; however this activity was not considered in Parker's analysis.

The effects of different ownership forms on efficiency were also analyzed but again the results have not reached clear conclusions. Dieke (2007) analyzed 31 Italian airports from 2001 to 2003 using DEA in the first stage and Mann-Whitney hypothesis testing in the second stage, to reveal that private airports operate more efficiently than their partially private counterparts. Hong (2006) found no connection between ownership form and efficiency after analyzing a dataset of worldwide airports for the years 2001 and 2002 utilizing DEA and hypothesis testing. Oum et al (2006, 2008) distinguished between public airports owned by public corporations and those owned by more than one public shareholder (multilevel). Referring to (Charkham, 1995), they argued that different ownership and governance structures affect the quality of managerial performance. Oum et al. (2006) analyzed a sample of 100 airports worldwide, covering the years 2001 to 2003 and utilizing variable factor productivity. They concluded that the productivity of a public corporation is not statistically different from that of a major private airport. However, airports with major public shares or multiple government involvement operate significantly less efficiently than other ownership forms. Oum et al. (2008) estimate a heterogeneous trans-log cost function with stochastic frontier analysis on a similar set of airports as that of Oum et al. (2006), measuring cost efficiency between the years 2001 and 2004. They found that airports with major private shareholders are more efficient than public airports, particularly those with a major public ownership structure.

2.4 Deregulation and Competition in Airport Sector

The traditional perspective of airports behaving as monopolists has changed as a result of the deregulation of the downstream aviation industry according to Kincaid (2010). Today, competition for airport services covers a multiplicity of markets including (1) a shared local catchment area, (2) connecting traffic through regional hubs and international gateways, (3) cargo traffic, (4) destination competition, (5) non-aeronautical services, (6) competing ground handling companies and off-site car parks and (7) alternative modes of transport such as high speed rail in the medium distance markets. Amongst the empirical literature, only Yuen and Zhang (2009) examined the effects of regional competition utilizing a Chinese airport dataset for the years 1995 to 2006. After applying DEA in the first stage and ordinary least squares in the second-stage, they observed that airports operating in a locally competitive environment tend towards efficiency. However, the outcome of their Tobit regression found competition intensity to be insignificant. Whereas research to date has analyzed the individual effects of ownership, regulation and competition on efficiency, the joint impacts may be of great interest as argued by Weyman-Jones (1992) that the degree of competitiveness in a firm's market, the extent to which it is incorporated as part of a public-sector bureaucracy, and the nature of the regulatory regime under which a firm operates are all primary sources of possible X-inefficiency. Consequently, his intention was to assess the combined impact of ownership structure and economic regulation given relevant levels of local and hub competition. A well-functioning air transport sector offers significant economic development benefits, particularly for landlocked, isolated, and low population- density countries (Bank T. w.). The ever growing demand for air travel has put pressure on airports to enhance their capacity in order to continuously provide smooth service to passengers (Zou, 2015).

2.5 Investment and Demand Forecasting in Aviation Sector

Aviation is a driver of economic and social development of a country. The turnover of the Indian Aviation sector today exceeds Rs 1 lac crores. Private sector has played an unprecedented role for developing the airport sector in the country (Domodaran, 2015). Air transport demand forecasts of the aircraft industry and institutions like ICAO (International Civil Aviation

Organization) use the number of passenger kilometers, counted as revenue passenger kilometers (RPK), as a unit of demand (Gelhausen, 2013).The demand as measured in RPK grew even stronger than the number of passengers in the sixteen year period from 1994 to 2010; the demand more than doubled and increased with an average growth rate of 5% (Boeing, 2010).

The studies of liberalization and foreign direct investment in the aviation sectors of India, People's Republic of China, and Thailand highlighted a number of key points. First, greater competition has developed within domestic markets, including from privately owned airlines and especially from low-fare carriers. Second, higher levels of foreign participation in airline operations would provide funding and management capacity that would support the adjustment process required in the incumbent carriers (Findlay). The long term forecasts of Boeing and Airbus as well as that of the ICAO have in common a continuation of the past development over the next 20 years and they assume further liberalization of air transport in the future as one of the key drivers of growth, especially in Asian and African regions (Gelhausen, 2013). The number of passengers transported worldwide in air transportation has reached a volume of almost 2500 million in 2010 (ICAO, 2011).

The entry of low-cost carriers pioneered by Air Deccan helped greatly reduce the costs involved in flying. This helped attract consumers for whom air travel was only a dream. Now a number of low-cost airlines are operating in India, namely Go Airways, Spice Jet, and Kingfisher Air, and they have a major share of the Indian aviation sector. Thus, domestic participation in this industry is projected to grow by 25–30% and internationally by 15%, increasing the potential customers by about 100 million in 2010. Also, by 2020 the cargo section is projected to rise to approximately three million tonnes (Bank T. W.). International markets contribute16% in terms of traffic generation and 29% of all connecting passengers in the US airport network (Suau-Sanchez, 2015).

FDI inflows in air transport (including air cargo) during April 2000 to January 2015 stood at US$ 562.65 million, Air Costa plans to add eight aircrafts before 2016 to its existing, Boeing is planning to set up an aircraft manufacturing base in India, Vistara has signed inter-line agreements with Singapore Airlines and Silk Air, Tata Group has launched its full-service Vistara airline on January 9, 2015 (IBEF, 2015). Air Transport can play a key role in economic development and in supporting long-term economic growth. It facilitates a country's integration into the global economy, providing direct benefits for users and wider economic benefits through its positive impact on productivity and economic performance (ATA.).

The biggest problem in India is the liquidity crunch. Indian aviation as such does not have money to pump. So the alternate is to invite FDI (Vidhusekhar). DGCA guideline suggests that in Greenfield projects, FDI up to 100% is allowed under the automatic route. In case of existing projects, FDI up to 74% is allowed through automatic route and beyond that and up to 100%, with prior approval of the Government (DGCA, 2013).

The policies of the Indian government encourage foreign participation. Government allows 100% FDI via the automatic route for the green field airports. Also, foreign investment up to 74% is permissible through direct approvals while special permissions are required for 100% investment. Private investors are allowed to establish general airports and captive airstrips while keeping a distance of 150 km from the existing ones. Complete tax exemption is also granted for 10 years. About 49% FDI is allowed for investment in domestic airlines via the automatic route. However, this option is not available for foreign airline corporations. Complete equity ownership is granted to NRIs (Non Resident Indians). Foreign direct investment up to 74% is allowed for non-scheduled and cargo airlines. Thus, all these policies promote foreign investment in this industry (Bank T. W.).

If traffic reaches levels that are close to the maximum throughput of the runway system then the airport encounters not only problems of maintaining good quality of operations but is faced with the fact that future traffic growth cannot be accommodated any more (Gelhausen, 2013). Some important airports, partly main hub airports, struggle already since years with capacity constraints, among them: London Heathrow, Frankfurt, Paris Charles de Gaulle in Europe, and New York LaGuardia in the USA (Gelhausen, 2013). The Indian aviation industry is forecasted to grow phenomenally in the coming years. The Vision 2020 announced by the Civil Aviation Ministry conceives of building infrastructure to support 280 million customers. Investments to the extent of US$ 110 billion are envisaged by 2020. About US$ 30 billion for development and sprucing up of existing airports and US$ 80 billion for building new fleets is being estimated (Bank T. W.).

2.6 Development of Greenfield Airports and Environmental Sustainability

Greenfield airports are the airports, which are developed on the new site- on the agricultural lands and in some cases it involves forest land either partly or fully. Government of India has announced the development of 100 green field airports during UPA II government to give boost to the economic development of the country and improve the air connectivity to Tier II and Tier III cities. Green field airports play a significant role in accelerating the urbanization of the country though at the same time development of green field airports has some adverse environmental impacts such as use of agricultural land, deforestation, cutting of hills, diversion of rivers and erosion of the sea shores etc. All these adverse environmental impact have significant ramification on environment. On the other hand airports are needed for development of economy, trade and tourism, urbanization and for cultural and religious integration. In view of the above GoI is adopting a balance approach between positive and negative impacts of development of Greenfield airports.

The United States General Accounting Office (2000) and the Congressional Research Service (2007) outlined some of the impacts of operation of airports on the environments. These impacts mostly related to air and water quality and noise pollution issues likely to be caused by activities like deicing and anti- icing activities, fuel storage problems and emissions of toxic air pollutants. The latter also so outlined were potential regulatory changes and incentives for airports to invest in suitable abatement technologies.

In a study on assessing the environmental impact of the addition of 3rd Airport at Istanbul, Byrakdar and Durmaz observed that the City and its nearby areas are likely to suffer significant environmental damage in terms of loss of productive agricultural land, meadows, wetlands along with loss of habitat and ecosystem of migratory birds. It is anticipated that such damage will lead to environmental devastation in the form of air pollution, drought and climate change.

Corpus et al. (2012), on the potential impact of the expansion of Hong International Airport, have demonstrated that despite the negative impact of such a development in the form of higher quantum of noise and air pollution, local residents are likely to support such initiatives in anticipation of greater economic benefits in the form of more jobs and better access to transport. Mullen -Gray has observed that air quality and noise pollution remain key concerns in the development of airports. Advocating the benefits of development of airports on environment he opined that airports are likely to function as preserves or conservation areas for natural resources that may be threatened by development "beyond the fence." Even now, perhaps inadvertently, managers of large air carrier airports in urban areas might find themselves effectively serving as custodians of special-status species (plant and animal), remnant landscape units, rare geological formations, wetlands of various types, aquifers, and surface water bodies.

In a study on health and environmental impact of upgradation of airport infrastructure with the expansion of Kuala Lumpur Airport, Sahrir et al. (2014) have found that increase in construction and land use intake had significant relations with the noise and particulate matter (PM) levels. It was observed that PM levels at the surrounding living area were above the recommended levels.

Celikel et al. have highlighted the importance to carry out trade-off assessments to understand the interrelation of different environmental impacts of proposed operational decisions in the aviation sector and to determine the economic effects of each decision. The feasibility of such an approach has been demonstrated through an example using Preferred emissions route (PER) and Preferred noise route (PNR) scenarios. One of the important aspects of the study has been to demonstrate that the combined use of airspace simulation, environmental and economic tools, makes trade-off assessment feasible for any kind of scenarios, and adds value to operational project evaluation.

From the review of literature we come to know that (i) the impact of privatization of Indian airports on efficiency and output (ii) impact of economic regulation of airports on efficiency and output, and (iii) the combined effect of privatization and regulation of Indian airports on efficiency and output have rarely been observed in the literature of aviation economics. Thus in view of this the present study will be unique of its kind to perform impact evaluation of economic regulations and privatizations on Indian airports.

India is an emerging country and privatization and regulation of airports are of recent origin. With the privatization of airport the need for economic regulation was felt by Govt. of India and subsequently Airport Economic Regulatory Authority (AERA) was formed on 5th December 2008. Much of the literature cited above analyzed the effect of privatization and regulation of airports in Europe and Australia. Hardly any scholars have studied the same in Indian context. In fact no study has been conducted on impact of privatization and economic regulation of Indian airports. In view of the research problem it will be in fitness of things to assess the impact of privatization and regulation on efficiency and output of Indian airports. So we believe that the proposed study will help in bridging this huge gap that has been observed in literature.

2.7 Concluding Remarks

After brief literature review the overarching research questions arises are what is the impact of privatization and economic regulation of Indian airports on efficiency, capacity generation, output, pricing and quality of service. Have the efficiency and output of Indian Airports not been changed after privatization? Have the efficiency and output of Indian airports not been changed after Economic Regulation? Have the efficiency and output of Indian Airports not been changed during joint operation of Privatization and Regulation?

This thesis attempted to answer the above mentioned questions by identifying the business problems, detecting research problems, finding out research gaps, formulating research objectives and adopting research methodologies as described in the following chapter.

CHAPTER 3

RESEARCH METHODOLOGY AND SCOPE OF STUDY

3.0 Business Problem

Privatization refers to transfer of ownership or control or both from government to private either partially or fully. Airport economic regulation refers to the regulation of aeronautical charges for major airports. Major airports are those airports handling more than 1.5 million Passenger traffic per ear. There are 16 major airports in India. In context of the Indian airports privatizations commenced in 2000 with privatization of Cochin Airports and the last phase was completed in May 2009 with the privatization of Bombay and Delhi Airports. Bangalore and Hyderabad was commissioned in March 2008 by private operators. Airport economic regulation commenced working in May 2009 after establishment of AERA in 2008.

It has been observed that in spite of infusing huge capital (INR 50,000 Cr.) in 6 metro airports, 35 major non-metro airports and 27 other airports during XI five year plan during the phase of privatization, the growth rate of airport output in terms of air traffic has been declining continuously (specially the domestic passenger traffic) from 38.6% in 2006-07 to -4.2% in 2012-13 (refer annexure I to V). This has adversely affected the profitability of Indian airports and consequently the airport price has been increased substantially to compensate the losses *(i.e. DIAL Tariff Order received from AERA – An increase of 352% on Aero Charges approved w.e.f. 15th May 2012:*[4] (meeting)). Also there is a surplus capacity to the tune of 30 million per annum at the end of V five year plans as against shortage of capacity during previous plan.

In view of the above it becomes important to measure the efficiency of airports after privatization and economic regulation; and also to major the effect of privatization and economic regulation on output of airports.

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[4] http://www.gmrgroup.in/Investors/pdf/Financial_Overview_Q4FY12.pdf

3.1 Research Problem

From the review of literature we come to know that (i) the impact of privatization of Indian airports on efficiency and output (ii) impact of economic regulation of airports on efficiency and output, and (iii) the combined effect of privatization and regulation of Indian airports on efficiency and output have rarely been observed in the literature of aviation economics. The present study will be unique of its kind. It can perform impact evaluation of economic regulations and privatizations on Indian airports.

3.2 Research Gap

India is an emerging country and privatization and regulation of airports are of recent origin. With the privatization of airport the need for economic regulation was felt by Govt. of India and subsequently Airport Economic Regulatory Authority (AERA) was formed on 5th December 2008. Much of the literature cited above analyzed the effect of privatization and regulation of airports in Europe and Australia. Hardly any scholars have studied the same in Indian context. In fact no study has been conducted on impact of privatization and economic regulation of Indian airports. In view of the research problem it will be in fitness of things to assess the impact of privatization and regulation efficiency and out of Indian airports. So we believe that the proposed study will help in bridging this huge gap that has been observed in literature.

3.3 Research Question

The research question in the proposed study is what is the impact of privatization and economic regulation of Indian airports on efficiency, capacity generation, output, pricing and quality of service. In view of the identified research gap the following are the research questions have been formulated:

- i) Have the efficiency and output of Indian Airports not been changed after privatization?
- ii) Have the efficiency and output of Indian airports not been changed after Economic Regulation?
- iii) Have the efficiency and output of Indian Airports not been changed during joint operation of Privatization and Regulation?

3.4 Research Objectives

Following are the research objectives-

i) To give overview of Privatization and economic regulation

ii) To undertake the performance analysis of 17 major Indian airports through efficiency analysis in post privatization and post economic regulation era

iii) To forecast traffic growth , capacity addition in airports and investment required in airport infrastructure for next 20 years

iv) To study the development of low-cost airports to improve air connectivity

v) To study the role development of green field airports in improving environment/sustainability of airports

The detail study of the above objectives were justified further with the help of (i) forecasting investment and capacity addition for Indian airports, (ii) assessing economics of low cost airport and air connectivity in India and finding out impact of development of Greenfield airports on environment and urbanization to assess the sustainability.

The aim of this research is therefore to analyze the impact of the structural changes in the aviation markets on airport efficiency and pricing in order to further our understanding of the most appropriate ownership form and regulatory regime.

The dataset in the proposed study will be taken from Indian airports in order to include a sufficiently heterogeneous sample with respect to the ownership structure and regulatory mechanism. The empirical results derived from DEA and Regression analysis will be analyzed to know that under relatively non-competitive conditions, airports should be regulated to encourage cost efficiency or not. It is also proposed to study whether airports of any ownership form under monopolistic conditions are likely to abuse market power and set higher aeronautical charges. It will also be studied whether unregulated and fully private airports require economic regulation or not. The data from 1995-96 to 2013-14 are proposed to be collected and analyzed using DEA and SFA tools.

The proposed study will be based on the secondary data collected from AAI airports and Joint venture airports on the capacity, efficiency, output, quality of service and pricing using Data Envelopment Analysis and Multivariate Regression Analysis.

3.5 Theoretical Framework

Output in context of airports is generally related to aircraft movement, passengers and cargo traffic. Similarly, inputs include number of employees, staff costs and other operational cost. Now our production function of airports is a function of the above mentioned inputs, which can be defined mathematically as:

$$Q_{it} = f(NE_{it}, SC_{it}, OC_{it}) \qquad (1)$$

Where,

Q_{it} : Output of the i-th airport in t-th time period in terms of aircraft movement, passengers and cargo traffic

NE_{it} : Number of employees of i-th airport in t-th time period

SC_{it} : Staff cost of i-th airport in t-th time period

OC_{it} : Other operational cost of i-th airport in t-th time period

Because we have multiple output and multiple inputs so let us assume that there are N inputs and M outputs for each of I airports. For the i-th airport these are represented by the column vectors x_i such as number of employees, staff costs and other operational costs etc. and q_i such traffic (aircraft movement-passengers and cargo), non-aeronautical revenue, aeronautical revenue, total revenue, profit etc. respectively. The NxI input matrix, X, and the MxI output matrix, Q, represent the data for all airports.

In order to estimate the efficiency of airports we use frontier framework by formulating it in linear programming technique. Frontiers have been estimated using many different methods over the past 60 years. Adequate amount of literature in this context have been observed in Lovell (1993).The two principal methods that have been used are Data Envelopment Analysis (DEA) and Regression Analysis, which involve mathematical programming and econometric methods, respectively.

3.6 Estimating Airport Efficiency through Data Envelopment Frontier Framework

In DEA we use linear programming to construct a non-parametric piece-wise surface over the data. This surface is known as frontier. Relative to this surface efficiency measures are calculated. There is a large amount of literature available in (Seiford L. R., 1990), (Lovell C. , "Production Frontiers and Productive Efficiency", in Fried, H.O.,, 1993), Lovell (1994) (Lovell C. , Linear Programming Approaches to the Measurement and Analysis, 1994), (Chames A. W., 1995), (Seiford L. , 1996), (Cooper W.W., 2000), (Fare R. S., 1985) (Fare R. S., 1994), (Thanassoulis E. , 2001)), and (Coelli, Rao, O'Donnell, & Battese, 2005) on efficiency measurement using DEA.

Being dissatisfied with the (Farrell, 1957) approach of the piece-wise-linear convex hull to frontier estimation, which was also considered by only a few authors, scholars like (Boles, 1966), (Shephard, 1970) and (Afriat, 1972) suggested mathematical programming methods that could achieve the task of measuring efficiency. However, this method was not widely recognized till the scholars like (Chames A. W., 1978) used DEA in their research work. Since then a large number of papers have appeared which have extended and applied the DEA methodology to measure efficiency (Coelli, Rao, O'Donnell, & Battese, 2005).

Using the duality in linear programming, we derive an equivalent envelopment form of CRS as suggested by (Coelli T. a., 1980-2000) :

$$\begin{aligned} &\min_{\theta,\lambda} \theta, \\ &st \quad -q_i + Q\lambda \geq 0, \\ &\qquad \theta x_i - X\lambda \geq 0, \\ &\qquad \lambda \geq 0, \end{aligned} \tag{2}$$

Where, θ is a scalar and λ, is a Ix1 vector of constants.

We assume in the above LP formulation that there are N inputs and M outputs for each of I firms. For the i-th airport these are represented by the column vectors x_i such as number of employees, staff costs and other operational costs etc. and q_i such traffic (aircraft movement-passengers and cargo), non-aeronautical revenue, aeronautical revenue, total revenue, profit etc. respectively. We also assume Q as *M*x*I* output matrix, represent for all I airports and X is the *N*x*I* input matrix.

However, (Coelli T. R., 2005) have advocated that constant returns to scale (CRS) assumption is appropriate when all firms are operating at an optimal scale. Therefore, they argued that imperfect competition, government regulations, constraints on finance, etc., may cause a firm to be not operating at optimal scale. The use of the CRS specification when not all firms are operating at the optimal scale, results in measures of technical efficiency (TE) that are confounded by scale efficiencies (SE). Thus the use of the VRS specification permits us the calculation of TE devoid of these SE effects in airport sector.

However, due to the above mentioned limitation the CRS linear programming problem is modified as suggested by (Coelli T. R., 2005) to account for VRS by adding the convexity constraint: $I1'\lambda = 1$ to equation 1 to provide:

$$\begin{aligned} &\min_{\theta,\lambda} \theta, \\ &st \quad -q_i + Q\lambda \geq 0, \\ &\qquad \theta x_i - X\lambda \geq 0, \qquad (3) \\ &\qquad I1'\lambda = 1 \\ &\qquad \lambda \geq 0, \end{aligned}$$

Where, I1 is an Ixl vector of ones.

This approach forms a convex hull of intersecting planes that envelope the data points more tightly than the CRS conical hull and thus provides technical efficiency scores that are greater than or equal to those obtained using the CRS model (Coelli, Rao, O'Donnell, & Battese, 2005).

The convexity constraint $I1'\lambda = 1$ essentially ensures that an inefficient airport is only "benchmarked" against airports of a similar size. That is, the projected point (for that airport) on the DEA frontier is a *convex* combination of observed airports. This convexity restriction is not imposed in the CRS case. Hence, in a CRS DEA, an airport may be benchmarked against airports that are substantially larger (smaller) than it. In this instance, the λ-weights sum to a value less than (greater than) one. Thus the value of θ obtained in this framework analysis is the efficiency score for the *i-th* airport.

3.7 Estimating Airport Efficiency in Regression Analysis

In data envelopment frame work, we consider a measure of the economic efficiency of airports through technical efficiency, which measures the ability of the firm to obtain the maximum output from given inputs; and through allocative efficiency, which measures the ability of the airports to use inputs in optimal proportions given their prices. Computing these efficiency measures involves estimating the unknown production frontier. In this section, we consider methods for estimating the efficiency parametrically in a regression analysis.

We use the econometrics model of the form:

$$\theta_i = x'\beta + u_i \tag{4}$$

Where θ_i represents the efficiency of the i-th airport; x_i is a Kx1 vector containing the independent variables; β is a vector of unknown parameters; and u_i, is a non-negative random variable.

3.8 Research Methodology and Scope of Study

The proposed study will be based on the secondary data collected from AAI airports and Joint Venture airports, for 17 Major Airports, on output and inputs as given in section 3.10 using Data Envelopment Analysis and Multivariate Regression Analysis.

3.9 Scope of study

To minimize heterogeneity only 17 Major airports viz.. Mumbai, Delhi, Bengaluru, Hyderabad, Cochin, Nagpur, Chennai, Kolkata, Trivandrum, Ahmedabad, Goa, Calicut, Guwahati, Jaipur, Srinagar, Amritsar and Port Bair airports are proposed to be covered. Because the other airports are much smaller in size and are publically operated and are not comparable with the Metro Airports and therefore that has been excluded from the study.

3.10 Data Requirement

The airports covered in this thesis for each objective are Mumbai, Delhi, Bengaluru, Hyderabad, Cochin, Nagpur, Chennai, Kolkata, Trivandrum, Ahmedabad, Goa, Calicut, Guwahati, Jaipur, Srinagar, Amritsar and Port Bair. Data requirement is given in Table 3.1 below

Table 3.0-1 Data to be collected

Objective	**Data collected (2011-12-2013-14)**		**Data Source**	**Model Used**
	Output	Input		
1	Traffic data on aircraft movement, passenger, cargo, and Revenue	Number of Employees, Operation cost, Depreciation/Investment and Interest/Debt	Concerned airport operators	DEA/ Regression using Dummy variable for Privatization and Regulation
2	Traffic data on aircraft movement, passenger, cargo, and Revenue	Number of Employees, Operation cost, Depreciation/Investment and Interest/Debt	Concerned airport operators	DEA/ Regression using Dummy variable for Privatization and Regulation
3	Traffic data on aircraft movement, passenger, cargo, and Revenue	Number of Employees, Operation cost, Depreciation/Investment and Interest/Debt	Concerned airport operators	DEA/ Regression using Dummy variable for Privatization and Regulation

Besides above data about air traffic, air pollution, GDP and IIP will also be collected for 20 or more years.

3.11 Research Methodology

Objective-1: To give overview of Privatization and economic regulation

The methodology adopted for this objective is based on the review of AERA orders viz. (i) Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services (AERA, 2010), (ii) In the matter of Determination of Aeronautical Tariff in respect of IGI Airport (AERA, 2012) and (iii) In the matter of Determination of Aeronautical Tariffs in respect of Kempegowda International Airport (Earlier Bengaluru International Airport) (AERA, 2014).

Objective-2: To undertake the performance analysis of 17 major Indian airports through efficiency analysis in post privatization and post economic regulation era

In order to assess the impact of privatization of Indian airports on airport output and efficiency we have used DEA technique for efficiency and Multiple Regression with combination of dummy variables continuous variable technique (as mentioned in theoretical frame work section) to estimate efficiency.

Objective-3: To forecast traffic growth, capacity addition in airports and investment required in airport infrastructure for next 20 years

The historical data collected from AAI for the period 1995-96 to 2014-15 for all Indian airports traffic (together) has been used for econometric modeling. World GDP and GDP of India have been used as explanatory variable for forecast of International passengers and domestic passengers respectively. Index of industrial production has been used as explanatory variable for forecast of Cargo traffic.

Initially, trend analysis with linear model and econometric analysis with linear regression model, double log/ exponential model taking real GDP of India as independent variable and air passenger traffic as dependent variable were undertaken. However, we got some disadvantage in linear models that are it starts underestimating in the future and underestimates continue to increase with increase in time horizon in long term forecast and therefore were not selected. The final double log model was selected because it gives increasing increments with the increase base of traffic which is validated statistically, based on 20 years historical data for air traffic. The growth rate arrived from econometric models has been adjusted for qualitative factors and expected economic policies. Adjustment for subjective factors viz., increase in oil prices, safe and secure environment for tourists, safe and secure air travel, other infrastructures like road and rail connectivity, creation of adequate hotel/motel capacity. The forecasts of other international organizations viz., ICAO, IATA, ACI and Aircraft manufacturers have also been considered while finalizing the growth rates.

The aircraft movements have been projected based on the ratios of passengers to number of aircraft movement. The plan period wise forecast traffic has been used to work out capacity addition for passenger and cargo terminals and ANS. These capacity additions have been used to derive investment requirement on the basis of norms used in previous five year plans.

Objective-4: To study the development of low-cost airports to improve air connectivity

An in depth exploratory interview of state and central officials of civil aviation, the expert of civil aviation consulting organizations and other related organization were carried out. The XII five year plan document of MOCA (Ministry of civil Aviation) and other reports of the consultants and committees set by MOCA were reviewed in detail to know such initiatives adopted so far. The suggested solutions and point of view of different organizations have been discussed and finally the region wise airports have been identified for development as Greenfield/Low cost airport to improve the regional connectivity.

Objective-5: To study the role development of green field airports in improving environment/sustainability of airports

This objective is achieved through study of secondary data collected from World Bank on air traffic, economic growth and environmental degradation for the period 1971-2014 and six case studies on representative Greenfield airports through focus group discussion and consultations with AAI.

In order to capture the impact of air traffic and economic growth on environment we introduced Cobb-Douglas production function, where carbon emission is taken as output variable with input of air traffic and economic growth.

Similarly, to know the impact of regulation in terms of either economic regulation or privatization or both and trade openness on environmental degradation, we have estimated the following model.

$$\ln Q = \alpha_1 \ln Y_1 + d_1 Y_2 + d_2 Y_3 + d_3 Y_4 + \mu_i$$

Where, $\ln Q$: natural log of carbon emission

lnY_1 : natural log of trade openness

Y_2 : no regulation (neither economic regulation nor privatization) dummy

Y_3 : privatization dummy

Y_4 : privatization and economic regulation dummy

μ_i : Stochastic random term

The following green field airports were selected for their environmental implication:

- Bombay II airports,
- MOPA Airports,
- Aranmulla Airports,
- Sirdi Airport,
- Kanoor airport and
- Pune Greenfield Airport.

In order to explore the environmental implications of development of Greenfield airports we visited these airports, conducted focus group discussions and developed case studies based on focus group discussions.

CHAPTER 4

AIRPORT PRIVATIZATION AND ECONOMIC REGULATION

4.0 Introduction

Airports are designed and developed to support and provide infrastructure facilities to airlines. Since many decades, the airports remained as natural and public monopolies with large economies of scale. Only recently and after the corporatization and privatization, airports come under economic regulation. Particularly, during last few decades the nature of the airport industry has undergone a drastic change. The business and commercial objective with profit/ revenue maximization in a corporate frame work have been adopted by almost all airports worldwide including Indian airports in particular. Regulating the profit maximization objective and increasing the efficiency, various effective regulation and different types of privatization have been dynamically encouraged by public authority with the informed and planned aim of increasing social welfare. Thus majority of privatized airports come under economic regulation with the objective of improving efficiency and augmenting social welfare during recent decades.

India is not exception to the above trend and the major six airports viz. Mumbai, Delhi, Bangalore, Hyderabad, Cochin and Nagpur have been privatized under PPP (Public Private Partnership) mode between 2000 - 2009. With the onset of privatization, Airport Economic Regulatory Authority (AERA) was established by an act of Parliament in 2008 for economic regulation of Indian Airports. With this background, this paper deliberates in detail the various regulatory approaches adopted by AERA since May 2009.

At the outset of this chapter, we touch on some background details. The next section presents review of literature followed by methodologies in section 4.2. The section 4.3 presents the result and discussion. Findings and concluding remarks of this chapter have been given in the last section.

4.1 Review of Literature

The neoclassical theory of the firm states that competition leads to increased productive and allocative efficiency as a result of lower prices and higher outputs. In the case of indivisibilities, as typically occurs in the provision of infrastructure based services and utilities, one large firm might be able to produce at lower costs leading to monopolistic conditions. In this case, in order to encourage efficiency and avoid abuse of market power, the natural monopolist should be subject to economic regulation (Lipczynski, 2009).

In Europe, airport charges have traditionally been regulated according to a rate of return or cost-plus principle (Reinhold, 2010). Such regulation permits airports to generate sufficient revenue to cover total expenditures, including the depreciation of capital and an expected rate of return on capital. However, according to Averch and Johnson (1962), this form of regulation may lead to overcapitalization, which does not engender productive efficiency. To solve the problem of overinvestment, Littlechild (1983) proposes an incentive based price-cap regulation. Price-caps are generally set over a regulatory period of five years according to the RPI-X formula where RPI represents the retail price index and X is the efficiency improvement that the regulators consider reasonable within the time frame. If the airport management achieves greater cost reductions over the five year period, the gains are enjoyed by the company. In the case of airports, the single till principle is applied in the UK, in which case both aeronautical and non-aeronautical revenues are constrained. Over the years, price-cap regulation has been emulated by other European authorities. However, unlike the UK model, a dual till approach[5] is applied whereby aeronautical revenues alone are subject to regulation (Gillen D. a.-M., 2008). Compared to traditional rate of return regulation, Gillen and Niemeier (2008) provided a comprehensive overview of the current economic regulation at European airports.

Price-cap creates incentives for cost savings hence encourages efficiency, however it equally may lead to underinvestment on the part of firms with heavy infrastructure sunk costs. Consequently, it may be necessary to regulate in order to ensure a reasonable level of quality with respect to the products or services offered. Another approach to stimulate efficiency is

[5] Mumbai, Delhi and Bangalore has been allowed hybrid till approach.

yardstick competition originally proposed by Shleifer (1985). This form of regulation implies virtual competition amongst regulated firms by comparing their cost levels and determining the permitted price based on an average level. The British CAA argued that the heterogeneous character of airports and the challenge to obtain appropriate data contribute to their reluctance to apply this type of economic regulation (Authority, 2000) .

In the theoretical literature, the debate as to the necessity for and type of airport regulation seems to be rather controversial. Gillen and Niemeier (2008) argued in favor of price-cap regulation but also that commercial and ground handling activities might be disciplined to some extent by potential competition, hence the dual till price-cap approach was preferable. Czerny (2006) argued that market power exists in both the aeronautical and commercial spheres of activity. For non-congested airports, he suggested that the single till outperforms dual till price-cap regulation in maximizing social welfare. For large, congested airports, Beesley (1999) argued that the single till is inappropriate because increasing concession profits would lead to lower airport charges over time. In addition, Starkie (2002) found no evidence of economies of scale for airports with large throughput and argued that demand complementarities across aeronautical and terminal activities will prevent airports from abusing market power, obviating the need for any regulation. In particular, airports generating additional revenues from non-aeronautical activities are likely to lower their charges and cross-subsidize using commercial revenues in order to attract both passengers and airlines (Zhang A. a., 2010)

To the best of our knowledge, the impact of regulation on efficiency and airport pricing has been empirically investigated by very few scholars. Barros and Marques (2008) have advocated that regulatory procedures contribute to cost savings. Oum et al. (2004) observed that airports under dual till price-cap regulation tend to have higher levels of gross total factor productivity than those with a single till price-cap or those that operate under the single till rate of return regulation. Furthermore, dual till approaches together with rate of return regulation appear to provide incentives to improve efficiency but are very complex to estimate. Bel and Fageda (2010) examined the impact of privatization, regulation and regional and intermodal competition on airport charges at European airports in 2007. Utilizing regression analysis, they found that private unregulated airports charge higher prices than public and regulated airports which are supporting the analytical findings of Oum et al. (2004).

Shapiro and Willig (1990) had a view that the government is better informed and more capable of regulating state-owned firms. Opponents of this point-of-view sought evidence to demonstrate that state intervention leads to inefficiency. Shleifer and Vishny (1994), for example, opined that the relationship between politicians and managers is governed by incomplete contracts leading to inefficient incentives.

Parker (1999) employing DEA technique to estimate the technical efficiency opined that British Airport Authority (BAA) remains subject to economic regulation and hence incentives to operate more efficiently are distorted as a result of government intervention.

Several tasks are to be performed to analyze airport regulation. One of these is to observe the ownership and regulatory pattern in a city or country, and seek to explain it in terms of efficiency and other objectives. Another task is to outline which approaches to airport ownership and regulation are most likely to be conducive in efficient operation of airports- have some countries implemented promising models, and are the approaches taken by others flawed? Finally, there is the task of assessing what ownership and regulatory frameworks can best promote efficiency while recognizing the constraints imposed by the non-efficiency objectives imposed by governments- does a particular framework represent a good compromise between objectives and is it possible to meet the non-economic objectives at less cost in terms of efficiency (Gillen D. , 2007).

In summary, whereas research to date has analyzed the effect of ownership, regulation and competition on efficiency, the impacts of regulation may be of great interest. Consequently, efforts have been made in this paper to review and analyze the regulatory approaches of Indian airports.

4.2 Methodology

The methodology adopted in this chapter is based on the review of AERA orders viz. (i) Regulatory Objectives and Philosophy in Economic Regulation of Airports and Air Navigation Services (AERA, 2010), (ii) In the matter of Determination of Aeronautical Tariff in respect of IGI Airport (AERA, 2012) and (iii) In the matter of Determination of

Aeronautical Tariffs in respect of Kempegowda International Airport (Earlier Bengaluru International Airport) (AERA, 2014).

The implication of this chapter focus light on effectiveness of economic regulation on price control and its impact on traffic growth and capacity addition of Indian Airports.

4.3 Result and Discussion

4.3.1 Airport Regulation in India

Privatization of Indian airports started in 2000 with the privatization of Cochin International Airport. Subsequently, Bangalore, Hyderabad, Mumbai, Delhi and Nagpur airports were also privatized with PPP mode under BOT (Built Operate Transfer) approach. The additional four more airports are on way to privatization. With the privatization of above mentioned airports, necessity for economic oversight/ regulation was felt and a frame work for this was established in December 2008 by creating Airport Economic Regulatory Authority.

The Airports Economic Regulatory Authority of India Act, 2008 was enacted on 5.12.2008. Under the Act, AERA's mandate covers determination of tariffs for aeronautical services, user charges and monitoring of set performance standards in respect of major airports[6]. Presently 17 airports in the country have annual passenger throughput in excess of one and a half million. These 17 airports include 6 joint venture airports and 11 public airports. The other 73 minor airports are regulated by Ministry of Civil Aviation (MOCA), Government of India (GoI). The air navigation services (ANS) are provided by Airport Authority of India (AAI), GoI at all civil airports.

The basic objectives of AERA are to create a level playing field and foster healthy competition amongst all major airports (government owned, PPP- based, Private), encourage investment in airport facilities, regulation of tariffs of aeronautical services, protection of reasonable interests of users, operation of efficient, economic and viable airports (International Civil Aviation Organization, 2013).

4.3.2 Regulatory Approaches Adopted in India

In the context of statutory functions of AERA under the Act and regulatory objectives &

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[6] Major airport means an airport which has, or is designated to have, annual passenger throughput in excess of one and a half million or any other airport as the Central Government may, by notification, specify as such.

principles for regulatory process, the regulatory approach on a number of important aspects are discussed below. The regulatory approaches adopted by AERA are also discussed here in the context of international examples, the context of Indian airports and air navigation services.

4.3.2.1 Price Cap Regulation

Price cap regulation is now a common way of setting prices in a wide range of monopoly or near-monopoly situations. Typically, the formulae for determining prices under such a cap incorporate terms that automatically reflect inflation (e.g. CPI) and it is commonly known as 'CPI-X regulation' or in exceptional situation CPI-X+Y. The 'X' factor principally takes into account the expected changes in business parameters pertaining to investments, depreciation, & cost implication of increased level of service on one hand and anticipated efficiency improvements (through reduced operating costs), and growth in volumes on the other and the benefit of Y factor is given to the airport operator if the huge investment has been undertaken recently and more investment is also required.

The formulae under such a form of regulation reflect the maximum possible percentage increase in prices over certain base parameter(s). The base parameter(s) itself can be (i) an aggregate term like yield per passenger or (ii) individual tariffs. This works with reference to a given level of base parameters at the initial year (T=0) of the regulatory cycle. These parameters are allowed to increase by the given formula. The increase (over the base parameters) is structured to give a reasonable rate of return (on investments or equity) to the investors in airport infrastructure (AERA, 2009).

While the initial concept works best for firms with easy to measure unit costs, the form of regulation has evolved to account for investing and service performance as well as operating expenditure. However, in case of qualitative service parameters it is not possible to measure precisely and this has been implemented through Airport Council International – Airport Service Quality (ACI-ASQ) survey. This survey is executed by the local consultant to be appointed by the airport operator and possibility influence by the airport operator cannot be ruled out. ACI undertakes survey design, data processing and report preparation. It has been observed that overall rating is higher than all the 33 parameters included in the survey which is not feasible if the survey is executed scientifically.

In the same way as for operating expenditure, it provides incentives for an airport to develop commercial revenues (AERA, 2009). Price Cap Regulation was originally proposed for economic regulation of monopoly utilities as a way of encouraging incremental improvements in performance[9] and, initially in the telecoms sector, to provide a route to eventual deregulation. Regulators in a number of countries have evolved the methods of Price Cap Regulation to address a wide range of circumstances. In the United Kingdom, CPI-X (or its UK equivalent, RPI-X) has been used in the regulation of designated airports since the privatization of British Airport Authority (BAA) in 1987 (AERA, 2009). In India price cap regulation has been implemented for Airport charges that is landing, parking, housing charges (Aircraft related charges) and passenger service fees, security charges etc.

4.3.2.2 Rate of Return Regulation

Rate of Return Regulation is the name for a form of regulation that permits the regulated firm to set prices at such a level that it recovers its costs, including a rate of return on an appropriately defined value of capital employed.

The predominant consideration under such a form of regulation would be determination of nature of return and the appropriate base / value of capital employed. Rate of return regulation is extensively used in the US across regulated sectors and is also used at certain airports in Europe. Traditionally, this form of regulation has been primarily used for publicly owned entities. In India rate of return regulation has been implemented for air navigation services (ANS) with a view that investment in upgradation technology is undertaken liberally and safety is not compromised.

4.3.2.3 Light Touch Regulation

A number of academic commentators have argued that the intrusive process of regulation itself creates distortions that can be worse than the effects of monopoly abuse[10] and that light touch regulatory approaches can deliver better performing sectors than formal price control (AERA, 2009) in competitive and non-substantial services. In this case threat of regulation restrains the airport operator for abuse of monopoly power.

Commentators and the regulatory authorities point out that an important component of light touch approaches is meaningful price monitoring and a realistic long term commitment to intruding regulation in the event of unacceptable outcomes. The light touch regulation is suitable for the services which are provided on mutually negotiated term or competitive bidding basis. These may include the firm setting prices at unacceptable levels, earning profits deemed excessive, reducing quality beyond some point or some other behavior or outcome considered a clear abuse of monopoly.

Light touch regulatory approaches in the airports sector have been adopted in New Zealand and Australia, and arguably wherever airports are free to set their own charges, subject for example to competition law constraints. Australia had a system of incentive regulation for its airports, which encountered problems, and was replaced by a loosely specified monitoring system. New Zealand has operated with no explicit regulation, but the threat of regulation exists in case performance is unsatisfactory.

In India light touch approach has been adopted for ground handling services, cargo services and oil refueling services etc. AERA has also defined the competitive services are those services where two or more service provider are operating. AERA has also defined non substantial services where the numbers of aircrafts movement are less than a pre-defined limit.

The price cap regime for airport regulation in Australia moved to price monitoring in 2002. In 2006, the Productivity Commission reviewed airport performance under the new regime. Generally, airports supported the current arrangements, while airlines argued that it did not sufficiently restrain the use of market power. The Australian Competition and Consumer Commission (ACCC) was also critical of current arrangements, agreeing with the airlines that restraints on the use of market power, were unspecific and too weak.

New Zealand took a different approach to light handed regulation, sometimes referred to as Shadow Regulation. Instead of an explicit review/sanction mechanism, the New Zealand approach involved a general provision in the relevant legislation to enable a review of pricing in industries such as airports to be initiated by the Minister at any time. Though they are not formally regulated, they are subject to the threat of price controls (AERA, 2009).

Academic commentators have pointed out that the assessment of light handed regulation depends on what it is expected to achieve. From a broad efficiency perspective, it has performed well, though it has not been without problems, especially those associated with investment. If the objective is to keep prices close to cost, and minimize the use of market power, the system may be seen as less successful (AERA, 2009). It is also not clear whether and to what extent light touch approaches depend on the commercial, governance and regulatory traditions of a country.

Light touch approach has been used in case of cargo services, ground handling services and Aircraft refueling services where either the services are competitive or they are not substantial in nature. In case the services are non-competitive and substantial in nature then price cap regulation will be applied for the above services also. The competitive and substantial services have been defined by AERA in the revision of respective charges.

4.3.2.4 Single Till and Dual Till Approaches

It is a generally accepted principle, endorsed by ICAO, that airport users should pay their full and fair share of the cost of providing the airport. However, a modern airport is engaged in a complex mix of aeronautical activities (handling passengers and aircraft) and non-aeronautical activities (retail, catering, car parking, and property rents). A critical question is whether, and to what extent, non-aeronautical activities should be taken into account in determining that fair share.

One approach is to adopt the ‘single till’ principle, where all airport related assets and costs are taken into account in determining allowed tariff rates or return or a general price cap, after considering all revenues from non-aeronautical services (AERA, 2009).

Single till approach does not make any distinction between aeronautical and non-aeronautical services at an airport and treats an airport as an integrated business and helps set airport charges so that the airport as a whole can generate appropriate returns for its investors. As a first step, total assets (aeronautical and non-aeronautical) are considered for allowing a certain return. The return is then adjusted for allowed depreciation and efficient operating expenditure (aeronautical and non-aeronautical). The adjusted return so obtained is then subsidized by the total non-aeronautical revenues to arrive at the net revenue required by the airport from aeronautical charges.

Effectively, single till uses profits from non-aeronautical activities at an airport to offset the aeronautical cost base for determining airport charges. Under this approach the allocation of costs between aeronautical and non-aeronautical services is less significant, given that the allowable revenue figure is based on total costs.

An alternative approach is to adopt a 'dual till', in which the revenues, costs & assets of an airport are allocated between 2 heads - aeronautical & non-aeronautical. In a pure dual till, the 'regulatory till' is made up of revenues, costs & assets (and thus the costs of financing those assets) that are solely associated with aeronautical activities plus a share of the common costs and assets that support both aeronautical & non-aeronautical activities (AERA, 2009).

Variants of the pure dual till include hybrid approaches that reflect some of the revenues, costs and assets directly associated with non-aeronautical activities in the cost base for airport charges. It is supposed that, under conventional cost allocation methods, non-aeronautical activities generate a higher rate of return on their assets than the airport's cost of capital. As such, a dual till approach (pure or hybrid) may tend to lead to a higher computation of required airport charges.

AERA has adopted single till approach in India however for Delhi International Airport Ltd. (DIAL) and Mumbai International Airport Ltd. (MIAL) the Operation Management and Development Agreement (OMDA) was signed before establishment of AERA and in the OMDA it was one of the condition that hybrid till with 30:70% will be applied i.e., 30% of non-aeronautical revenue will be counted towards fixation of aeronautical charges and 70% will be retained by the airport operator. In view of the above hybrid till has been applied for Delhi and Mumbai Airport, subsequently BIAL also approached AERA for the hybrid till on the pattern of Mumbai and Delhi airport.

While BIAL's letter dated 30th July 2013 indicated a request for review of proposal under what it calls as Hybrid Till, the Authority had noted, from the submissions made by BIAL that it had considered Shared Revenue Till model wherein 30% of Gross Revenues from Non-Aeronautical Services had been set off from the Aggregate Revenue Requirements computed for the Aeronautical Services, without taking into account the costs associated with providing these Non-Aeronautical services (AERA, 2014).

A Shared Revenue till of 40% would strike an appropriate balance between the needs of expansion of the airport as well as passenger interest, in terms of keeping the user charges at reasonable level. Therefore, 40% of gross revenue generated by BIAL from Non Aeronautical

Services may be reckoned towards subsidizing Aeronautical charges and User Development Fees (UDF) (AERA, 2014). However AERA accepted Hybrid till with 40:60 ratios. At remaining 14 airports single till approach has been adopted.

4.4 Concluding Remarks

The economic regulation in airport infrastructure in India was implemented after privatization which resulted into the adaptation of different regulatory approach for private and public airports. In the first cycle of revision of airport charges by AERA in 2009 the prices has been increased more than four-fold with the result that Indian airports has come in the category of costliest airports of the world i.e. consumer has not been benefited as has happened in case of competitive industry such as telecommunication. Also the high traffic growth of Indian aviation sector, which started after introduction of low cost airports in 2003-04, was adversely affected by steep hike in prices by private airport operators. However, the aviation has been benefited out of privatization in terms of creation of adequate capacity and quality of world class infrastructure. The efficiency in use of resources has also been improved after privatization but it is not known whether the same is because of economies of scale or privatization or economic regulation or ownership which needs to be researched further.

The rates for first round of revision were revised from USD 3427 to USD 250623 for B-747

Table 4.0-1 The Ranking of IGI Airport from Highest to Lowest in Airport Charges

Rank of IGI Airport from the top after first round of revision which changed from 211LH/221MH/218SH			
Type of Aircraft	**Aircraft related charges**	**Passengers related charges**	**Total charges**
Long Haul(747)	27	6	7
Medium Haul(767)	33	6	6
Short Haul(AB320)	43	16	19
Rank of IGI Airport among more than 25 million passengers handling airport			
Type of Aircraft	**Aircraft related charges**	**Passengers related charges**	**Total charges**
Long Haul(747)	3	1	1
Medium Haul(767)	3	1	1
Short Haul(AB320)	7	2	2

(Source: compiled from ICAO Document 7100-2011)

And implemented w.e.f. 15-5-2012 i.e. 7.3 times. This was failure of AERA to control airport charges and retain within reasonable limits. The ICAO guide lines recommend not allowing steep increase even if it is required(Refer table 4.1 above and annexure 4.1-4.3). The first round of airport charges revision was implemented with approval by AERA w.e.f. 15-5-2012 at IGI Airport when total charges for B-747(Long Haul) increased from USD 3427 to USD 25062 raising its rank from 211 to 7th costliest airport (Refer annexure 4.1). For B-747(Medium Haul) total airport charges were increased from USD 1849 to USD 14527 raising its rank from 221 to 6th costliest airport (Refer annexure 4.2) and for A-320(Short Haul) total airport charges were increased from USD 991 to USD 6273 raising its rank from 218 to 19th costliest airport (Refer annexure 4.3).

The policy implication of this study suggests that the privatization and regulation is good for capacity addition, improving quality of infrastructure and efficiency in use of resources. However, the price control should be implemented rigorously to keep them within reasonable limit and at the same time growth in traffic should not be adversely affected. The pricing should be matching with Indian cost structure and should be capable of attracting investment in airport infrastructure. The leakage of public revenue by creating number of subsidies by private operators may be checked.

CHAPTER 5

PERFORMANCE ANALYSIS OF MAJOR AIRPORTS IN INDIA

5.0 Introduction

Airports are the commercial enterprises and their services, location, requirement of physical infrastructure and use of technology are such that they are happened to be natural monopolies. Most of the airports of the world are either publically owned or privately operated and due to monopolistic nature they bring attention of many researchers. Evaluating efficiencies of major airports, most of the scholars suggested policy changes of regulation in the airports sector. Thus only recently and after the corporatization and privatization, airports have come under economic regulation. Particularly, during last few decades the nature of the airport industry has undergone a drastic change. The business and commercial objective with profit/revenue maximization in a corporate frame work have been adopted by almost all airports worldwide including Indian airports in particular (Singh, Dalei, & Raju, 2015). Privatization has been a major trend among major airports except some airports in Asia, Europe and North America. The privatization of Indian airports started in 2000 with the privatization of Cochin International Airport. Subsequently, Bangalore, Hyderabad, Mumbai, Delhi and Nagpur airports were also privatized with Public Private Partnership (PPP) mode under Build Operate Transfer (BOT)/Build Own Operate and Transfer (BOOT)/ Build Own and Operate (BOO) approach (Dalei & Singh, 2015). The publicly owned airports have now been functioned as corporate enterprises while focusing more on commercial objectives. Different modes of privatization have been actively promoted by governments with the proclaimed intention of reducing government involvement and increasing airport productivity and innovation. India has 133 airports including 22 international airports and now Government of India (GoI) in its budget 2016-17 has declared development of 160 airports including conversion of 10 non-operational airports into operational airports.

Thus with the hypothesis that privatization and regulation have positive impact on social welfare, an effort has been made to measure the efficiency of major Indian airports. Computing efficiency of major airports requires estimation of unknown production frontier with the help of independent input factors. Thus the objective of this chapter was to identify input and output factors in order to compute and compares efficiency of major Indian airports. The chapter also analyzes the factors affecting efficiency viz. ownership, economies of scale, regulatory approach of airport and compares the efficiency of airports with combination of different category of airports and regulatory approaches. In the airport sector economies of scale is the most significant factor affecting efficiencies and therefore the efficiencies have also been compared after eliminating the effect of economies of scale.

5.2 Efficincy of Major Airports in different Regions of the World

There are many studies available in the literature of airport efficiency. Most of the efficiency evaluation studies of major airports of world fall in the European, US, Australian (New Zealand), and Asian regions. Some studies of efficiency of international airports are also found across the regions. The region wise efficiency of major airports is given below.

5.2 .1 European Airports

Randrianarisoa et al. (2015) investigated the effects of corruption on operating efficiency of 47 major European airports from 2003 to 2009. By using Multilateral Index Number method and Cluster Random Effects model they found strong evidence that corruption has negative impacts on airport operating efficiency; and the effects depend on the ownership form of the airport; and airports under mixed public–private ownership with private majority achieve lower levels of efficiency when located in more corrupt countries. Applying data envelopment analysis and assuming the aeronautical output as exogenous, in order to estimate the relative efficiencies of a set of 85 European regional airports over the last decade, Adler et al (2013) estimated the potential savings and revenue opportunities to be in the order of 50% and 25% respectively because cost increases were in excess of any changes in demand over the timeframe. Using second stage regressions they examined the reasons for poor performance, which include discretionary variables such as the failure to search for commercial opportunities or to produce ground-handling and fueling activities in-house.

Using first stage Data Envelopment Analysis and second stage Tobit Regression the effect of the proposition of cargo traffic relative to total traffic on technical and scale efficiency at 35 Spanish airports was studied by Inglada et al.(2016). They explored that cargo traffic has a positive impact on the technical and scale efficiency of Spanish airport operations. Airports with a higher share of cargo traffic are expected to have higher overall technical efficiency, pure technical efficiency, and scale efficiency, in comparison to airports with a lower share. Using Data Envelopment Analysis and Stochastic Production Frontier (SPF) techniques Tovar & Martin-Cejas (2009) estimates a distance function to analyze and explain Spanish airport efficiency. They have a view that there is positive contribution of outsourcing and non-aeronautical revenues on the efficiency of the Spanish airports' network. The productivity change of 26 Spanish airports was analyzed by Tovar & Martin-Cejas (2010) using Stochastic Distance Function and Total Factor Productivity (TFP). They have observed that hub airports showed an above average level of efficiency and found that there is a significant difference in efficiency between mainland airports and island airports. The efficiency of 39 Spanish airports for the years 2006 and 2007 was evaluated by Lozano & Gutie (2011) using Data Envelopment Analysis approach and slacks-based measure model and their findings shows that the efficiency assessment of the airports when their undesirable outputs are ignored is generally different and can therefore be misleading. They have also found that a large proportion (more than a half) of airports are technical efficient with the rest having significant inefficiencies. Adopting a comparative technical efficiency analysis of 35 Spanish airports using panel data for 2009-2011 Coto-Millan, et al. (2014) estimated that airport size has a positive impact on the technical and scale efficiency and that the presence of low cost carriers has positively affected the scale efficiency of the airports where they operate.

Using Hicks-Moors teen index method See & Li (2015) examined the total factor productivity (TFP) change of the 45 main UK airport industries from 2001 to 2009 and estimated that the industries experienced an average annual growth in TFP of 0.32 per cent with efficiency change being the main contributor to the TFP growth and private UK airports enjoy slightly higher TFP growth than those in public or mixed ownership. Using Bayesian dynamic frontier model on 54 UK airports over the period 1998–2008 Gillen & Barros (2012) have given a more structural explanation in estimating the variation in airports' inefficiency and its cost inefficiency effects. Using Markov Chain Monte-Carlo simulation they found that UK airports improved their efficiency over time. They found airport size, price regulation, price cap variations and airport competition as the important determinants of cost efficiency. The study by Ison et al. (2011) on 25 UK airports reveals that it is difficult to separate out the impact of commercialization from privatization.

The technical efficiency of 18 Italian Airports during the period 2000-2004 using a bootstrapped Data Envelopment Analysis was estimated by Curi et al. (2011). They explored that the airport dimension allows for financial efficiency advantages in the case of hubs and disadvantages in the case of the smallest airports. They also have a view that the introduction of a dual-till price cap regulation might create incentives which lead to the increase of financial efficiency at the detriment of the operational performance. Considering 28 Italian Airports and using Data envelopment analysis Gitto & Mancuso (2012) measured the operational performance during 2000-2006. They found that Italian airport industry experienced a significant technological regress, with few airports achieving an increase in productivity led by improvements in efficiency. They also have a view that the form of ownership of an airport management company does not significantly affect performance.

Applying Directional Distance Function model and bootstrapping procedure in 33 Italian airports Martini et al.(2013) found that improvements in technical/environmental efficiency might be obtained by inducing airlines to substitute narrow-bodies with regional jets when the route load factors using narrow-bodies are rather low. They further opined that the higher the stake of public local authorities in the airports' ownership structure, the higher is their technical/environmental efficiency and with regard to the influence of airlines on airport efficiency, the presence of low-cost carriers is not significant from the environmental point of view.

Using stochastic cost frontier method with translog frontier model and the maximum likelihood estimation technique in 13 portuguese airports over the period 1990-2000 Barros (2008) found that the most important airports analyzed are efficient, while a proportion of the less important airports are revealed to be inefficient when the benchmark used is the mean or the median. They found that capital, prices , sales to planes, sales to passengers and aeronautical fee are the main determinant of efficiency.

5.2 .2 US Airports

Data Envelopment Analysis methods were used by Perelman & Serebrisky (2012) to compute comprehensive efficiency of 21 Latin American airports over the period 2000-2007 and investigated that privately operated airports enjoyed higher rates of total factor productivity growth and technical efficiency in Latin American airports shows notable variations from airports on the frontier (with a value of 1) to airports that have technical efficiency scores close to 0.

The study by Assaf & Gillen (2014) on a sample of 45 US airports over the period 2002–2010, presents one of the few attempts to account for bad outputs in measuring airport efficiency using Bayesian input distance function. They have a view that excluding the bad output underestimates the efficiency results and there are important differences in the ranking of airports based on their efficiency when the bad output is excluded from the model. Performance measures can also affect the access to, and cost of, capital to an airport and also they found that efficiency and productivity growth for the sample of airports was positive and significant in all years for the models with and without bad output. A series of 12 in-depth semi-structured interviews were conducted with senior managers from sample of 23 of the 29 large-hub US airports by Richardson et al. (2014) to examine the financial implications of the different types of airline lease agreements used by these airports, where the authors investigated that compensatory airports are the most financially efficient, particularly in terms of debt efficiency, revenue generation and profitability while the vertical airport airline relationship that is common at residual airports delivers higher levels of commercial performance and cost efficiency.

5.2.3 New Zealand Airports

Using Malmquist Data Envelopment Analysis, Abbott (2015) in first part of their study have found that the efficiency and productivity of the three airports of New Zealand improved over the years, although this was influenced to some degree by locational factors. Similarly, using Data Envelopment Analysis in a two-stage process his second part of the study found that the larger airports were more efficient than the smaller ones, and jointly owned airports are somewhat less efficient. Productivity gains appear to enable airport expansion, rather than price reductions (Abbott, 2015). Tsui et al. (2014) extended the study of Francis (2007) by exploring the efficiency and productivity changes of New Zealand's 11 major airports between the period 2010 and 2012 using Slacks-Based Measure (SBM) model and the Malmquist productivity index (MPI) and suggested that the majority of New Zealand airports increased efficiency and productivity during the period under investigation, but should decrease scale of operations in order to operate at their most productive size.

5.2.4 Asian Airports

The influence of competition and aviation policy reform in China on the efficiency generated through Data Envelopment Analysis of 25 Chinese airports was investigated by Chi-Lok & Zhang (2009). They observed that there is strong evidence that publicly listed airports are significantly more efficient than non-listed airports and that the correlation between listing and productivity growth is statistically insignificant. Ka et al. (2008) using non-parametric, linear-programming based method of data envelopment analysis in studying the patterns of productivity changes in 25 regional Chinese airports during the period 1995–2004 found that there was no regular trend in average airport efficiency or its variation over time. They have opined that if the Chinese central government requires a more balanced development among airports, then its policy should focus on airports in the northeast region, non-hub airports, and non-listed airports.

Using a two-stage method; first-stage Data Envelopment Analysis to assess airport efficiency, followed by the second-stage regression analysis to identify the key determinants of airport efficiency of 21 Asia-Pacific airports between 2002 and 2011 Kan et al. (2014) found that Adelaide, Beijing, Brisbane, Hong Kong, Melbourne, and Shenzhen are the efficient airports and that percentage of international passengers handled by an airport, airport hinterland population size, dominant airline(s) of an airport when entering global airline strategic alliance, and an increase in GDP per capita are significant in explaining variations in airport efficiency. Using Data envelopment analysis (DEA) and the Malmquist productivity index (MPI) Yang (2010) have estimated the efficiency and productivity growth of the 12 Asia-Pacific international airports over the period 1998–2006. He found that airports improved their technical efficiencies with appropriate scale size and high utilization of resources. Using Data Envelopment Analysis and considering 11 major Asia Pacific airports over the years 2001–2005 Lam et al. (2009) investigated that technical, scale and mix efficiencies are high among the major Asia Pacific airports.

Using Network Data Envelopment Analysis (NDEA) and Panel Data model Liu (2016) evaluated the overall efficiency and the operational efficiencies of aeronautical service sub-process and commercial service sub-process for 10 East Asia airport companies over the period 2009-2013. They predicted that only Airport Authority Hong Kong in 2012 and 2013 performed efficiently in both sub-processes and achieved overall efficiency whereas the overall efficiencies of all other companies are not high. They also found that the number of airlines served and the number of destinations have significant and positive influences on the efficiency of aeronautical service.

Low & Tang (2006) using cross-sectional multivariate regressions and others econometric techniques and considering 9 International Asian airports found that increases in price elasticities and substitutability of labor and capital indicate that airports in Asia have become more adept at reacting to price changes.

5.2.5 Other International Airports

Merkert & Assaf (2015) considering 30 international airports investigated whether perceived airport quality has an impact on airport profit margins. They found that excluding quality as an output measure can distort the true overall efficiency ranking of international airports. Based on their combined single efficiency measure they explored that, airports with high share of non-aeronautical in total revenues, high share of LCC airline in total airline seats, private ownership and located in Asia Pacific perform well on average.

Oum et al. (2008) studying the effects of ownership forms on airports' cost efficiency of 109 airports around the World by applying Stochastic frontier framework and Markov Chain Monte Carlo simulation under the Bayesian framework find that countries considering privatization of airports should transfer majority shares to the private sector. They further have opined that mixed ownership of airport with a government majority should be avoided in favor of even 100% government owned public firm; US airports operated by port authorities should consider to transfer ownership/management to independent airport authorities; and privatization of one or more airports in cities with multiple airports would improve the efficiency of all airports.

Considering 23 international airports and using data envelopment analysis and Malmquist productivity index for the time period 2006 to 2011 Ahn & Min (2014) have investigated that the productivity of an airport was influenced by exogenous factors such as shifts in government policies and technological advances rather than endogenous factors driven by improvements in managerial practices. They predicted that there will be more room for airport performance improvement through managerial breakthroughs such as increased privatization and public-private partnerships for airport finances and operations.

Magalhães et al., (2015) tested the prevalent hypothesis in the literature that the flexible airports are able to better cope with market volatility and consequently, to at least maintain their productivity results over time in comparison to the non-flexible airports of 140 North American, European and Asian airports using a cluster analysis. But this hypothesis didn't support because the flexible airports do not evidence visible advantages over the other airports. Cost frontier estimation was used by Voltes-dorta & Pagliari (2012) to estimate the impact of the recession on 194 European and North American airport's cost efficiency and financial performance, where the results showed that airports struggled to control operating costs during the recession. Considering 50 major airports in Asia Pacific, Europe and North America Oum et al. (2003) compared their productive efficiency, firstly by computing gross total factor productivity (TFP) by regression models and secondly by computing residual TFP after removing the effects of the factors largely beyond managerial control. They have a view that larger airports are expected to achieve higher gross TFP because of the economies of scale in airport operations, not necessarily because they are more efficient than smaller airports; airports with a larger percentage of international traffic are expected to have lower gross TFP levels; an airport's ownership structure does not appear to have any statistically significant effect on its productivity performance; airports with higher passenger satisfaction level does not appear to have lower productivity; an airport that diversify and expand their non-aeronautical activities such as concessions and other commercial services are likely to achieve a higher TFP level; airports with capacity constraints are expected to have a higher TFP level although it will impose delays on aircraft and passengers.

It is revealed from the above literature that the efficiency analysis of Indian airports have not been undertaken by any researcher so far in spite of the India being the second largest country of the World by population. This has motivated us to undertake the efficiency assessment of major[7] Indian airports.

Thus in view of gaps revealed by review of literature as above, an effort has been made to compute and compare the efficiency of Indian airports and to estimate unknown production

[7] Major Indian airports are defined as those airports which handled more than 1.5 million passenger traffic per annum.

frontier with the hypothesis that both privatization and regulation contribute to efficiency and productivity of Indian airports.

5.3 Methodology and Data Source

For the purpose of efficiency measurement Data Envelopment Analysis (DEA) techniques has been used taking revenue earned, aircraft movements, passengers and cargo traffic as output variables and manpower, fixed cost/depreciation(proxy variable for investment), operating expenses and interest (proxy variable for debt) as input variables. The results are analyzed using Variable Return to Scale (VRS) method maximizing combined output for given inputs. In DEA Analysis the efficiency of the most efficient Airport is taken as 1 and the efficiency of other Airports is taken as relative to the most efficient Airport. In the subsequent years a different Airport may emerge as the most efficient Airport and the relative efficiency of remaining Airport may change even if their efficiency remains constant. In DEA analysis each Airport has been considered as Decision Making Unit (DMU). The average of efficiency has been taken as arithmetic mean instead geometric mean because the arithmetic and geometric mean is found close to each other.

Output in context of airports is generally related to revenue, aircraft movement, passengers and cargo traffic. Similarly, inputs include number of employees/staff costs, depreciation and other interest cost. Now our production function of airports is a function of the above mentioned inputs, which can be defined mathematically as

$$Q_{it} = f(NE_{it}, SC_{it}, OC_{it}) \qquad (1)$$

Where,

Q_{it} : Output of the i-th airport in t-th time period in terms of revenue, aircraft movement, passenger and cargo traffic

NE_{it} : Number of employees of i-th airport in t-th time period

SC_{it} : Depreciation cost of i-th airport in t-th time period

OC_{it} : Operating cost & Interest cost of i-th airport in t-th time period etc.

Because we have multiple output and multiple inputs so let us assume that there are N inputs and M outputs for each of I airports. For the i-th airport these are represented by the column vectors x_i such as number of employees/staff costs, depreciation, other operational cost and interest costs etc. and q_i such as revenue, traffic (aircraft movement, passengers and cargo) etc. The *N*x*I* input matrix, X, and the *M*x*I* output matrix, Q, represent the data for all airports.

In order to estimate the efficiency of airports we use frontier framework by formulating it in linear programming technique.

In DEA we use linear programming to construct a non-parametric piece-wise surface over the data. This surface is known as frontier. Relative to this surface efficiency measures are calculated.

Coelli, Rao, O'Donnell, & Battese (2005) have advocated that constant returns to scale (CRS) assumption is appropriate when all firms are operating at an optimal scale. They argued that imperfect competition, government regulations, constraints on finance, etc., may cause a firm to be not operating at optimal scale. The use of the CRS specification when not all firms are operating at the optimal scale, results in measures of technical efficiency (TE) that are confounded by scale efficiencies (SE). Thus the use of the Variable Return to Scale (VRS) specification permits us the calculation of TE devoid of these SE effects in airport sector.

Following Coelli, Rao, O'Donnell, & Battese (2005) we formulated the VRS specification as:

$$\begin{aligned} &\min_{\theta,\lambda} \theta, \\ st \quad & -q_i + Q\lambda \geq 0, \\ & \theta x_i - X\lambda \geq 0, \\ & I1'\lambda = 1 \\ & \lambda \geq 0, \end{aligned} \tag{3}$$

Where, I1 is an Ixl vector of ones.

This approach forms a convex hull of intersecting planes that envelope the data points more tightly than the CRS conical hull and thus provides technical efficiency scores that are greater than or equal to those obtained using the CRS model (Coelli, Rao, O'Donnell, & Battese, 2005).

The convexity constraint $I1^{'}\lambda = 1$ essentially ensures that an inefficient airport is only "benchmarked" against airports of a similar size. That is, the projected point (for that airport) on the DEA frontier is a *convex* combination of observed airports. This convexity restriction is not imposed in the CRS case. The value of θ obtained in this framework analysis is the efficiency score for *i-th* airport.

In data envelopment frame work, we consider a measure of the economic efficiency of airports through technical efficiency, which measures the ability of the firm to obtain the maximum output from given inputs; and through allocative efficiency, which measures the ability of the airports to use inputs in optimal proportions given their prices. Computing these efficiency measures involves estimating the unknown production frontier. In this chapter, we consider methods for estimating the efficiency parametrically in a regression analysis.

We use the econometrics model of the form:

$$\theta_i = x'\beta + u_i \qquad (4)$$

Where, θ_i represents the efficiency of the i-th airport; x_i is a Kx1 vector containing the independent variables; β is a vector of unknown parameters; and u_i, is a non-negative random variable.

5.4 Descriptive Data Analysis

The descriptive statistics of input and output variables have been worked out for the time period from 2011-12 to 2013-14 for each of the 17 Airports. The summary results are presented in Table 1 - 4.

5.4.1 Output Variables

We have considered operating revenue, aircraft movements, passengers, and cargo as the output variables in this study(refer annexure 5.2 and 5.3for actual data). The descriptive data analysis of all the output variables is reported below.

5.4.1.1 Revenue (Rs. in Cr.)

It is seen from Table 5.1 that average revenue for 3 years is highest for Delhi Airport followed by Mumbai, Ahmedabad, Goa, Trivandrum, Hyderabad, Bangalore and so on. For Delhi Airport the revenue has grown fastest at 46.87 % followed by Mumbai (27.10 %), Kolkata (26.28 %), Port Blair (23.98 %), Srinagar (23.42 %) and so on. The variation is also large for Delhi followed by Mumbai, Goa, Ahmedabad, Calicut, Trivandrum, and Chennai Airports etc.

Table 5.1: Revenue (in Cr.)

Airports	Mean	SD	Min	Max	CAGR
Delhi	25400	9914	14000	32000	46.87
Mumbai	16000	4359	13000	21000	27.10
Bangalore	6233	252	6000	6500	4.08
Hyderabad	6833	808	5900	7300	11.23
Cochin	3000	500	2500	3500	18.32
Nagpur	3085	559	2556	3670	19.81
Chennai	6533	503	6000	7000	2.99
Kolkata	4733	1106	3700	5900	26.28
Trivandrum	9369	1202	8066	10435	13.74
Ahmedabad	14590	1457	13454	16232	9.84
Goa	11965	1863	10091	13818	17.02
Calicut	7597	1219	6332	8765	17.65
Guwahati	7092	694	6432	7816	10.23
Jaipur	6129	905	5239	7049	15.99
Srinagar	6033	1245	4677	7124	23.42
Amritsar	3085	559	2556	3670	19.81
Port Blair	2275	479	1751	2692	23.98

Source: Concerned Airport Operators and Association of Private Airport Operators\

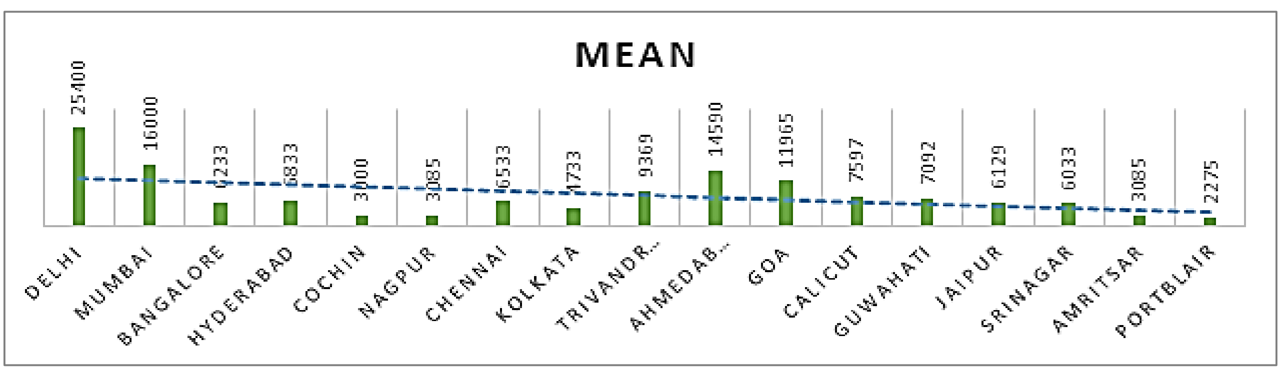

Figure 5.1: Revenue (Rs. in Cr.)

5.4.1.2 Aircraft Movements (in No.)

It has been seen from Table 5.2 that Average Aircraft movements handled by Delhi Airport is highest followed by Mumbai, Bangalore, Chennai, Kolkata and so on. The variation in aircraft movement is largest in Mumbai Airport followed by Delhi, Bangalore, Kolkata and Hyderabad and so on. The growth in aircraft movement has been negative for Delhi, Bangalore, Hyderabad, Nagpur, Kolkata and Guwahati. For remaining Airports there is marginal positive growth except Srinagar where growth rate is 12%.

Table 5.2 Aircraft Movements (in No's)

Airports	Mean	SD	Min	Max	CAGR
Delhi	288992	7548	280713	295491	-0.80
Mumbai	252219	8108	244499	260666	1.81
Bangalore	113600	7766	104642	118431	-0.30
Hyderabad	92302	5936	87741	99013	-5.86
Cochin	42120	3385	40150	46029	7.03
Nagpur	13931	1230	12990	15322	-7.92
Chennai	119787	2219	117418	121817	0.70
Kolkata	95348	3900	92871	99843	-3.55
Trivandrum	25274	1777	23781	27239	-6.56
Ahmedabad	40341	1975	38289	42229	2.10
Goa	27715	1076	26810	28904	2.65
Calicut	16368	318	16150	16733	0.22
Guwahati	27375	623	26938	28088	-1.78
Jaipur	18890	813	18260	19808	3.19
Srinagar	13861	1565	12187	15288	12.00
Amritsar	9476	501	9167	10054	4.49
Port Blair	8293	475	7759	8668	4.38

Source: Concerned Airport Operators and Association of Private Airport Operators

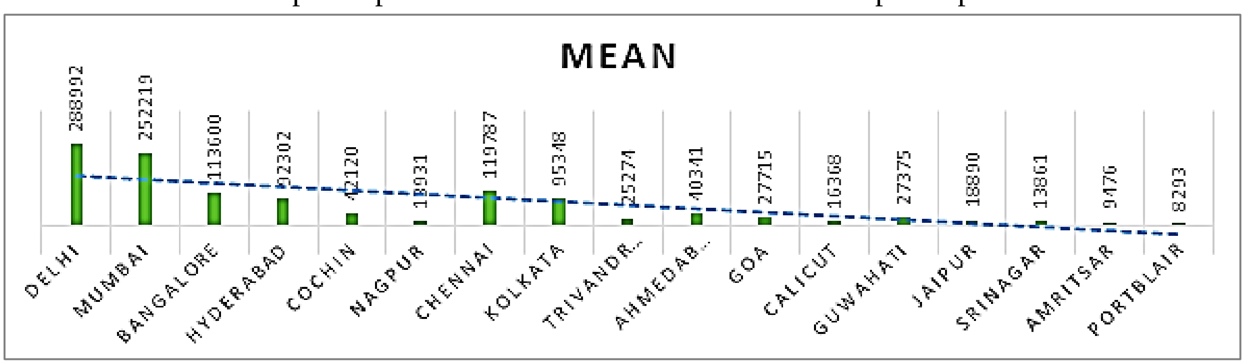

Figure 5.2: Aircraft Movements (in No's)

5.4.1.3 Passengers (in No.)

Table 5.3 suggests that Delhi Airport is the largest Airport in terms of passengers followed by Mumbai, Chennai, Bangalore, Kolkata and so on. The variation in passengers is also highest for Delhi followed by Mumbai, Chennai, Ahmedabad, Hyderabad etc. The growth in passenger traffic during this period has either been negative or marginally positive except for Port Blair, Srinagar and Amritsar where traffic has grown at compound annual growth rate of 11.29, 10.79 and 7.55 respectively.

Table 5.3 Passengers (in No's)

Airports	Mean	SD	Min	Max	CAG
Delhi	357091	12631	343684	368769	1.38
Mumbai	310589	10423	302075	322213	2.37
Bangalore	125203	46383	119938	128688	0.67
Hyderabad	846621	17768	830043	865378	1.23
Cochin	499384	34684	471765	538311	6.82
Nagpur	131447	87701	126383	141573	-5.52
Chennai	128660	78657	127767	129252	-0.11
Kolkata	101912	10361	101002	103039	-0.99
Trivandrum	286263	63045	281479	293407	2.10
Ahmedabad	447402	27740	416274	469511	-1.40
Goa	364993	20424	352155	388545	5.04
Calicut	231602	13263	220971	246464	5.61
Guwahati	217308	86525	207693	224468	-1.05
Jaipur	187091	97026	180247	198195	4.12
Srinagar	183232	18727	163209	200318	10.79
Amritsar	939783	79724	892104	103182	7.55
Port Blair	690559	73767	611184	757009	11.29

Source: Concerned Airport Operators and Association of Private Airport Operators

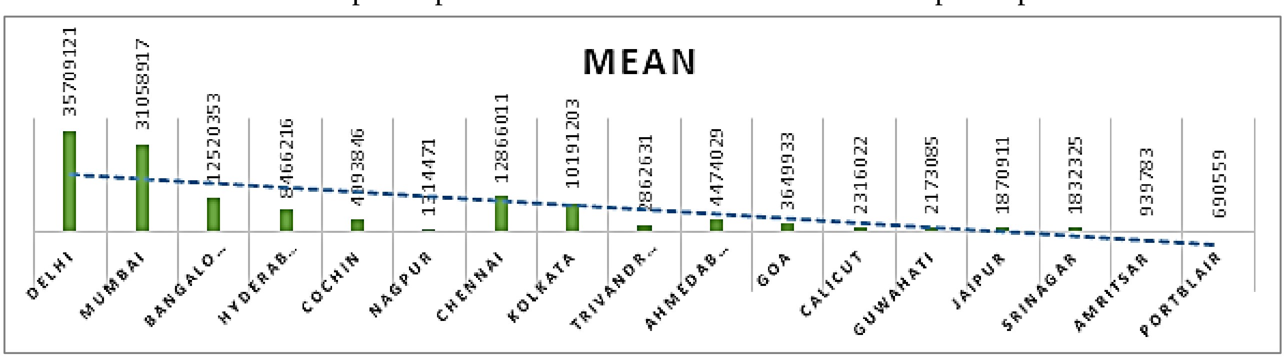

Figure 5.3: Passengers (in No's)

5.4.1.4 Cargo (in MT)

In terms of cargo traffic Table 5.4 shows that Mumbai Airport is biggest airport followed by Delhi, Chennai, Bangalore, and Kolkata and so on. The variation in cargo traffic is highest at Chennai Airport followed by Delhi, Mumbai, and Ahmedabad and so on. The growth in cargo traffic is either negative or marginally positive except Ahmedabad, Srinagar and Cochin where growth rate has been 27.5, 25.6 and 10.9 per cent respectively.

Table 5.4 Cargo (in MT)

Airports	Mean	SD	Min	Max	CAGR
Delhi	573455	30021	546311	605699	3.23
Mumbai	647125	11241	635163	657470	-0.67
Bangalore	231296	9642	224949	242391	3.80
Hyderabad	81591	4500	78099	86670	5.34
Cochin	47340	4866	42706	52408	10.78
Nagpur	5235	275	4976	5524	5.36
Chennai	321717	32946	292080	357191	-9.57
Kolkata	125869	3783	122232	129782	1.65
Trivandrum	38911	9574	29077	48202	-22.33
Ahmedabad	43856	10620	31757	51637	27.51
Goa	5300	760	4767	6170	-12.10
Calicut	25367	2364	22899	27612	-5.41
Guwahati	7227	1054	6013	7907	0.94
Jaipur	6697	18	6677	6710	-0.04
Srinagar	3037	681	2361	3722	25.56
Amritsar	3405	3189	1512	7087	-52.26
Port Blair	2426	243	2206	2687	6.12

Source: Concerned Airport Operators and Association of Private Airport Operator

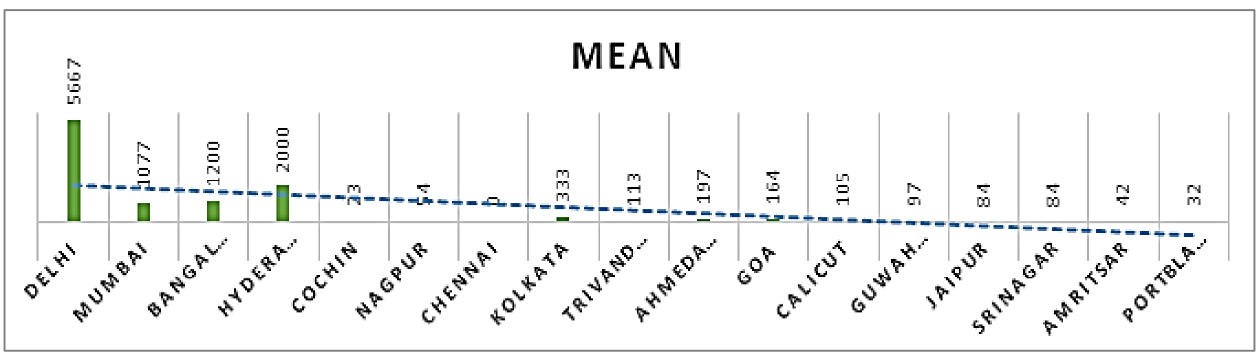

Figure 5.4: Cargo (in MT)

5.4.1.5 Summary of Output Variables

We have considered operating revenue, aircraft movements, passengers, and cargo as the output variables in this study. The Airport Throughput Unit (ATU) represents size of the airport. The descriptive data analysis of all the output variables is reported below.

It is seen from Table 5.5 that average revenue for 3 years is highest for Delhi Airport followed by Mumbai, Ahmedabad, Goa, Trivandrum, Hyderabad, Bangalore and so on. The average Aircraft movements handled by Delhi Airport is highest followed by Mumbai, Bangalore, Chennai, Kolkata and so on.

Table 5.5 Average Value of output Variables (in Cr.)

Air Ports	Revenue (crores)	Aircraft movements (No.)	Passengers (No.)	Cargo (MT)	ATU (millions)
Delhi	25400	288992	357091	57345	70.3
Mumbai	16000	252219	310589	64712	62.8
Bangalore	6233	113600	125203	23129	26.2
Hyderabad	6833	92302	846621	81591	18.5
Cochin	3000	42120	499384	47340	9.7
Nagpur	3085	13931	131447	5235	2.8
Chennai	6533	119787	128660	32171	28.1
Kolkata	4733	95348	101912	12586	21.0
Trivandrum	9369	25274	286263	38911	5.8
Ahmedabad	14590	40341	447402	43856	8.9
Goa	11965	27715	364993	5300	6.5
Calicut	7597	16368	231602	25367	4.2
Guwahati	7092	27375	217308	7227	5.0
Jaipur	6129	18890	187091	6697	3.8
Srinagar	6033	13861	183232	3037	3.2
Amritsar	3085	9476	939783	3405	1.9
Port Blair	2275	8293	690559	2426	1.5

Source: Concerned Airport Operators and Association of Private Airport Operators\

Note1: The averages in the above table are based on last 3 years (2011-12 to 2014-15) actual data

Note 2: Airport Throughput Unit (ATU) , 1 passenger = 1 ATU, 1 Aircraft Movement = 100 ATU, 1 Metric Ton Cargo = 1 ATU

The above Table 1 suggests that Delhi Airport is the largest Airport in terms of passengers followed by Mumbai, Chennai, Bangalore, Kolkata and so on. In terms of cargo traffic Table 1 shows that Mumbai Airport is biggest airport followed by Delhi, Chennai, Bangalore, and Kolkata and so on. The Airport Throughput Unit suggests very high level of heterogeneity in the size of airports which vary from 1.5 million ATU to 70.3 million ATU. This will require to analyzing the effect of economies of scale and its elimination to compare the efficiencies of different airports by bringing them at common base.

5.4.2 Input Variables

We have considered manpower, depreciation, operative expenses and interest as the input variables in this study (refer annexure 5.2 and 5.3). The descriptive data analysis of all the input variables is reported below from Table (5.6-5.9).

5.4.2.1 Manpower

Table 5.6 depicts that the manpower remained constant during last 3 years because the change in manpower is effected only when new terminals are commissioned or Airports are substantially expanded.

Table 5.6 Manpower (in No's)

Airports	Mean	SD	Min	Max	CAGR
Delhi	1491	0	1491	1491	0.00
Mumbai	1500	0	1500	1500	0.00
Bangalore	950	0	950	950	0.00
Hyderabad	900	0	900	900	0.00
Cochin	650	0	650	650	0.00
Nagpur	600	0	600	600	0.00
Chennai	950	0	950	950	0.00
Kolkata	1028	0	1028	1028	0.00
Trivandrum	520	0	520	520	0.00
Ahmedabad	322	0	322	322	0.00
Goa	102	0	102	102	0.00
Calicut	226	0	226	226	0.00
Guwahati	250	0	250	250	0.00
Jaipur	294	0	294	294	0.00
Srinagar	72	0	72	72	0.00
Amritsar	208	0	208	208	0.00
Port Blair	30	0	30	30	0.00

Source: Concerned Airport Operators and Association of Private Airport Operators

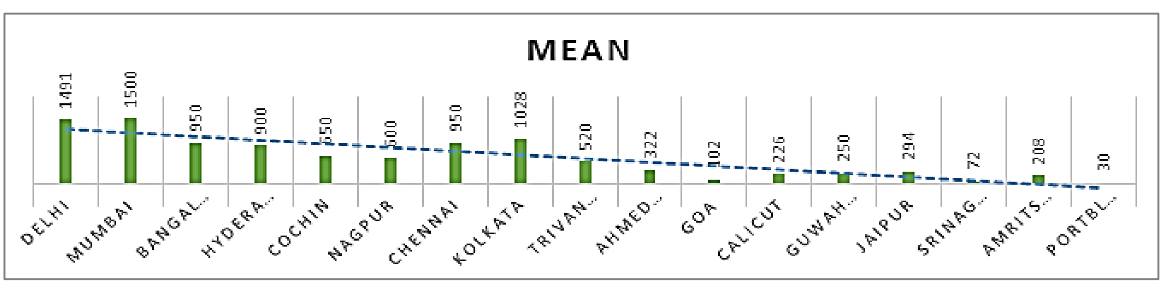

Figure 5.5: Manpower (in No's)

5.4.2.2 Depreciation

The average depreciation reported in Table 5.7 has been largest at Delhi Airport followed by Ahmedabad, Goa, Chennai, Mumbai, Bangalore, Hyderabad etc. The variation in depreciation is largest at Kolkata followed by Nagpur, Trivandrum and Mumbai etc. The CAGR varies from 0 to 132% that is the growth in depreciation is largest at Kolkata followed by Trivandrum and Cochin etc.

Table 5.7 Depreciation (in Cr.)

Airports	Mean	SD	Min	Max	CAGR
Delhi	4000	0	4000	4000	0.00
Mumbai	1700	265	1500	2000	15.47
Bangalore	1300	100	1200	1400	8.01
Hyderabad	1233	58	1200	1300	4.08
Cochin	200	100	100	300	73.21
Nagpur	626	76	582	714	10.77
Chennai	2033	1012	1400	3200	51.19
Kolkata	1267	1242	500	2700	132.38
Trivandrum	1439	869	441	2030	114.67
Ahmedabad	2728	420	2319	3159	16.71
Goa	2243	477	1739	2689	24.34
Calicut	1425	310	1091	1706	25.01
Guwahati	1326	207	1109	1521	17.12
Jaipur	1149	235	903	1372	23.24
Srinagar	1134	297	806	1386	31.14
Amritsar	579	137	441	714	27.30
Port Blair	428	114	302	524	31.74

Source: Concerned Airport Operators and Association of Private Airport Operators

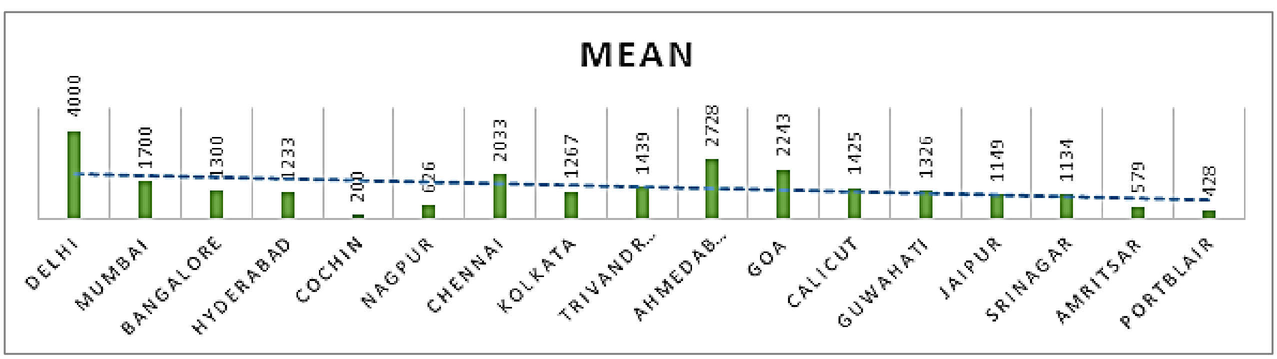

Figure 5.6: Depreciation (in Cr.)

5.4.2.3 Operating Expenses

Table 5.8 Operating Expenses (in Cr.)

Airports	Mean	SD	Min	Max	CAGR
Delhi	7033	1115	6200	8300	15.70
Mumbai	4000	1000	3000	5000	29.10
Bangalore	2000	300	1700	2300	16.32
Hyderabad	2133	58	2100	2200	2.35
Cochin	1600	100	1500	1700	6.46
Nagpur	1919	262	1768	2223	12.12
Chennai	2800	265	2500	3000	9.54
Kolkata	1937	522	1550	2530	27.76
Trivandrum	4458	2631	1448	6320	108.89
Ahmedabad	8558	1143	7623	9831	13.57
Goa	7027	1326	5717	8369	20.99
Calicut	4462	861	3587	5309	21.65
Guwahati	4160	547	3644	4734	13.97
Jaipur	3599	651	2968	4269	19.93
Srinagar	3547	840	2650	4315	27.61
Amritsar	1813	389	1448	2223	23.88
Port Blair	1337	322	992	1631	28.19

Source: Concerned Airport Operators and Association of Private Airport Operators

It has been observed from Table 5.8 that the growth in operating expenses has been highest in Mumbai followed by Port Blair, Kolkata, Srinagar, and Amritsar etc.

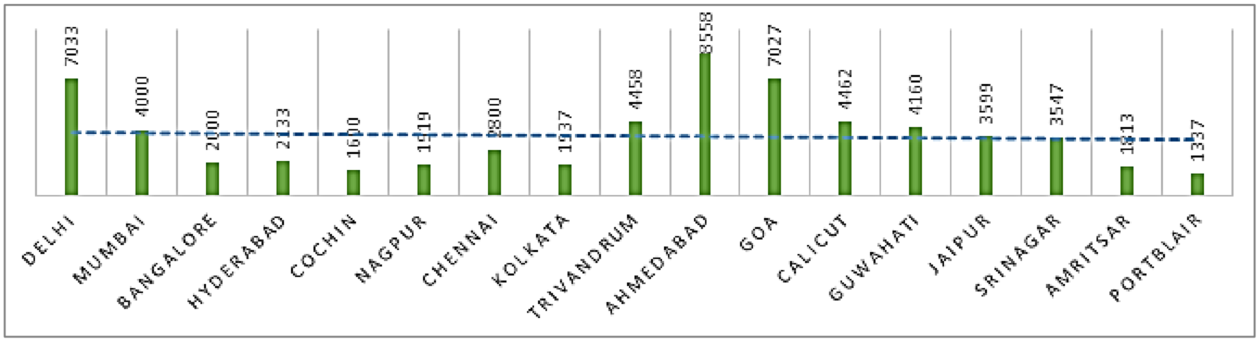

Figure 5.7: Operating Expenses (in Cr.)

5.4.2.4 Interest

Table 5.9 depicts that the interest Expenses remained highest in Delhi followed by Hyderabad, Bangalore and Mumbai. There is a large variation in interest expenses for Mumbai, Delhi Kolkata and Ahmedabad Airport.

Table 5.9 Interest (in Cr.)

Airports	Mean	SD	Min	Max	CAGR
Delhi	5667	577	5000	6000	-8.71
Mumbai	1077	713	660	1900	69.67
Bangalore	1200	100	1100	1300	-3.92
Hyderabad	2000	0	2000	2000	0.00
Cochin	23	25	0	50	58.11
Nagpur	54	6	47	58	-9.51
Chennai	0	0	0	0	0.00
Kolkata	333	208	100	500	-50.00
Trivandrum	113	83	22	183	148.29
Ahmedabad	197	77	115	268	34.99
Goa	164	72	86	228	43.81
Calicut	105	47	54	147	44.59
Guwahati	97	40	55	134	35.47
Jaipur	84	36	45	116	42.54
Srinagar	84	41	40	120	51.68
Amritsar	42	18	22	58	47.24
Port Blair	32	15	15	45	52.37

Source: Concerned Airport Operators and Association of Private Airport Operators

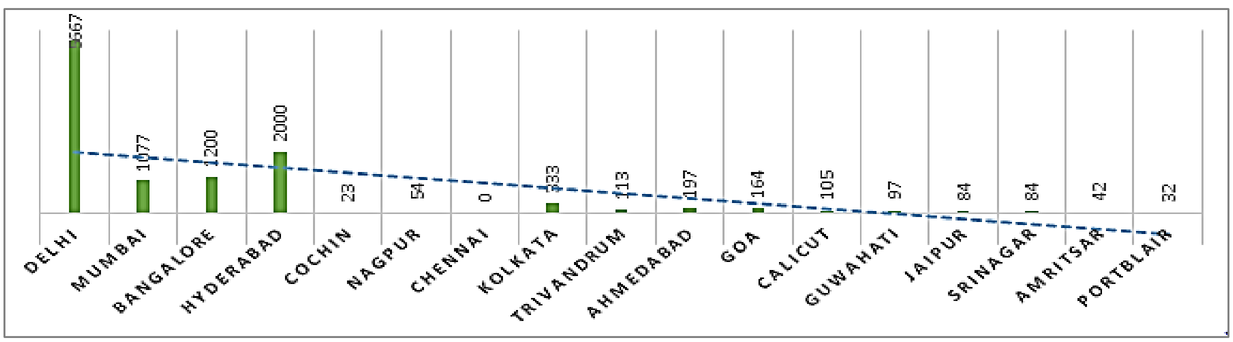

Figure 5.8: Interest (in Cr.)

5.4.2.5 Summary of Input Variables

We have considered manpower, depreciation, operative expenses and interest as the input variables in this study. The descriptive data analysis of all the input variables is reported below in Table 5.10. Table 5.10 depicts that the last 3 years average manpower varies from 30 to 1500 between different airports. The average depreciation reported in Table 2 has been largest at Delhi Airport followed by Ahmedabad, Goa, Chennai, Mumbai, Bangalore, Hyderabad etc. This varies from Rs. 1337 crores to Rs. 7033 Crores. Average depreciation changes from Rs. 200 crores for Cochin airport to crores to Rs. 4000 Crores for Delhi Airport.

The variation in average interest payment is very large i.e. it changes from Rs. 0 crores for Chennai airport to crores to Rs.5567 Crores for Delhi Airport.

Table 5.10 Average Value of Input Variables (in No's)

Airports	Manpower (No's)	Operating Expenses (crore)	Depreciation/ Investment (Crore)	Interest/ Debt (crore)
Delhi	1491	7033	4000	5667
Mumbai	1500	4000	1700	1077
Bangalore	950	2000	1300	1200
Hyderabad	900	2133	1233	2000
Cochin	650	1600	200	23
Nagpur	600	1919	626	54
Chennai	950	2800	2033	0
Kolkata	1028	1937	1267	333
Trivandrum	520	4458	1439	113
Ahmedabad	322	8558	2728	197
Goa	102	7027	2243	164
Calicut	226	4462	1425	105
Guwahati	250	4160	1326	97
Jaipur	294	3599	1149	84
Srinagar	72	3547	1134	84
Amritsar	208	1813	579	42
Port Blair	30	1337	428	32

Source: Concerned Airport Operators and Association of Private Airport Operators

Note: The avg in the above table are based on the 3 years (2011-12 to 2014-15) actual data.

5.5 Result and Discussion

The efficiency analyses of 17 major Indian airports[8] have been undertaken based on last 3 years data (2011-2012 to 2013-2014). These 17 airports include 6 Joint Venture/Private Airports viz. Delhi Airport, Mumbai Airport, Bangalore Airport, Hyderabad Airport, Cochin Airport & Nagpur Airport.

Delhi & Mumbai airports have been leased on Build, Operate & Transfer (BOT) basis for 60 years[9]. Bangalore and Hyderabad Airports have been developed on Build, Own, Operate & Transfer (BOOT) basis by Private Operators. Cochin Airport is developed on Build, Own &

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[8] Airports handling more than 1.5 million passengers per year are defined as major airports.

[9] 30+30

Operate (BOO) basis. Nagpur Airport is managed by a joint venture 'Multimodal International Cargo Hub at Nagpur (MIHAN)' and Airports Authority of India (AAI). The Remaining 11 Airports managed and owned by AAI, a government owned public sector undertakings are Chennai, Kolkata, Trivandrum, Ahmedabad, Goa, Calicut, Guwahati, Jaipur, Srinagar, Amritsar, and Port Blair. The outcomes of DEA analysis is given below:

5.5.1 Combined Efficiency

Combined efficiency for revenue earned, aircraft movements' passengers and cargo as output variables and manpower, fixed cost, operating expenses and interest as input variables is presented in Table 5.11 below. Delhi and Mumbai Airport has been evaluated as most efficient in maximizing the output for given inputs with the highest efficiency of 1 followed by Goa (0.78), Srinagar (0.69), Bangalore (0.65) and Ahmedabad (0.60). The average efficiency of JV Airports is 0.64 as against the average efficiency of 0.55 of AAI Airports leading to an overall average efficiency of 0.58. Thus, it has been concluded that the efficiency of JV airports is higher than the efficiency of Govt. Airports, in use of inputs for maximization of outputs. This has been achieved due to use of economies of scale and management efficiency of private operators.

Table 5.11: Combined Efficiency

Airports	2011-12	2012-13	2013-14	AVG
Delhi	1.00	1.00	1.00	1.00
Mumbai	1.00	1.00	1.00	1.00
Bangalore	0.63	0.73	0.61	0.65
Hyderabad	0.43	0.71	0.38	0.51
Cochin	0.36	0.60	0.30	0.42
Nagpur	0.11	0.52	0.14	0.26
Chennai	0.66	0.63	0.68	0.66
Kolkata	0.50	0.72	0.39	0.53
Trivandrum	0.26	0.52	0.39	0.39
Ahmedabad	0.50	0.52	0.76	0.60
Goa	0.81	0.52	1.00	0.78
Calicut	0.38	0.52	0.60	0.50
Guwahati	0.35	0.52	0.53	0.47
Jaipur	0.26	0.52	0.41	0.40
Srinagar	0.66	0.52	0.90	0.69
Amritsar	0.19	0.52	0.31	0.34
Port Blair	0.62	0.52	0.95	0.70
Average- JV	0.59	0.76	0.57	0.64
Average AAI	0.47	0.55	0.63	0.55
Average	0.51	0.62	0.61	0.58

5.5.2 Efficiency of manpower utilizations

The DEA technique has been used by considering revenue earned, aircraft movement passengers and cargo as output variables and manpower as input variables. In this analysis Delhi has been assessed as most efficient Airports with the efficiency score of 1, followed by Mumbai (0.98), Goa (0.82), and Chennai (0.71) and so on. The average efficiency of JV Airport (0.60) is higher than the average efficiency of AAI Airports (0.45) leading to the combined average efficiency of 0.50. Thus, it is concluded that the JV Airports are more efficient in utilization of manpower possibly due to economies of scale. Detailed results are reported in Table 5.12 below.

Table 5.12: Efficiency of Manpower Utilization

Airports	2011-12	2012-13	2013-14	AVG
Delhi	1.00	1.00	1.00	1.00
Mumbai	0.94	1.00	1.00	0.98
Bangalore	0.63	0.60	0.62	0.62
Hyderabad	0.46	0.34	0.32	0.37
Cochin	0.27	0.27	0.25	0.26
Nagpur	0.10	1.00	0.05	0.38
Chennai	0.74	0.74	0.71	0.73
Kolkata	0.44	0.39	0.36	0.39
Trivandrum	0.26	0.22	0.17	0.22
Ahmedabad	0.52	0.50	0.48	0.50
Goa	1.00	0.88	0.57	0.82
Calicut	0.34	0.39	0.29	0.34
Guwahati	0.42	0.25	0.23	0.30
Jaipur	0.24	0.18	0.15	0.19
Srinagar	0.63	0.66	0.45	0.58
Amritsar	0.18	0.12	0.09	0.13
Port Blair	0.98	0.69	0.60	0.76
Average- JV	0.56	0.70	0.54	0.60
Average AAI	0.52	0.46	0.37	0.45
Average	0.54	0.54	0.43	0.50

5.5.3 Efficiency of use of operating expenses/operating cost

In this study we considered revenue, aircraft movements, passengers and cargo as output variables and operating cost as input variables. The result in Table 5.13 reveals that Mumbai Airport is most efficient in operating cost management with the efficiency score of 1 followed by Bangalore (0.84), Delhi (0.61), Chennai (0.60), Hyderabad (0.58), and Kolkata (0.55) and so on. The average efficiency of JV Airport (0.58) is substantially higher than the average efficiency of AAI Airports (0.17) leading to an overall average efficiency of 0.32.

Table 5.13: Efficiency of use of operating expenses/operating cost

Airports	2011-12	2012-13	2013-14	AVG
Delhi	0.57	0.57	0.69	0.61
Mumbai	1.00	1.00	1.00	1.00
Bangalore	0.83	0.83	0.87	0.84
Hyderabad	0.55	0.56	0.61	0.58
Cochin	0.32	0.32	0.49	0.38
Nagpur	0.10	0.10	0.09	0.10
Chennai	0.57	0.57	0.67	0.60
Kolkata	0.26	0.77	0.62	0.55
Trivandrum	0.04	0.22	0.07	0.11
Ahmedabad	0.08	0.06	0.07	0.07
Goa	0.09	0.06	0.07	0.07
Calicut	0.05	0.05	0.07	0.06
Guwahati	0.11	0.09	0.07	0.09
Jaipur	0.08	0.07	0.07	0.08
Srinagar	0.10	0.05	0.07	0.08
Amritsar	0.11	0.08	0.07	0.09
Port Blair	0.09	0.09	0.07	0.09
Average- JV	0.56	0.56	0.62	0.58
Average AAI	0.15	0.19	0.18	0.17
Average	0.29	0.32	0.33	0.32

5.5.4 Efficiency of Investment Management

In this study we considered revenue earned, aircraft movement passengers and cargo as output variables and depreciation as input variables (see Table 5.14). Depreciation here has been taken as proxy variable for investment. The outcome of DEA reveal that Cochin Airport(1.00) has been found as most efficient in application of investment followed by Mumbai (0.82), Delhi (0.47), Kolkata (0.43), Bangalore (0.39), Hyderabad (0.33) and so on. This case also the average efficiency of JV Airports (0.35) is significantly higher than AAI Airport (0.25) resulting into an overall average efficiency of 0.35. The efficiency in investment is achieved through the creation of optimum capacity to handle the demand.

Table 5.14 Efficiency of Investment Management

Airports	2011-12	2012-13	2013-14	AVG
Delhi	0.20	0.55	0.67	0.47
Mumbai	0.46	1.00	1.00	0.82
Bangalore	0.23	0.48	0.46	0.39
Hyderabad	0.15	0.36	0.47	0.33
Cochin	1.00	1.00	1.00	1.00
Nagpur	0.05	0.23	0.39	0.22
Chennai	0.21	0.50	0.22	0.31
Kolkata	0.45	0.65	0.20	0.43
Trivandrum	0.05	0.25	0.39	0.23
Ahmedabad	0.04	0.24	0.39	0.23
Goa	0.04	0.22	0.38	0.21
Calicut	0.04	0.24	0.39	0.23
Guwahati	0.04	0.22	0.38	0.22
Jaipur	0.04	0.22	0.38	0.22
Srinagar	0.04	0.22	0.38	0.21
Amritsar	0.04	0.22	0.38	0.22
Port Blair	0.04	0.22	0.38	0.22
Average- JV	0.35	0.60	0.66	0.54
Average AAI	0.10	0.29	0.35	0.25
Average	0.18	0.40	0.46	0.35

5.5.5 Efficiency in application of debt in the management of Airports

In this study we considered revenue earned, aircraft movements, passengers and cargo as output variables and interest as input variables (see Table 5.15). Interest has been taken as proxy variable for application of debt. In this case Chennai Airport (0.67) has been found as most efficient in use of debt followed by Cochin Airport (0.50), Nagpur Airport (0.47) and Kolkata Airport (0.36). In application of debt the variation in efficiency scored is high and also contrary to the previous analysis the average efficiency AAI Airports (0.21) is marginally higher than the average efficiency of JV Airport (0.20).Resulting into an average efficiency of 0.20. This maybe concluded that the JV Airports have used higher proportion of debt as compared to AAI Airports.

Table 5.15: Efficiency in application of debt in the management of Airports

Airports	2011-12	2012-13	2013-14	AVG
Delhi	0.01	0.02	0.08	0.04
Mumbai	0.05	0.14	0.20	0.13
Bangalore	0.01	0.03	0.12	0.05
Hyderabad	0.01	0.01	0.04	0.02
Cochin	0.26	0.23	1.00	0.50
Nagpur	0.03	1.00	0.38	0.47
Chennai	1.00	1.00	0.00	0.67
Kolkata	0.03	0.05	1.00	0.36
Trivandrum	0.15	0.04	0.38	0.19
Ahmedabad	0.05	0.04	0.39	0.16
Goa	0.04	0.02	0.33	0.13
Calicut	0.04	0.04	0.38	0.15
Guwahati	0.05	0.03	0.35	0.14
Jaipur	0.05	0.03	0.34	0.14
Srinagar	0.04	0.02	0.34	0.13
Amritsar	0.05	0.02	0.33	0.14
Port Blair	0.06	0.03	0.35	0.14
Average- JV	0.06	0.24	0.30	0.20
Average AAI	0.14	0.12	0.38	0.21
Average	0.11	0.16	0.35	0.21

5.5.6 Comparison of Efficiencies before adjustment to scale

Five categories of efficiencies have been computed using DEA Techniques with combination of four outputs variable viz. Revenue, Aircraft Movements, Passengers & Cargo Traffic and the following five categories of input variables:

(i) Combined efficiency: Manpower, Operating Expense, Depreciation as shadow variable for Investment and Interest as shadow variable for Debt management.

(ii) Manpower Efficiency: Manpower.

(iii) Operating Expenses Efficiency: Operating Expenses.

(iv) Investment Efficiency: Depreciation.

(v) Debt Efficiency: Interest

Three year's average efficiencies for above five categories of major 17 airports are presented in Table 5.16 below.

Table 5.16: Average Efficiencies before adjustment to scale

Airports	Efficiency				
	Combined	Manpower	Operating	Investment	Debt
Delhi	1.00	1.00	0.61	0.47	0.04
Mumbai	1.00	0.98	1.00	0.82	0.13
Bangalore	0.65	0.62	0.84	0.39	0.05
Hyderabad	0.51	0.37	0.58	0.33	0.02
Cochin	0.42	0.26	0.38	1.00	0.50
Nagpur	0.26	0.38	0.10	0.22	0.47
Chennai	0.66	0.73	0.60	0.31	0.67
Kolkata	0.53	0.39	0.55	0.43	0.36
Trivandrum	0.39	0.22	0.11	0.23	0.19
Ahmedabad	0.60	0.50	0.07	0.23	0.16
Goa	0.78	0.82	0.07	0.21	0.13
Calicut	0.50	0.34	0.06	0.23	0.15
Guwahati	0.47	0.30	0.09	0.22	0.14
Jaipur	0.40	0.19	0.08	0.22	0.14
Srinagar	0.69	0.58	0.08	0.21	0.13
Amritsar	0.34	0.13	0.09	0.22	0.14
Port Blair	0.70	0.76	0.09	0.22	0.14
Average- JV	0.64	0.60	0.58	0.54	0.20
Average AAI		0.45	0.17	0.25	0.21
Average	0.58	0.50	0.32	0.35	0.21

Note: The average efficiencies in the above table are based on average of last 3 years (2011-12 to 2014-15) efficiencies.

The above table reveals that Private/JV airports are more efficient than Govt. airports for all the five categories. Delhi and Bombay airports are most efficient in combined efficiency. Delhi airport in use of manpower, Bombay airport in use of operating expenses, Cochin airport in use of investment and Chennai airport in use of debt is most efficient.

5.6 Analysis of impact of economies of scale on efficiency and comparison of scale adjusted efficiencies for different Airports

The efficiency analyses of 17 major Indian airports[10] have been undertaken based on last 3 years data (2011-2012 to 2013-2014). These 17 airports include 6 Joint Venture/Private Airports viz. Delhi Airport, Mumbai Airport, Bangalore Airport, Hyderabad Airport, Cochin Airport & Nagpur Airport.

Delhi & Mumbai airports have been leased on Build, Operate & Transfer (BOT) basis for 60 years[11]. Bangalore and Hyderabad Airports have been developed on Build, Own, Operate & Transfer (BOOT) basis by Private Operators. Cochin Airport is developed on Build, Own & Operate (BOO) basis. Nagpur Airport is managed by a joint venture 'Multimodal International Cargo Hub at Nagpur (MIHAN)' and Airports Authority of India (AAI). The Remaining 11 Airports managed and owned by AAI, a government owned public sector undertaking, are Chennai, Kolkata, Trivandrum, Ahmedabad, Goa, Calicut, Guwahati, Jaipur, Srinagar, Amritsar, and Port Blair. The outcomes of DEA analysis is given Table 5.17.

5.6.1 Analysis of marginal efficiencies is presented in Table 5.17 below

Item	Manpower Utilization	Operating Expenses	Investment Management	Debt Management	Combined
Airport Throughput Unit (ATU)	0.010657* (0.0026)	0.007408* (0.0019)	0.005979* (0.0019)	0.005491*** (0.0030)	0.0079* (0.0015)
JV Airports	-0.00952# (0.1410)	-0.03318# (0.1033)	0.010284# (0.1069)	0.285517*** (0.1631)	-0.2497*
Price Cap Hybrid Till	0.0# (0.0)	0.0# (0.0)	0.0# (0.0)	0.0# (0.0)	0.0#
Light touch approach	0.0# (0.0)	0.0# (0.0)	0.0# (0.0)	0.0# (0.0)	0.0#
Price Cap single Till	0.193737# (0.1909)	-0.22874# (0.1398)	-0.7353# (0.1446)	0.011326# (0.2207)	-0.1081#

[10] Airports handling more than 1.5 million passengers per year are defined as major airports.

[11] 30+30

JV Airports with Hybrid Till	0.108623# (0.1748)	0.122411# (0.1281)	-0.70539* (0.1325)	-0.062759* (0.2022)	0.0933#
JV airports (Light Touch Approach)	0.0# (0.0)	0.0# (0.0)	0.0# (0.0)	0.0# (0.0)	0.0#
JV airports (Single Till)	0.0# (0.0)	0.0# (0.0)	0.0# (0.0)	0.0# (0.0)	0.0#
Intercept (Avg. of Govt. & single till)	0.1697# (0.1981)	0.338143* (0.1451)	0.931845* (0.1502)	0.158002# (0.2291)	0.5925* (0.1129)

Table 5.17: Analysis of marginal efficiencies

Figures within bracket represent standard error

*=significant at 1%, ** =significant at 5%, ***=Significant at 10% #=significant at>10%or not significant for actual models refer annexure 5.1-1 to5.1-5.

The interpretation of results of table 5.17 is described below:

- **Overall Efficiency:** Efficiency increases significantly with increase in size of airport i.e. Economies of Scale is most significant factor influencing efficiency. The efficiency decreases significantly with privatization of airport. The effect of type of regulation on efficiency is not statistically significant individually.
- **Manpower Efficiency:** Efficiency increases with size of airport significantly, the effect of privatization and regulation is not significant.
- **Operating Expenses Efficiency**: Efficiency increases with size of airport significantly, the effect of privatization and regulation is not significant.
- **Investment Efficiency:** Efficiency increases with size of airport significantly but decreases significantly with the combination of privatization and hybrid till.

- **Debt Efficiency:** Increases with size of airport at 10% level of significance and also increases with privatization at 10% level of significance but decreases with the combination of privatization and hybrid till significantly.
- **Govt. Ownership:** Efficiency increases significantly with government ownership and single till regulation in all of the above cases.
- **Private Ownership:** Combined efficiency decreases significantly with private ownership but debt efficiency increases at 9% level of significance. Private ownership in combination with hybrid till decreases debt efficiency significantly.

The above Results can be presented in the following mathematical models after omitting non-significant marginal efficiency.

The dummy Variables considered for presenting models (addition to Airport Throughput Unit) are also given below

D1=JV Airports	D4=Price Cap single Till	D1*D4=JV airports with
D2= Price Cap	D1*D2=JV Airports with Hybrid Till	
D3=Light touch	D1*D3= JV airports with Light Touch	

Combined Efficiency

Combined efficiency = 0.592506 + 0.007982*ATU (in million) - 0.24977*D1(JV-Airports)

P-value (8.62E-06) (1.58E-06) (0.027272)

F-value = 21.70625

Adjusted R Square = 0.536608 **…..(i)**

The above analysis brings out that the marginal efficiency of Airport size measured in million ATU is 0.008066, which is highly significant at 0.05% level of significance. The differential co-efficient for JV airports are negative which means that there is decrease in efficiency due to privatization. The differential co-efficient for remaining variables were not significant and have been dropped

Manpower utilization Efficiency

Manpower utilization Efficiency = 0.1697 + 0.010657*TU (in million)

P-value (0.396154) (0.000144)

F-value = 8.885759

Adjusted R Square = 0.29987 **…..(ii)**

The efficiency of manpower utilization is also affected by the size of the airport significantly. The differential coefficients for other variables are statistically insignificant.

Operating Expenses utilization Efficiency

Operating Expenses Utilization efficiency = 0.338143 + 0.007408*TU (in million)

P-value (0.024269) (0.00028)

F-value = 31.29689

Adjusted R Square = 0.620966 **…..(iii)**

Only economies of scale are statistically significant.

Investment Management Efficiency (IME)

Investment Efficiency = 0.931845+ 0.005979*TU (in million) - 0.70539*D1*D2

P-value (1.42E-07) (0.003595) (2.94E-06)

F-value = 18.06782

Adjusted R Square = 0.490287 **…..(iv)**

It is seen from the above equation that the coefficient of airport size and Joint Venture Airport with hybrid till regulation are statistically significant.

Debt Management Efficiency (DME)

DME = 0.158002+ 0.005491*TU (in million) + 0.285517*D1(JV Airport) -0.62759* D1*D2

P-value (0.49393) (0.071166) (0.086682) (0.003258)

F-value = 3.337595

Adjusted R Square = 0.070589 **…..(v)**

In equation 1 to 5 above, the intercept in each represents the base value of efficiency for government run airports under price cap regulation with single till approach.

5.6.2 Comparative Analysis of Efficiencies of different Airports and different categories before & after adjustment to scale

It has been established in section 6.2 above that economics of scale is the highly significant factor affecting each category of efficiency and also all the 17 airports under study are very heterogeneous with reference scale (ATU). Therefore efficiencies have been compared after adjustment to scale in Table 5.18 below, where airport size is defined as-

Large Airports	Airports which handles Passenger Traffic > 30 million/year.
Medium Airports	Airports which handles Passenger Traffic<=30 million/year and > 10 million/year
Small Airports	Airports which handles Passenger Traffic <=10 million/year and > =1.5 million/year

Table 5.18 : Comparative Analysis of Efficiencies of different Airports and different categories before & after adjustment to scale

Airport/ Category	Efficiency									
	Combined		Manpower		Operating Expenses		Investment		Debt	
Unadjusted=UA Adjusted=A	UA	A	UA	A	UA	A	UA	A	UA	A
Delhi	1	0.6	1	0.35	0.61	0.15	0.47	0.06	0.04	0
Mumbai	1	0.68	0.98	0.43	1	0.83	0.82	0.48	0.13	0
Bangalore	0.65	0.61	0.62	0.47	0.84	1	0.39	0.26	0.05	0
Hyderabad	0.51	0.5	0.37	0.25	0.58	0.69	0.33	0.24	0.02	0
Cochin	0.42	0.48	0.26	0.23	0.38	0.49	1	1	0.5	0.87
Nagpur	0.26	0.34	0.38	0.48	0.1	0.14	0.22	0.22	0.47	0.88
Chennai	0.66	0.6	0.73	0.58	0.6	0.61	0.31	0.16	0.67	1
Kolkata	0.53	0.5	0.39	0.24	0.55	0.62	0.43	0.33	0.36	0.48
Trivandrum	0.39	0.48	0.22	0.23	0.11	0.12	0.23	0.22	0.19	0.32
Ahmedabad	0.6	0.73	0.5	0.55	0.07	0.02	0.23	0.2	0.16	0.23
Goa	0.78	1	0.82	1	0.07	0.05	0.21	0.19	0.13	0.2
Calicut	0.5	0.65	0.34	0.41	0.06	0.06	0.23	0.23	0.15	0.26
Guwahati	0.47	0.6	0.3	0.34	0.09	0.1	0.22	0.21	0.14	0.23
Jaipur	0.4	0.52	0.19	0.22	0.08	0.1	0.22	0.22	0.14	0.24
Srinagar	0.69	0.91	0.58	0.73	0.08	0.1	0.21	0.21	0.13	0.23
Amritsar	0.34	0.46	0.13	0.16	0.09	0.13	0.22	0.23	0.14	0.26
Port Blair	0.7	0.95	0.76	0.99	0.09	0.14	0.22	0.23	0.14	0.27
Private Airports	0.64	0.54	0.6	0.37	0.59	0.55	0.54	0.38	0.2	0.29
Govt. Airports	0.55	0.67	0.45	0.5	0.17	0.19	0.25	0.22	0.21	0.34
Overall	0.58	0.62	0.5	0.45	0.32	0.31	0.35	0.27	0.21	0.32
Hybrid Till	0.79	0.6	0.74	0.37	0.76	0.67	0.5	0.26	0.06	0
Light Touch	0.42	0.48	0.26	0.23	0.38	0.49	1	1	0.5	0.87
Single Till	0.53	0.64	0.45	0.49	0.17	0.18	0.25	0.22	0.24	0.38
Overall	0.58	0.62	0.5	0.45	0.32	0.31	0.35	0.27	0.21	0.32
Large Airport-	1	0.64	0.99	0.39	0.81	0.49	0.65	0.27	0.09	0
Medium	0.59	0.56	0.53	0.38	0.64	0.73	0.37	0.25	0.28	0.37
Small	0.5	0.65	0.41	0.48	0.11	0.13	0.29	0.29	0.21	0.36
Over all	0.58	0.62	0.5	0.45	0.32	0.31	0.35	0.27	0.21	0.32

Following is the interpretation of data given in the Table 20 above

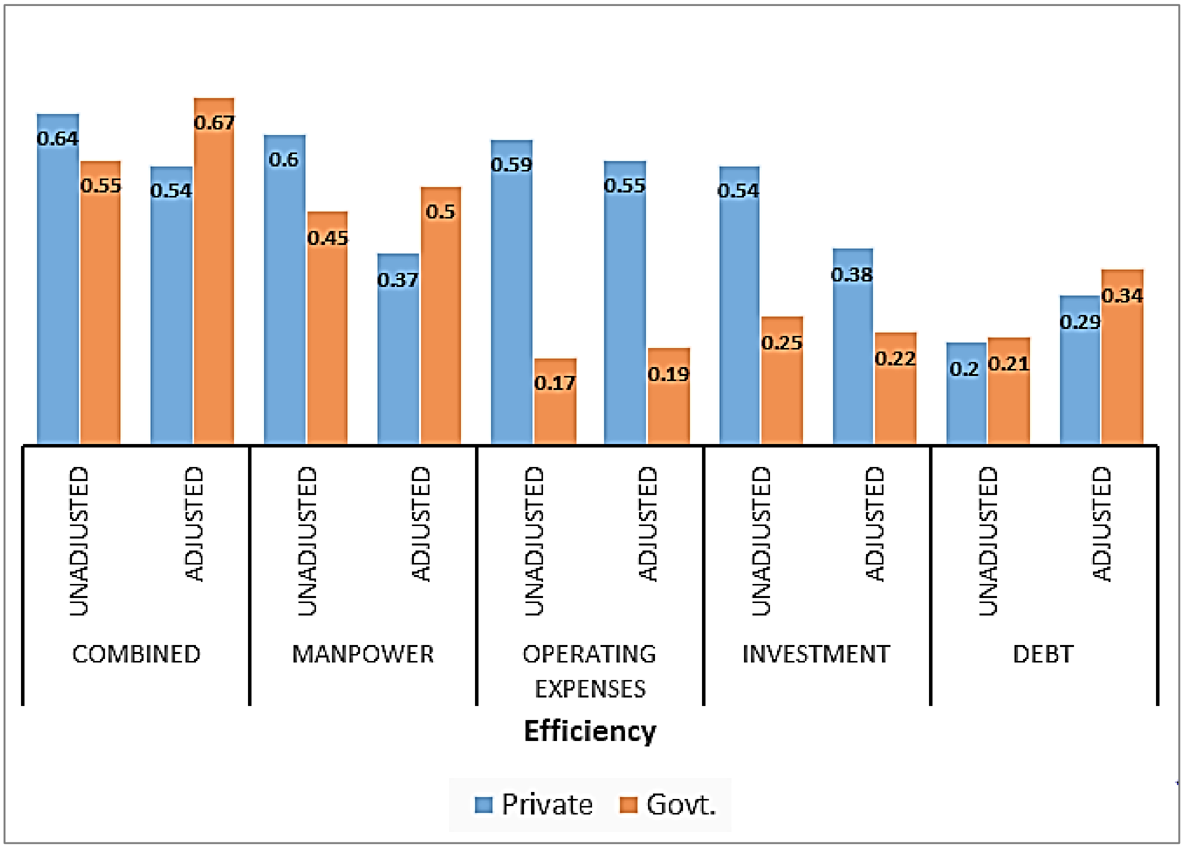
(i) After adjustment to scale, efficiency of Govt. Airports is higher than the efficiency of private airports

(ii) After scale adjustment smaller airports which are under government management are more efficient as compared with larger or medium size airports.

(iii) Regulatory approaches do not have significant difference on efficiency.

(iv) The above results are depicted in Fig.5. 9-5.12 below

Figure 5.9 Efficiency of Private Vs Govt. Airport before adjustment to scale and after adjustment to scale



Efficiency of Private Vs Govt.'s airport before adjustment to scale and after adjustment to scale may be interpreted based on Figure-5.9 as above:

The scale adjusted average combined, manpower and debt efficiency of Govt. airports is higher than adjusted efficiency of JV airports which was lower before adjustment. But the position remains unchanged in case of operating expenses and investment efficiency.

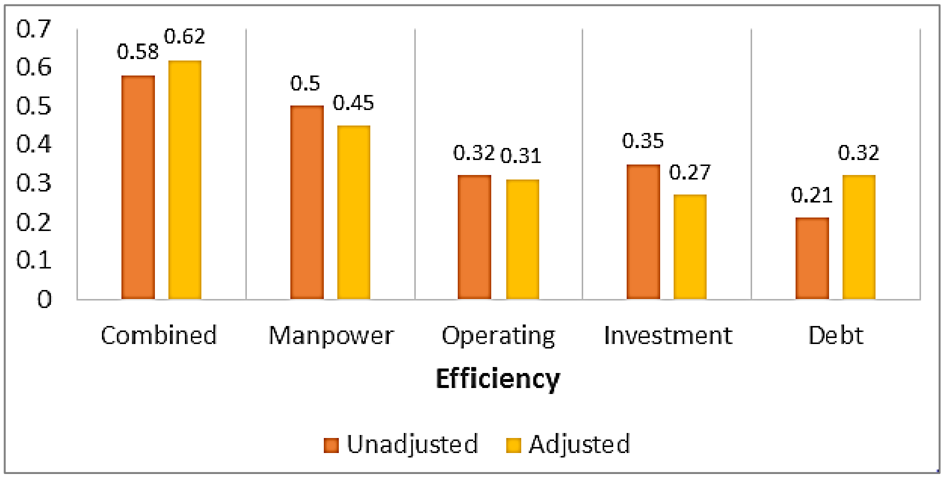


Figure 5-10 Overall efficiency of Private & Govt. airport

Figure 5.10 above may be interpreted as below:

The overall average adjusted combined and debt efficiency is higher than unadjusted efficiency. But relative comparative position of efficiency for manpower, operating expenses and investment efficiency, after adjustment and before adjustment remain unchanged.

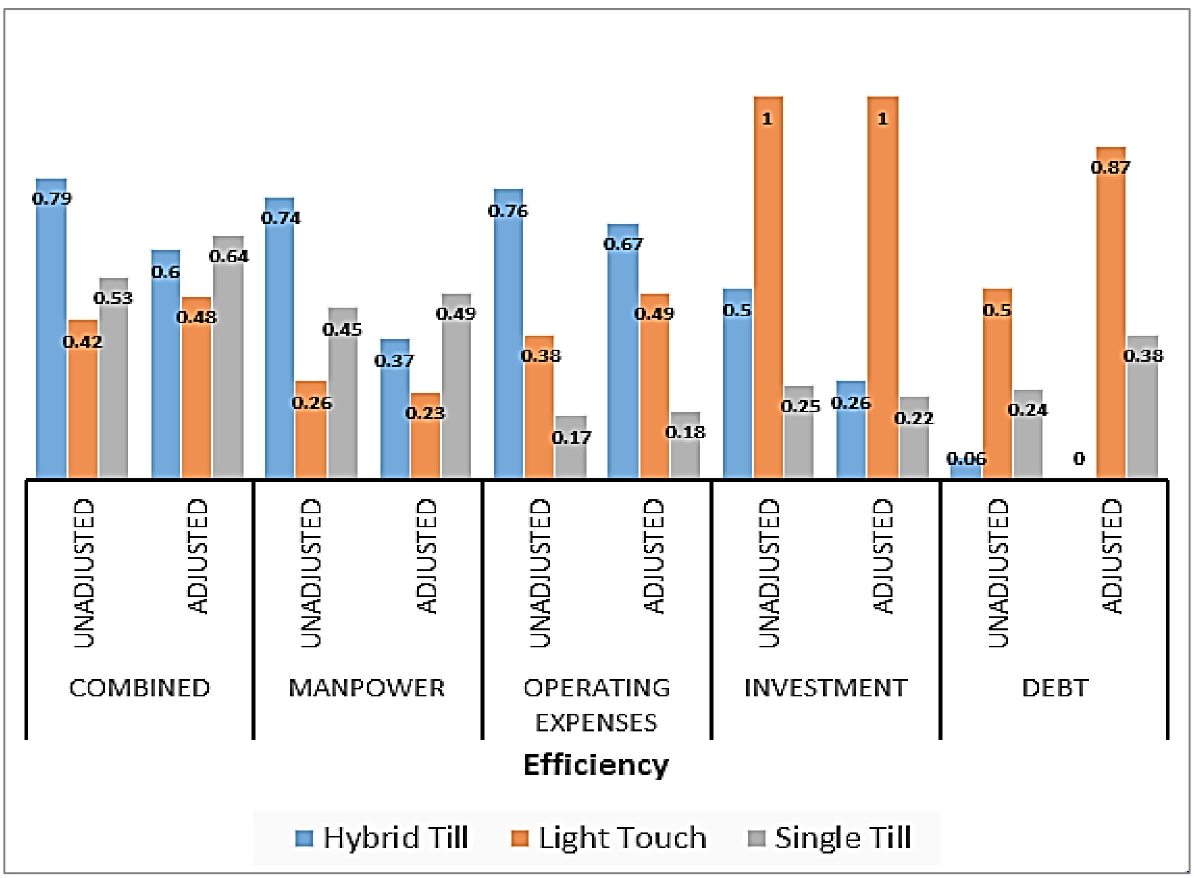


Figure 5-11Efficiency comparison of hybrid, single till & light touch when unadjusted and adjusted

Figure 11 above may be interpreted as below:

Relative position of efficiency, before and after adjustment, do not change for price cap (hybrid till and single till), and light touch regulatory approach because regulatory approach do not have significant difference.

5.7 Conclusion and Policy Implication

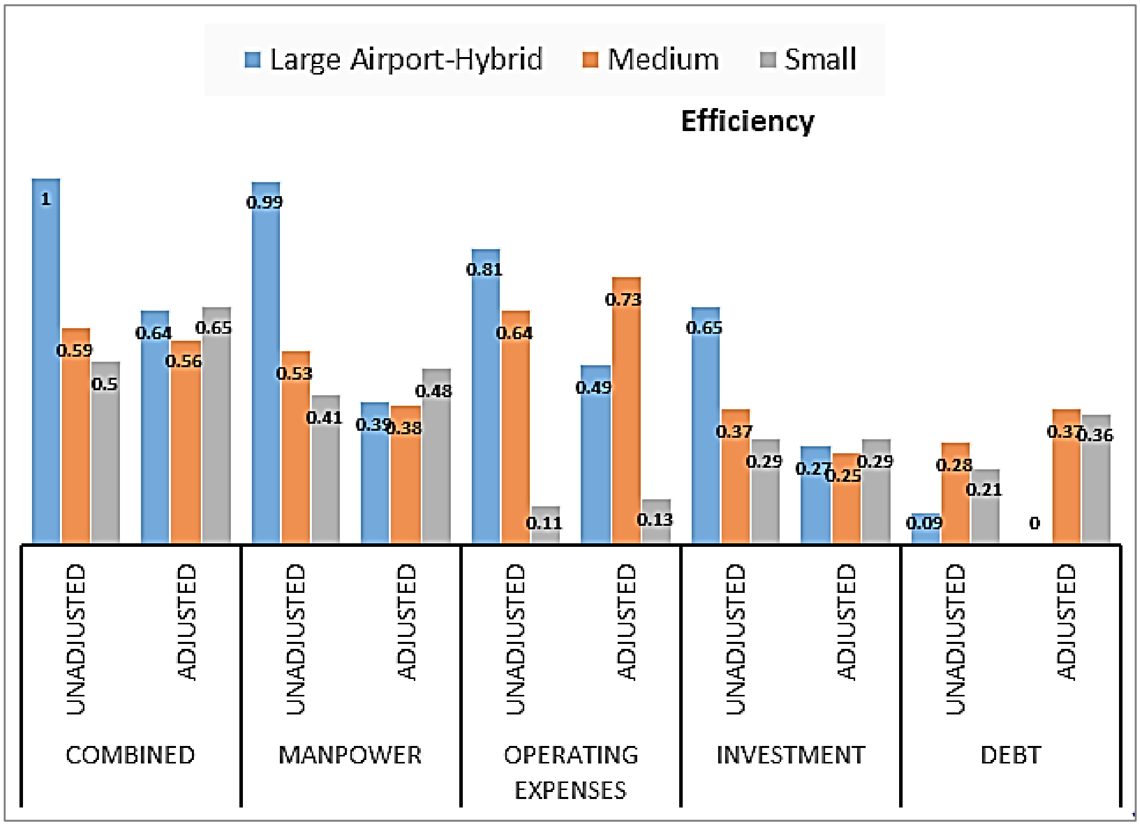


Figure 5-12 Efficiency of large, medium & Small airport when unadjusted and adjusted

Following conclusion has been drawn (see Figure 12):

The average adjusted efficiency of smaller airports has become higher than the average unadjusted efficiency of medium and large airports for combine, manpower and investment efficiency. But relative efficiency position remains unchanged after adjustment for operating expenses and debt efficiency.

Privatization of airports has caused over utilization of scarce resources such as investible financial resources, debt, manpower and operating expenses.

Privatization in combination with hybrid till has caused the consumption of excess capital resources/use of higher operational leverage and use of more debt/higher financial leverage.

Economies of scale are most important factor in minimization of consumption of input resources for given outputs.

Government ownership in combination with single till regulation also minimizes use of input resources for given output and needs to be encouraged in airport sector.

Policy Implication:

(i) Privatization in combination with hybrid till leads to overinvestment due to negative marginal efficiency of investment.

(ii) Privatization in combination with hybrid till leads to use of excessive debt due to negative marginal efficiency of Debt.

(iii) Government Ownership in combination with single till regulation minimize the use of inputs due to positive marginal efficiency may be promoted in airport sector

(iv) Privatization leads to inefficient use of resources due to negative marginal efficiency and needs to be discouraged in monopoly sector such as airports.

Limitation of this research

First round of regulation was undertaken in 2012 and therefore data for only 3 years was available. Effect of technology on efficiency could not be studied due to short period data.

Scope for future research

This research may be undertaken after 5-10 years when data for longer period is available. Efficiency analysis of Indian airports vis-à-vis foreign airports may be undertake

CHAPTER 6

FORECASTING INVESTMENT AND CAPACITY ADDITION OF INDIAN AIRPORTS

6.0 Introduction

With the advent of economic liberalization during 1991 there has been increase in the economic activities and with the resultant economic boom, disposable income of individuals has reached the new peak. The real GDP per capita of India which was growing at a compound annual growth rate (CAGR) of 3.9% during 1992-2001, started growing at an accelerated CAGR of over 6% during 2014-2015. Even during the recent global meltdown, India's economy was least affected and then recovered very fast than any other economy which explains the strong economic fundamentals of India. The recent trend in economic growth reveals that India is expected to be on the high growth trajectory during the next 20 years and Indian aviation sector will be no exception to it. Thus along with growth of economy we need to develop our aviation infrastructure in order to accommodate growing needs of the future. Empirical evidence suggests that there is a direct correlation between economic development and air travel. Therefore as economy grows, Civil Aviation is expected to grow significantly. With the increasing real GDP per capita and with the associated value of time or leisure time, demand for air travel is on rise in India. Airports facilitate business tourism, medical tourism, educational tourism, ethnic tourism, leisure tourism etc. Manufacturing and service sector activities get escalated with development of airports. In a nutshell, modern airport infrastructures are engine for economic growth and development of the nation.

Before economic liberalization and introduction of open sky policy in 1991, aviation was traditionally viewed as an elite activity. The two government airlines Air India (long haul international) and Indian Airlines (domestic and short haul international) were the only Indian carriers. With the advent of open sky policy, private airlines entered into the Indian sky, first as air taxi operators and then as scheduled operators. Indian aviation sector witnessed an unprecedented change and the resultant growth after 2003. During this period, the importance of aviation for the development of business, trade and tourism was recognized and the industry saw dramatic reforms across the aviation value chain.

In 2003, there were just 3 private carriers viz., Jet Airways, Air Sahara and Air Deccan, all operating full service models. The private carriers in those days were limited to operating domestic routes only. In 2015, there are 5 private carriers viz., Jet Airways, Kingfisher, Spice Jet, Indigo and Go Air are operating under 9 brand names and 3 of them are permitted to operate on international routes.

During the XI Plan Period, domestic carriers embraced to the Low Cost Carrier (LCC) model. The market share of LCC during 2014-15 has crossed 40% of the total domestic traffic. As a result, Indian carriers catered to 70 million on board domestic passengers and 50 million (all international carriers) on board international passengers during 2014-15 (190 million passengers handled at airports) and earned a total revenues of around Rs. 47,800 crores. During the XII Plan period, the domestic traffic for Indian carriers is growing at a healthy average annual rate of around 9%. The traffic growth has resulted in increased capacity utilization of domestic carriers with average passenger load factor having reached the new peak of over 76% mark during 2014-15. To cater need of the increasing demand, the domestic carriers have doubled their fleet size from around 200 to 450 during the XII plan period.

Economic activity and trade are closely connected and interlinked and therefore the fruits of India's impressive growth in international and domestic trade during the XII plan have been well reaped by the Indian air-cargo industry.

Total cargo traffic handled by Indian airports increased at a CAGR of 6.2% in last five years to reach 2.53 Million Metric Ton (MMT) per annum by 2014-15. International cargo, which accounts for two-thirds of the total cargo handled, is mainly concentrated at metro airports like Mumbai, Delhi, Chennai, Kolkata, Bangalore and Hyderabad. During the XII Plan period, these international airports witnessed entry of global players/ cargo handlers such as Celebi, Cargo Service Centre India Pvt. Ltd. (CSC), Menzies [12], etc. as cargo terminal operators.

[12] Celebi, CSC, and Menzies are global companies in cargo handling.

Ground handling business at Indian airports has grown to reach a size of approximately over Rs. 2,000 crores. This segment also witnessed increased participation of private players such as SATS, Celebi, Bird Group, Menzies[13], etc. In Joint Ventures (JVs), AIR India SATS (AISATS) is a JV between national carrier Air India and Singapore Air Transport Services. In 2011, Ministry of Civil Aviation (MOCA) announced a new ground handling policy under which only three ground handlers were allowed at each of the six metro airports in the country. One was an Air India subsidiary, the other a subsidiary of the airport operator and the third one, an entity selected through competitive bidding.

Airports Authority of India (AAI) continued its leadership in creating air connectivity across the country by incurring expenditure to the tune of Rs. 12,500 crores during the XI Plan period and Rs.70,000 crores was planned for the XII Plan period. AAI has upgraded and modernized 35 non-metro airports in the country, at an estimated cost of about Rs. 4,500 crores. AAI is enhancing air connectivity in the northeast by way of Greenfield airports at Pakyong (Sikkim), Itanagar (Arunachal Pradesh) and Cheitu (Nagaland).

The private sector played a major role during the XI Five Year Plan in the development of airports through Public Private Partnership (PPP) model. These include development of Greenfield International airports at Bangalore and Hyderabad and modernization of Delhi and Mumbai international airports. Total investment made by private airport operators in the last five years being about Rs.30,000 crores, which includes investment of Rs.12,857 crores for commissioning of the 34 Million Passenger per annum capacity Terminal 3 (T3) at the Delhi International Airport and Terminal 2 (T2) of Mumbai airport at the cost of over Rs. 5000 crores.

India has become the 9th largest civil aviation market in the world. The passenger handling capacity has grown from 73 million during 2005-06 to 190 million during 2014-15, resulting more than twofold increase. The cargo handling capacity has also grown from 1.4 million MT during 2005-06 to 3.3 million MT during 2014-15 i.e. more than 2.3 fold increase. Connectivity to north eastern region has gone up from 87 flights per week to over 300 flights per week indicating a 3 fold increase. Government of India has formed Airport Regulatory

[13] SATS, Celebi, Bird Group, Menzies are global cargo handling companies.

Authority of India (AERA) to safeguard the interests of the users and service providers at Indian airports.

In view of the above, airports are being viewed as commercial enterprises rather than public service organization and any progressive commercial enterprises require additional investment to sustain the future growth in demand. The overarching question that arises here in the above context is how much future investment is needed in airport sector in order to meet the growing demand of its services. Thus, future forecasting of investment in airport sector is the basic objective of this study which will enable planners and policy makers to take correct decisions and the government to allocate sufficient budget for development and expansion of airports in the country.

The remaining part of this chapter is as follows. The literature survey of this chapter is presented in section 6.1 followed by Objectives in section 6.2. Section 6.3 contains factors affecting growth in aviation sector with discussion of methodology and data source in section 6.4. Results and discussion are described in section 6.5 followed by concluding remark in section 6.6.

6.1 Review of Literature

A well-functioning air transport sector offers significant economic development benefits, particularly for landlocked, isolated, and low population- density countries (The World Bank). The ever growing demand for air travel has put pressure on airports to enhance their capacity in order to continuously provide smooth service to passengers (Zou, Kafle, Chang , & Park, 2015).

Aviation is a driver of economic and social development of a country. The turnover of the Indian Aviation sector today exceeds Rs 1 lac crores. Private sector has played an unprecedented role for developing the airport sector in the country (Domodaran , 2015). Air transport demand forecasts of the aircraft industry and institutions like ICAO (International Civil Aviation Organization) use the number of passenger kilometers, counted as revenue passenger kilometers (RPK), as a unit of demand (Gelhausen, Berster, & Wilken, 2013).The demand as measured in RPK grew even stronger than the number of passengers in the sixteen year period from 1994 to 2010; the demand more than doubled and increased with an average growth rate of 5% (Boeing, 2010).

The studies of liberalization and foreign direct investment in the aviation sectors of India, People's Republic of China, and Thailand highlighted a number of key points. First, greater competition has developed within domestic markets, including from privately owned airlines and especially from low-fare carriers. Second, higher levels of foreign participation in airline operations would provide funding and management capacity that would support the adjustment process required in the incumbent carriers (Findlay & Goldstein, 2004). The long term forecasts of Boeing and Airbus as well as that of the ICAO have in common a continuation of the past development over the next 20 years and they assume further liberalization of air transport in the future as one of the key drivers of growth, especially in Asian and African regions (Gelhausen, Berster, & Wilken, 2013). The number of passengers transported worldwide in air transportation has reached a volume of almost 2500 million in 2010 (ICAO, 2011).

The entry of low-cost carriers pioneered by Air Deccan helped greatly reduce the costs involved in flying. This helped attract consumers for whom air travel was only a dream. Now a number of low-cost airlines are operating in India, namely Go Airways, Spice Jet, and Kingfisher Air, and they have a major share of the Indian aviation sector. Thus, domestic participation in this industry is projected to grow by 25–30% and internationally by 15%, increasing the potential customers by about 100 million in 2010. Also, by 2020 the cargo section is projected to rise to approximately three million tonnes (The World Bank). International markets contribute16% in terms of traffic generation and 29% of all connecting passengers in the US airport network (Suau-Sanchez , Voltes-Dorta , & Rodríguez-Déniz, 2015).

FDI inflows in air transport (including air cargo) during April 2000 to January 2015 stood at US$ 562.65 million, Air Costa plans to add eight aircrafts before 2016 to its existing, Boeing is planning to set up an aircraft manufacturing base in India, Vistara has signed inter-line agreements with Singapore Airlines and Silk Air, Tata Group has launched its full-service Vistara airline on January 9, 2015 (IBEF, 2015). Air Transport can play a key role in economic development and in supporting long-term economic growth. It facilitates a country's integration into the global economy, providing direct benefits for users and wider economic benefits through its positive impact on productivity and economic performance (ATA).

The biggest problem in India is the liquidity crunch. Indian aviation as such does not have money to pump. So the alternate is to invite FDI (Vidhusekhar). DGCA guideline suggests that in Greenfield projects, FDI up to 100% is allowed under the automatic route. In case of existing projects, FDI up to 74% is allowed through automatic route and beyond that and up to 100%, with prior approval of the Government (DGCA, 2013).

The policies of the Indian government encourage foreign participation. Government allows 100% FDI via the automatic route for the green field airports. Also, foreign investment up to 74% is permissible through direct approvals while special permissions are required for 100% investment. Private investors are allowed to establish general airports and captive airstrips while keeping a distance of 150 km from the existing ones. Complete tax exemption is also granted for 10 years. About 49% FDI is allowed for investment in domestic airlines via the automatic route. However, this option is not available for foreign airline corporations. Complete equity ownership is granted to NRIs (Non Resident Indians). Foreign direct investment up to 74% is allowed for non-scheduled and cargo airlines. Thus, all these policies promote foreign investment in this industry (The World Bank).

If traffic reaches levels that are close to the maximum throughput of the runway system then the airport encounters not only problems of maintaining good quality of operations but is faced with the fact that future traffic growth cannot be accommodated any more (Gelhausen, Berster, & Wilken, 2013). Some important airports, partly main hub airports, struggle already since years with capacity constraints, among them: London Heathrow, Frankfurt, Paris Charles de Gaulle in Europe, and New York LaGuardia in the USA (Gelhausen, Berster, & Wilken, 2013). The Indian aviation industry is forecasted to grow phenomenally in the coming years. The Vision 2020 announced by the Civil Aviation Ministry conceives of building infrastructure to support 280 million customers. Investments to the extent of US$ 110 billion are envisaged by 2020. About US$ 30 billion for development and sprucing up of existing airports and US$ 80 billion for building new fleets is being estimated (The World Bank).

6.2 Objectives

The following are the objectives of this chapter:

(i) To make forecast for aircraft movements, passenger traffic and cargo traffic up to 2030-31 both international and domestic categories separately.

(ii) To make an assessment of plan period-wise capacity additions for passenger and cargo terminals required up to 2030-31 i.e. up to the end XV Five Year Plan to handle the projected Traffic Growth

(iii) To make an assessment of plan period-wise investment required to create the above capacity additions in passenger terminal, cargo terminals and ANS services.

6.3 Factors affecting Growth of Aviation Sector

The following economic factors have been identified for the exceptional growth in the Indian aviation sector from 2004-05 onwards.

(i) India has become the fastest growing economy after China due to liberalization since 1991.

(ii) Fast expansion of all sectors of the economy in consonance with economic reforms resulted in robust and sustained GDP growth of about 7-8%.

(iii) Rapid expansion of higher income and middle income group.

(iv) Market dynamics helped in the emergence of low cost airlines and APEX fare system, which in turn helped the middle income group also to travel by air.

(v) Fast expansion/growth of service sector including IT services.

The following government interventional policies have been identified (Civil Aviation, 2015) as a major cause for the exceptional growth in the Indian Aviation.

(i) Open sky policy and liberal policy of license to new scheduled operators.

(ii) Waiver of landing charges in respect of aircraft with maximum certified capacity of less than 80 seats operated by domestic scheduled operators and helicopters of all types.

(iii) Liberal permission to acquisition of new aircraft

(iv) Domestic carriers, including private operators are permitted to operate on international sectors including UK and USA.

(v) Private investment is encouraged in both airlines and airport infrastructure development including FDI.

(vi) Liberal bi-lateral relation and agreements.

Though India is the fastest growing economy after China, India's civil aviation sector is the fastest growing ahead of China. According to Airports Council International (ACI) data, India's civil aviation growth rate (15%) has surpassed China's Growth rate (14%) for the year 2010. ACI has projected that India will be the third largest aviation market in the world within 15 to 20 years. Airbus projects that the domestic aviation market in India will be the fastest growing market in the world over the next 20 years.

6.4 Methodology and Data Source

The historical data collected from AAI for the period 1995-96 to 2014-15 for all Indian airports traffic (together) has been used for econometric modeling. World GDP and GDP of India have been used as explanatory variable for forecast of International passengers and domestic passengers respectively. Index of industrial production has been used as explanatory variable for forecast of Cargo traffic.

Initially, trend analysis with linear model and econometric analysis with linear regression model, double log/ exponential model taking real GDP of India as independent variable and air passenger traffic as dependent variable were undertaken. However, we got some disadvantage in linear models that are it starts underestimating in the future and underestimates continue to increase with increase in time horizon in long term forecast and therefore were not selected. The final double log model was selected because it gives increasing increments with the increase base of traffic which is validated statistically, based on 20 years historical data for air traffic. The growth rate arrived from econometric models has been adjusted for qualitative factors and expected economic policies. Adjustment for subjective factors viz., increase in oil prices, safe and secure environment for tourists, safe and secure air travel, other infrastructures like road and rail connectivity, creation of adequate hotel/motel capacity. The forecasts of other international organizations viz., ICAO, IATA, ACI and Aircraft manufacturers have also been considered while finalizing the growth rates.

The aircraft movements have been projected based on the ratios of passengers to number of aircraft movement.

The detail methodologies both for passenger and cargo traffic have been explained in the following sections.

6.4.1 Methodology of estimating past CAGR of Air Traffic

Relationship between Passenger Traffic and Economic growth

Economic growth affects air passenger traffic significantly. Similarly, industrial output also affects cargo traffic significantly. This has been established by all international organizations which ICAO, ACI, ATA, Aircraft Manufacturers and operators of the major airports worldwide. Thus the response of passenger air traffic due to change in economic growth and the response of cargo traffic due to change in industrial output play important role in estimating the growth rate of air traffic, which can help in arriving at future forecast of investment in aviation sector in order to meet growing demand of aviation services.

In view of this we assume an exponential relationship between passenger air traffic and economic growth and between cargo air traffic and industrial output.

Thus the relationship passenger traffic and economic growth can be written as:

$$P_t = f(Y_t) \qquad 1$$

Where, P : passenger traffic

Y : GDP (proxy for economic growth)

t : Time period

Assuming exponential relationship between passenger traffic and economic growth, we can write:

$$P_t = \beta_1 Y_t^{\beta_2} \qquad 2$$

Taking natural log to both side of eq.2, we get,

$$\ln P_t = \ln \beta_1 + \beta_2 \ln Y_t \qquad 3$$

Differentiate both side of eq.3 w.r.t. Y_t,

$$\frac{1}{P_t}\frac{dP_t}{dY_t} = \beta_2 \frac{1}{Y_t}$$

$$\Rightarrow \frac{Y_t}{P_t}\frac{dP_t}{dY_t} = \beta_2 \qquad 4$$

Now in equation 4, ceteris paribus β_2 measures the elasticity of passenger traffic due to change in economic growth. That is how much passenger traffic is responding to percentage change in economic growth keeping all other factors constant.

Relationship between Cargo Traffic and Industrial Output

Similarly, the relationship cargo traffic and industrial output can be written as:

$$C_t = f(Q_t) \qquad 5$$

Where,	C	:	cargo traffic
	Q	:	industrial output
	t	:	Time period

Assuming exponential relationship between cargo traffic and index of industrial production, we can write:

$$C_t = \alpha_1 Q_t^{\alpha_2} \qquad 6$$

Taking natural log to both side of eq.2, we get,

$$\ln C_t = \ln \alpha_1 + \alpha_2 \ln Q_t \qquad 7$$

Differentiate both side of eq.3 w.r.t. Q_t,

$$\frac{1}{C_t}\frac{dC_t}{dQ_t} = \alpha_2 \frac{1}{Q_t}$$

$$\Rightarrow \frac{Q_t}{C_t}\frac{dC_t}{dQ_t} = \alpha_2 \qquad 8$$

Now in equation 4, ceteris paribus α_2 measures the elasticity of cargo traffic due to change in industrial output. That is how much cargo traffic is responding to percentage change in industrial output keeping all other factors constant.

Future Growth of Passenger Traffic

We have considered the elasticity β_2 and economic growth rate (R) to compute future compound annual growth rate (CAGR) of passenger traffic. So the projected CAGR can be written as:

$$\mu = \beta_2 R \qquad 9$$

Where,

μ	:	CAGR of passenger traffic
R	:	economic growth rate
β_2	:	GDP elasticity of passenger traffic

The μ arrived above is then adjusted suitably for other economic factors and government policy interventions and applied for future forecasting of passenger traffic.

Future Growth of Cargo Traffic

We have considered the elasticity α_2 and index of industrial production (IIP) to compute future compound annual growth rate (CAGR) of cargo traffic. So the projected CAGR can be written as:

$$\omega = \alpha_2 \lambda \qquad 9$$

Where,

ω	:	CAGR of cargo traffic
λ	:	IIP of industrial output
α_2	:	IIP elasticity of cargo traffic

The ω arrived above is then adjusted suitably for other economic factors and government policy interventions and applied for future forecasting of passenger traffic.

Projected Aircraft Movement

The aircraft movements have been projected based on the ratios of passengers to number of aircraft movement with suitable adjustment for change in aircraft mix[14].

6.4.2 Methods of Forecasting Investment in Airport Sector

The plan period wise forecast traffic has been used to work out capacity addition for passenger and cargo terminals and ANS. These capacity additions have been used to derive investment requirement on the basis of norms used in previous five year plans.

6.5 Result and Discussion

6.5.1 Passenger Traffic and Economic growth

GDP will continue to grow at the rate of 7 to 8% up to 2030-31 as per revised forecast of GDP by Government of India. Indian IIP will continue to grow at 8 to 10% as projected by Government of India.

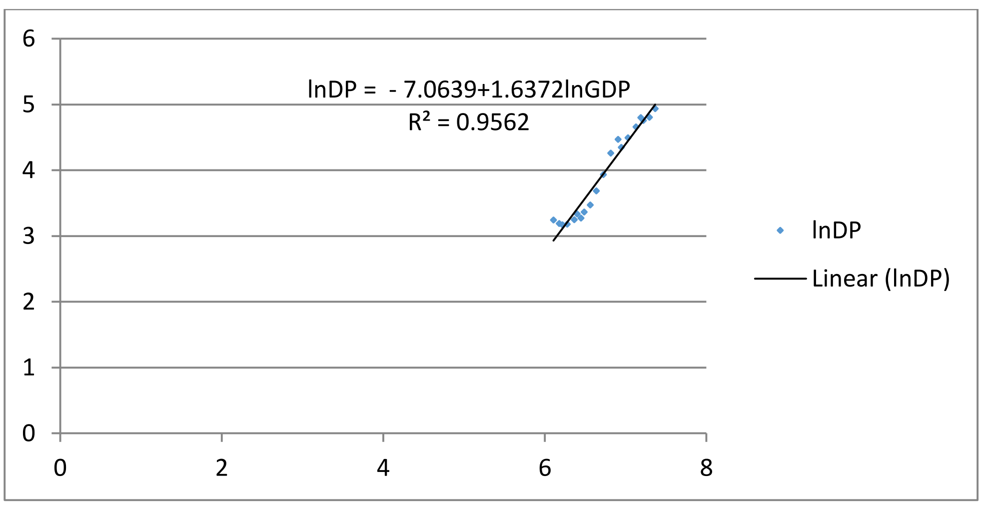


Figure 6-1 Econometric Model for domestic passenger traffic

DP = Domestic Passenger Traffic,GDP = Gross Domestic Product of India

The GDP elasticity of domestic passenger traffic is 1.64 which indicates that domestic passenger traffic is highly responsive to economic growth i.e. 10 % increase in GDP stimulate

[14] Aircraft mix means combination of small medium and heavy aircrafts.

16.4 % growth in domestic passengers traffic subject to adjustment of other economic factors and government intervention policies (see Fig. 6.1 and Table 6.1).

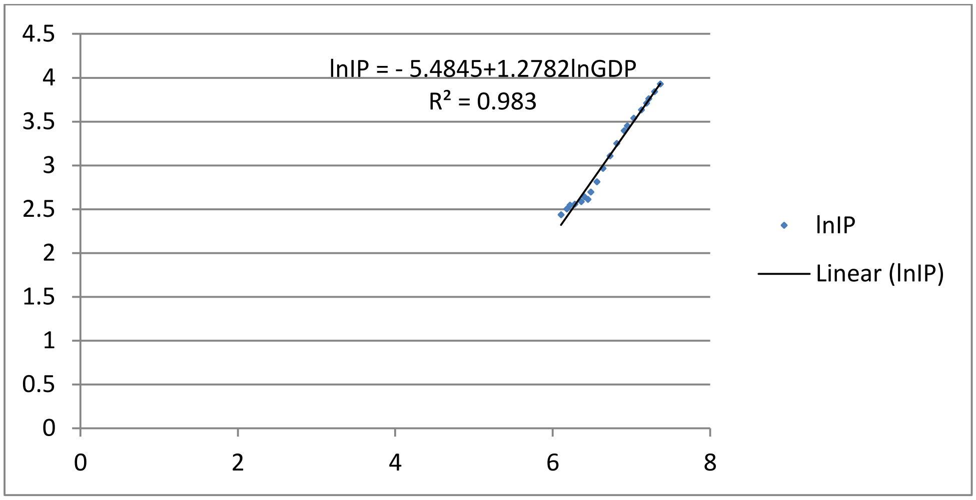


Figure 6-2 Econometric Model for international passenger traffic

IP = International Passenger Traffic,GDP = Gross Domestic Product of India

The GDP elasticity of international passenger traffic is 1.28 which indicates that international passenger traffic is moderately responsive to economic growth i.e. 10 % increase in GDP stimulate 12.8 % growth in domestic passengers traffic subject to adjustment of other economic factors and government intervention policies(see Fig. 6.2 above and Table 6.1).

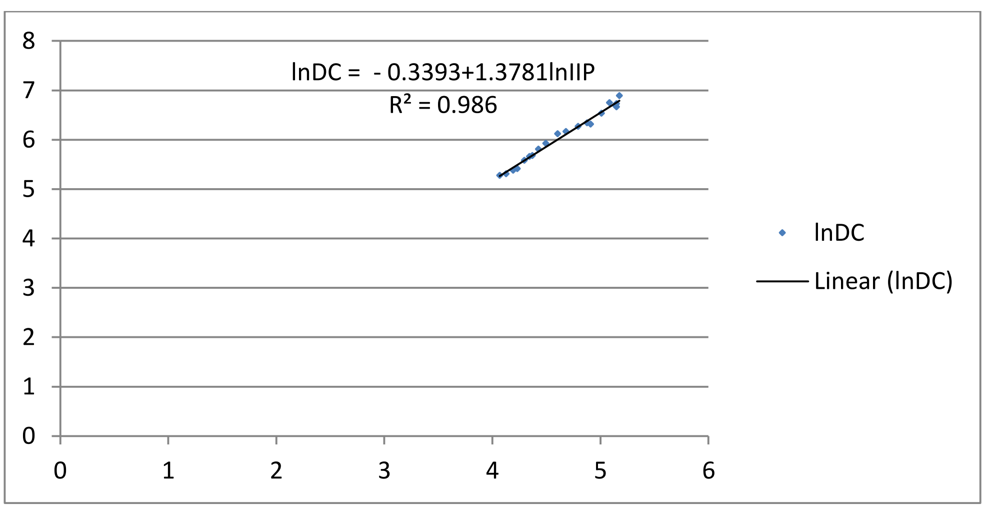


Figure 6-3 Econometric Model for domestic cargo traffic

DC = Domestic Cargo Traffic,IIP = Index of Industrial Production for India

The IIP elasticity of domestic cargo traffic is 1.38 which indicates that domestic cargo traffic is also moderately responsive to growth in industrial production, i.e. 10 % increase in GDP stimulate 13.8 % growth in domestic cargo traffic subject to adjustment of other economic factors and government intervention policies(see Fig. 6.3 above and Table 6.1).

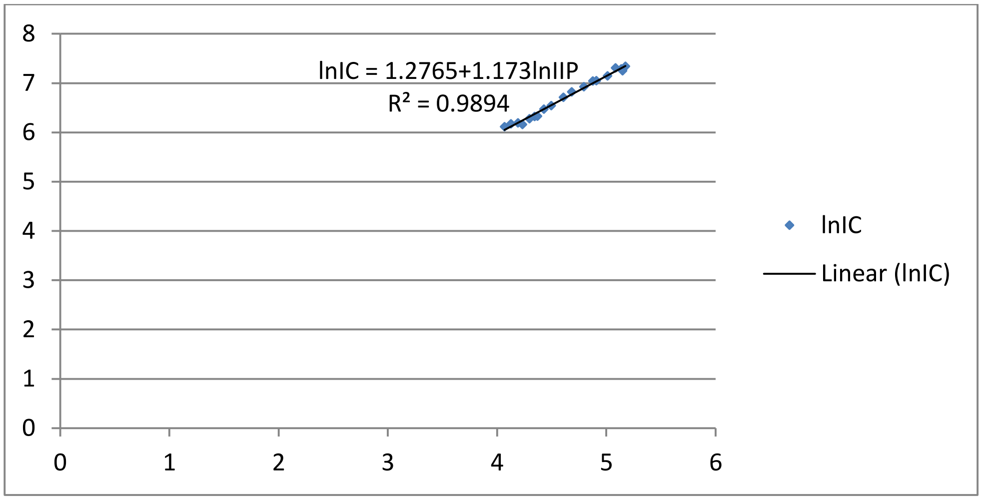


Figure 6-4 Econometric Model for international cargo traffic

IC = International Cargo Traffic,IIP = Index of Industrial Production for India

The IIP elasticity of international cargo traffic is 1.17 which indicates that international cargo traffic is also moderately responsive to growth in industrial production, i.e. 10 % increase in GDP stimulate 11.7 % growth in domestic cargo traffic subject to adjustment of other economic factors and government intervention policies(see Fig. 6.4 above and Table 6.1).

For the above models F- Test has been applied for the validity of overall model & T- Test has been used to test the significance of intercept & slope coefficients of the double log linear models. The R- square value has been found more than 0.95 in all the four models & the F and T values were highly significant.

Table 6.1: Air Traffic Elasticity (1995-96 to 2014-15)

Variables	lnDP	lnIP	lnDC	lnIC
lnGDP[a]	1.64*** (0.082)	1.28*** (0.039)	-	-
lnIIP[b]	-	-	1.38*** (0.038)	1.17*** (0.028)

*** Significant at 1% level ($p<0.01$)

Note: 1. [a]GDP of India,

[b]IIP of India

2. Standard errors are given in the parentheses.

Source: Author’s estimation for actual data refer annexure 6.1 to 6.3

6.5.2 Trend of CAGR from Past Air Traffic

Based on the above discussion, growth experience has been analyzed for last 5 years, 10 years, 15 years and 19 years. The first period from 1995-96 to 2000-01 is considered as normal growth period. The second period pertains to 1995-96 to 2005-06 is considered as beginning of high growth period. Similarly, from 1995-96 to 2010-11 and from 1995-96 to 2014-15 are relatively higher growth period.

Passengers

From the Table 6.2 below, it is seen that, total passengers’ movement had registered a maximum growth of 12.4% CAGR from 1995-96 to 2005-06. During the same period the international and domestic passenger traffic has increased by 10.1 % and 13.3% respectively.

The following Table 20 gives the Passengers Traffic at all Indian Airports for 1995-96, 2000-01, 2005-06, 2010-11 and 2014-15.

Table 6.2 Passengers Traffic at Indian Airports

Year	Passengers(in millions)		
	Int’l	Dom	Total
1995-96	11.45	25.56	37.01
2000-01	14.01	28.02	42.03
2005-06	22.37	50.97	73.34
2010-11	37.91	105.52	143.43
2014-15	50.80	139.33	190.13
CAGR (Last 5 years)	8.1%	9.3%	9.0%
CAGR (Last 10 years)	10.1%	13.3%	12.4%
CAGR (Last 15 years)	9.3%	11.9%	11.1%
CAGR (Last 19 years)	8.2%	9.3%	9.0%

Source: AAI and authors computation

The international passenger traffic has increased from 11.45 million in 1995-96 to 50.80 million in 2014-15 leading an increase of 4.4 fold. The domestic passenger traffic has increased from 25.56 million in 1995-96 to 139.33 million in 2014-15 which works out to be

5.5 fold i.e. the domestic traffic has increased at a faster rate of 9.3% CAGR as against the corresponding CAGR of 8.2% for international passenger traffic during the same period.

The international traffic has grown at a CAGR of 8.1%, 10.1%, 9.3% and years,15 years and 19 years respectively. The corresponding growth rate for domestic passenger are 9.3%, 13.3%, 11.9% and 9.3% respectively leading to a growth of 9%, 12.4%,11.1% and 9% respectively in total passenger traffic.

Cargo Traffic

The following Table 6.3 below gives the Cargo Traffic at all Indian Airports for 1995-96, 2000-01, 2005-06, 2010-11 and 2014-15.

Table 6.3 Cargo Traffic at Indian Airports

Year	Cargo (in '000 MT)		
	Int'l	**Dom**	**Total**
1995-96	452.85	196.52	649.37
2000-01	557.77	288.37	846.15
2005-06	920.15	477.15	1397.30
2010-11	1496.24	852.66	2348.90
2014-15	154.55	985.02	2527.57
CAGR (Last 5 years)	4.0%	7.4%	5.2%
CAGR (Last 10 years)	6.5%	8.0%	7.1%
CAGR (Last 15 years)	7.4%	9.1%	8.0%
CAGR (Last 19 years)	6.7%	8.9%	7.4%

Source: AAI and authors computation

From the Table 6.3 above, it is seen that, in absolute terms the international cargo traffic has increased from 452.85 thousand MT in 1995-96 to 1542.55 thousand MT in 2014-15 which represent an increase of 3.4 fold or 6.7% CAGR. The domestic cargo traffic has increased from 196.52thousand MT in 1995-96 to 985.02 thousand MT in 2014-15 representing a growth of over 5 fold or 8.9% CAGR.

The CAGR for international cargo traffic during last 5 year,10 year, 15 year and 19 year are 4.0%, 6.5%, 7.4% and 6.7% respectively. The corresponding CAGR for domestic cargo traffic during last 5 year,10 year, 15 year and 19 year are 7.4%, 8.0%, 9.1% and 8.9% respectively. In other words, domestic cargo traffic has increased at a faster rate as compared to growth rate of international cargo traffic due to its smaller base, faster economic development and effort of GoI to restrict the import in the country.

Aircraft Movement

The Table 6.4 below gives the Aircraft Movement at all Indian Airports for 1995-96, 2000-01, 2005-06, 2010-11 and 2014-15.

Table 6.4 Aircraft Movement at Indian Airports

Year	Aircraft Movement (in '000)		
	Int'l	**Dom**	**Total**
1995-96	92.52	314.73	407.25
2000-01	103.21	386.58	489.79
2005-06	190.88	647.34	838.22
2010-11	300.20	1093.57	1393.76
2014-15	345.36	1257.66	1603.02
CAGR (Last 5 years)	4.1%	3.7%	3.8%
CAGR (Last 10 years)	7.8%	8.5%	8.4%
CAGR (Last 15 years)	8.6%	8.5%	8.6%
CAGR (Last 19 years)	7.2%	7.6%	7.5%

Source: AAI and authors computation

In absolute terms the international aircraft movements has increased from 92.52 thousands in 1995-96 to 345.36 thousands in 2014-15 registering a CAGR of 7.2% or an increase of 3.7 fold. The domestic aircraft movement has increased from 314.73 thousands to 1257.66 thousands in 2014-15 representing a CAGR of 7.6% or a growth of about 4 fold.

The CAGR during last 5 years, 10 years, 15years and 19years are computed and given in Table 4 above.

6.5.3 Growth Rate for Future Air Traffic

Growth of Passengers

International passenger are projected to grow at the rate of 7 - 8 % and will reach 176.11 million at the end of XV Plan (2031-32) where as domestic traffic is projected to grow at 8-9% and will reach 565.17 million at the end of XV Plan (2031-32). Thus the total passenger traffic will become 741.29 million by the end of XV Plan.(refer Table 6.5 below)

Table 6.5 Passenger Traffic Forecast (in Millions)

Passengers	2014-15	Growth Rate	2024-25	Growth Rate	2031-32
International	50.80	8.0%	109.67	7.0%	176.11
Domestic	139.30	9.0%	329.77	8.0%	565.17
Total	190.10	8.7%	439.45	7.8%	741.29

Growth of Cargo

The international cargo has been projected to grow at the rate of 7 % and will become 4872.44 thousand MT by 2031-32 and the domestic cargo traffic has been projected to grow at a relatively higher growth rate of 8% and will become 3649.59 thousand MT by the end of 2031-32. Refer Table 6.6 below.

Table 6.6 Cargo Traffic Forecast (in 000 MT)

Cargo	2014-15	Growth Rate	2024-25	Growth Rate	2031-32
International	1542.49	7.0%	3034.31	7.0%	4872.44
Domestic	986.37	8.0%	2129.50	8.0%	3649.59
Total	2528.86	7.4%	5163.81	7.4%	8522.03

Source: Author's projection

Growth of Aircraft Movements

The international aircraft movement are projected to grow between 6 -7% and will reach to 1021.83 thousands at the end of 2031-32. The domestic aircraft moment will touch 4359.66 thousand in 2031-32 with a projected growth of 7-8% (refer Table 6.7 below)

Table 6.7 Aircraft Movement Forecast (in 000)

Category	2014-15	Growth Rate	2024-25	Growth Rate	2031-32
International	345.46	7.0%	679.57	6.0%	1021.83
Domestic	1257.56	8.0%	2714.98	7.0%	4359.66
Total	1603.02	7.8%	3394.55	6.8%	5381.49

Source: Author's projection

6.5.4 Areas Identified for Capacity Addition and Investment

Need for Investment in Aviation Sector in India

During next 17-20 years, an additional capacity of about 551.19 MPPA (International: 125.31 MPPA and Domestic: 425.87 MPPA) will be required besides the existing capacity of 233 MPPA. Out of 551.19 MPPA capacities, the 125 MPPA is envisaged to be added by end of 13th Five Year Plan. This will require the augmentation of the capacity by expanding the existing terminals, creating new terminals at Brownfield airports[15] and creation of 30-35 Greenfield airports.

Some airports like Kota and Rajkot are located right next or in the middle of urban townships. There is no possibility to acquire additional land in their vicinity for their up-gradation for any worthwhile aviation activities. It will be prudent for AAI to offer these airports which have useful land parcels to State Government for their further use and obtain land away from the city for another Greenfield airport, in form of barter exchange deal. Amendments to Aircraft Rules etc., as necessary may have to be worked out in consultation with State Government and Law Ministry.

In the first phase, 10 airports will be taken up for City Side Development. The City Side Development process has already been initiated for which RFQ/RFP/Model Concession Agreements are being finalized. The process will involve development either through PPP or by leasing for a period of 30 years extendable by another 30 years. City Side Development at Chennai, Kolkata, Hyderabad and Ahmedabad shall also be undertaken during the period.

The primary objective of Air Traffic Management would be to develop an ATM system that ensure optimum safety to the aviation industry and provide the airspace users the desired level of operational efficiency to achieve cost effective operations through Gate-to-Gate operational strategy of airlines to ensure Safe, Efficient and cost effective operations, minimize delays and enhance capacity.

Historically, airspace management has been considered a rigid subject – with defined spaces for different players. However, the introduction of flexible air space management system

[15] Brownfield airports are existing airports, Greenfield airports are airports developed at new sites.

allows us to work along a continuum. This helps reduce flight times, which results in fuel savings, improved plane utilization, passenger comfort and reduced emissions.

During next 17-20 years, 6 million metric tonnes per annum (MMTPA) Cargo Capacity is projected to be added (International: 3.3 MMTPA and Domestic: 2.7 MMTPA). Out of the 6 MMTPA, 1.5 MMTPA (International: 1.00 MMTPA & Domestic: 0.5 MMTPA) cargo capacity is envisaged to be added by the end of XIII Plan Period.

AAI will consider the development of Cargo Terminals at Pune, Sri Nagar, Guwahati, Chandigarh, Surat, Mangalore and Trichy in next 5 to 10 years. Recently, Cargo Terminal was operationalized at Port Blair for Domestic cargo operation with the assistance of Andaman and Nicobar Administration. When International flights start at Port Blair, AAI will start International Cargo operation departmentally.

On the initiatives of the Ministry of Civil Aviation and Commerce and Industry, AAI will upgrade the EDI from ICES 1.0 to ICES 1.5 version in co-ordination with customs and airlines since Cargo operation at AAI managed Airports to move towards paperless transaction.

Continuing with EDI and automation, AAI will actively work with Banks for e-payment transactions for the customers to pay custodian charges. AAI shall upgrade the cargo infrastructure at Chennai by automation and installing Automated Storage and Retrieval System (ASRS).

Needs for Capacity Addition in the Aviation Sector

There is a need for capacity addition in aviation sector in India. To meet the future air traffic demand, capacity addition is required in the airport infrastructure which in turn requires the investment in the airport infrastructure that includes investment in passenger terminal, cargo terminal, ANS/CNS, safety & security etc.

The following Table 6.8 and Fig.6.5 below, depicts the actual traffic during 2014-15, forecasted traffic during 2031-32, absolute traffic increase in traffic from 2014-15 to 2031-32 and the capacity addition required from 2014-15 to 2031-32.

Table 6.8 Traffic Forecast and Capacity Addition required from 2010-11 to 2031-32

Capacity Addition	Air Traffic	2014-15 (Actual)	2031-32 (Forecasted)	Capacity Addition (2010-11 to 2031-32)
Aircraft Movement (IN '000S)	International	345.46	1021.83	676.37
	Domestic	1257.56	4359.66	3102.1
	Total	1603.02	5381.49	3778.47
Passenger Traffic (IN MILLION)	International	50.8	176.11	125.31
	Domestic	139.3	565.17	425.87
	Total	190.1	741.29	551.19
Cargo Traffic (IN '000 M.T.)	International	1542.49	4872.44	3329.95
	Domestic	986.37	3649.59	2663.22
	Total	2528.86	8522.03	5993.17

Source: AAI and author's computation

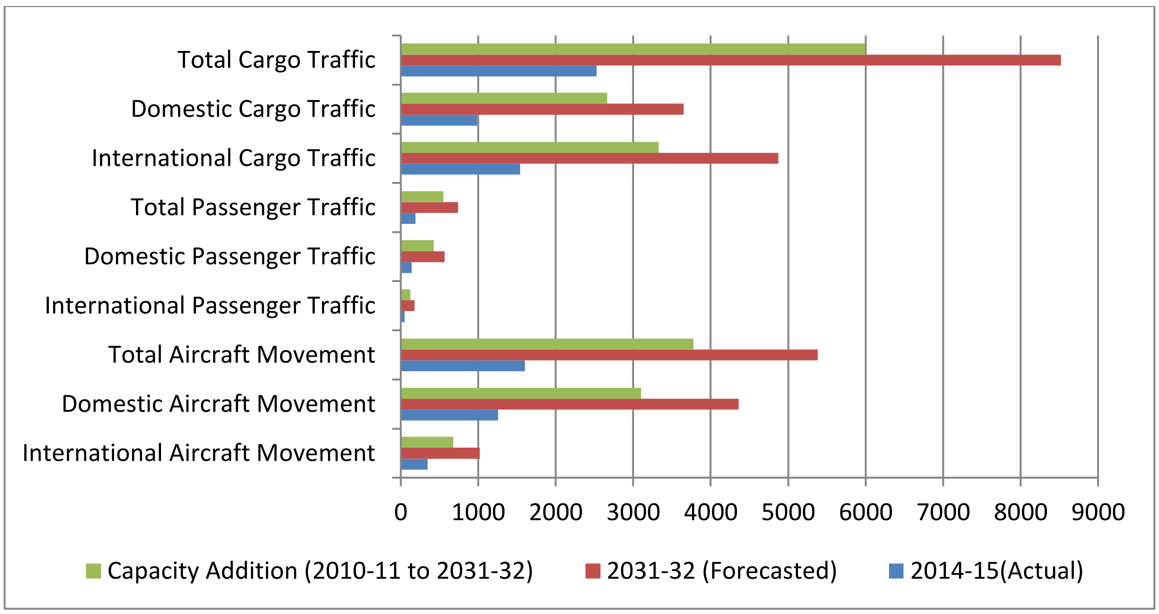


Figure 6.5 Traffic Forecast and Capacity Addition required from 2010-11 to 2031-32

Need for Human Resources

The number of ATC Officers has gone up from 1,500 in 2008 to around 1,900 in 2011. However still there is a shortage of ATC officers around 350-400. Given the unique nature of this service – zero tolerance for error and high levels of technical skills requirement – this shortage is a cause for severe concern.

AAI runs ATC training facilities at the Civil Aviation Training College (CATC), Allahabad and at the Hyderabad Airport. It takes nearly three years for an ATCO trainee to be fully capable of handling independent operations. Though the planned introduction of satellite based navigation (GAGAN) is likely to reduce the stress level of ATC officers still there is the need to augment the number of ATC officers to keep pace with the increase in air traffic. Therefore training of ATC officers should be considered as most priority towards human resource development.

There is acute shortage of trained pilots in India. India currently has over 4,500 pilots, including 400 expatriates. With the doubling of fleet size expected by 2017, India will require a total of around 9,000 pilots by 2017. This implies an average addition of at least 800 pilots per year for the next five years, not accounting for attrition and replacements of expatriate pilots (about 400), required to be phased out by end of 2013. Shortage of pilots leads to an artificial increase in their salary levels which hurts the profit margins of airlines, especially the LCCs. Also shortage of pilots has resulted in unethical practices, resulting in safety of fliers being compromised. Therefore there is an urgent need to increase the number of pilot training institutes and the capacity of existing institutes. The success of CAE at Rae Bareli and Gondia may be replicated at other locations also.

The Indian Air Force (IAF) has one of the finest pilot training infrastructures in the country. There is a need to collaborate with them to explore ways in which their facilities and staff can be used for producing civilian pilots without affecting IAF’s operational requirements.

The demand for aircraft maintenance engineers and cabin grew is likely to increase in an exponential growth rate as the fleet size of Indian carriers rise as forecasted. So there is an urgent need to train more Aircraft Maintenance Engineers and Cabin Crew.

Again there is shortage of MRO personnel in India who can carry out complete and complicated repairs on the latest version of aircraft. Therefore there is an urgent need to establish MRO training institutes.

6.5.5 Investment on Human Resource Development

Last but not the least, the supply of available skilled manpower in the aviation industry is much short of actual demand. With passengers and aircraft fleet likely to triple by 2025, the need to induct the more skilled manpower supply is the urgent requirement. \

As per KPMG, total manpower requirement of airlines is estimated to rise from 62,000 in 2010-11 to 117,000 by 2016-17. This includes the number of pilots, cabin crew, aircrafts engineers and technicians (MRO), ground handling staff, cargo handling staff, administrative and sales staff. Benchmarks provided by ICAO for different classes of personnel (pilot, cabin crew, etc.) per aircraft were used to arrive at the above estimates.

Similar analysis was performed for projecting manpower requirements at the airports. Employee per million passenger ratio for large airports (Delhi, Mumbai, Chennai, Kolkata, Bengaluru and Hyderabad) was found to be around 65 whereas for remaining airports this ratio was around 200. Based on the projected passenger traffic and assuming the employee per million passenger ratio will flatten for smaller airports as modernization and other efficiency improvement initiatives are undertaken, the manpower requirement (including ANS) for the airports is estimated to increase from current 20,000 to 26,000-30,000 by 2016-17.

In addition, aviation industry is typically estimated to generate indirect and induced employment of nearly six times the direct employment. With direct employment across airports and airlines to be more than 140,000 by 2016-17, the aviation sector in India is expected to provide an indirect and induced employment to additional 900,000 people by 2016-17.

6.5.6 Investment Requirement

Investment requirement in the airport projects during XII plan

Investment requirement in the airport projects during XII plan (2012-13 to 2016-17) is given in the following Table 6.9.

It worked out that investment of Rs.300 crores per million passengers is required for brown field airports and Rs.205 crores per million passengers is required for green field airports. Similarly investment of RS.1250 crores per million metric tons of cargo is required.

Table 6.9 Investment requirement in the airport projects during XII plan

Investment By	Investment Category	Investment in Rs. (in Crores)	Revised Investment in Rs. (in Crores)
AAI	Airports	15,600	4780
	ANS including GAGAN Projects	4,400	1330
	Total	20,000	6110
Private Operators	Airports	50,000	15200
AAI + Private Operators	Grand Total	70,000	21310

Source: Ministry of Civil Aviation and AAI, GoI

Detailed calculation of investment requirement in the airport projects during the next 20 years are shown in the following Table 6.10 below.

To meet the airport infrastructure development plans during the next 20 years, an investment of about Rs. 168578 Crores is envisaged. The cost excludes addition of 1200 Aircraft to the fleet and other expenditure on airlines.

Out of the total investment of Rs. 168578 crores, partly it will be made through Govt., private sector and Joint ventures in the JV airports. It is projected that 30% of the investment will come through the Govt. sector, and the remaining 70% will be invested through private sector. Also, the 70% of the investment will be made in Brownfield airports and 30% will be made in Greenfield airports.

Table 6.10 Investment Requirements in Airport Infrastructure during the next 20 years at 2015 prices

PLAN PERIOD	Description	INVESTMENT IN CRORES					
		Brown Field	Green Field	Cargo	Total	ANS Services	Grand Total
Investment Requirement of Traffic Category		Rs.300 Crores per Million Pax	Rs.205 Crores per Million Pax	Rs.1250Crores per Million Metric Tones	-	-	-
XII Plan (2012-13 to 2016-17)	Revised Incremental Traffic	32 Million Pax	32 Million Pax	0.6 Million Metric Tonnes	-	0.32 Million Aircraft Movements	-
	Investment Planned Rs.(Crores)	37,500	25,625	2,475	65,600	4,400	**70,000**
	Revised Investment Rs.(Crores)	9600	6560	750	16910	4,400	21310
XIII Plan (2017-18 to 2021-22)	Incremental Traffic	151 Million Pax	151 Million Pax	2.58 Million Metric Tonnes	-	0.85 Million Aircraft Movements	-
	Investment Required (Rs. In Crores)	17550	11993	1562.5	31105	1325	32430
XIV Plan (2022-23 to 2026-27)	Incremental Traffic	84 Million Pax	84 Million Pax	1.79 Million Metric Tonnes	-	1.16 Million Aircraft Movements	-
	Investment Required (Rs. In Crores)	25200	17220	2238	44658	3400	48058
XV Plan (2027-28 to 2031-32)	Incremental Traffic	116 Million Pax	116 Million Pax	2.56 Million Metric Tonnes	-	1.51 Million Aircraft Movements	-
	Investment Required (Rs. In Crores)	34800	23780	3200	61780	5000	66780
20 Years Total Investment (Rs. in Crores)		87150	59553	7751	154453	14125	168578

Note: *1. Authors have revised the forecast figures for XII Five Year Plan and accordingly the investment required for XII five year plan has been revised from 70,000 crores to* 21,310 crores

2. US$ 1= INR 65.5

6.6 Concluding Remarks

Domestic and international passenger traffics are responding well to economic growth and in each case other economic factors and government intervention policies play an important role. Similarly, domestic and international cargo traffics are also responding well to growth in industrial production with the help of other economic factors and government intervention policies.

Total passengers' movement had registered a maximum growth from 1995-96 to 2005-06. During the same period the international and domestic passenger traffic has increased substantially.

The international and domestic cargo traffic has also increased substantially. However, domestic cargo traffic has increased at a faster rate as compared to growth rate of international cargo traffic due to its smaller base, faster economic development and effort of GoI to restrict the import in the country.

In absolute terms the international and domestic aircraft movements has increased substantially. International passenger are projected to grow at the rate of 7 - 8 % and will reach 176.11 million at the end of XV Plan (2031-32) where as domestic traffic is projected to grow at 8-9% and will reach 565.17 million at the end of XV Plan (2031-32). Thus the total passenger traffic will become 741.29 million by the end of XV Plan. The international cargo has been projected to grow at the rate of 7 % and will become 4872.44 thousand MT by 2031-32 and the domestic cargo traffic has been projected to grow at a relatively higher growth rate of 8% and will become 3649.59 thousand MT by the end of 2031-32. Similarly, the international aircraft movement are projected to grow between 6 -7% and will reach to 1021.83 thousands at the end of 2031-32. The domestic aircraft moment will touch 4359.66 thousand in 2031-32 with a projected growth of 7-8%.

It has been estimated that investment of Rs.300 crores per million passengers is required for brown field airports and Rs.205 crores per million passengers is required for green field airports. Similarly investment of RS.1250 crores per million metric tons of cargo is required. Thus to meet the airport infrastructure development plans during the next 20 years, an investment of about Rs. 168578 Crores is envisaged. The cost excludes addition of 1200 Aircraft to the fleet and other expenditure on airlines.

It has been projected that during next 17-20 years, an additional capacity of about 551.19 MPPA will be required besides the existing capacity of 233 MPPA. Out of 551.19 MPPA capacities, the 125 MPPA is envisaged to be added by end of 13th Five Year Plan. This will require the augmentation of the capacity by expanding the existing terminals, creating new terminals at Brownfield airports[16] and creation of 30-35 Greenfield airports.

During next 17-20 years, 6 million metric tonnes per annum (MMTPA) Cargo Capacity is projected to be added. Out of the 6 MMTPA, 1.5 MMTPA cargo capacities are envisaged to be added by the end of XIII Plan Period.

The supply of available skilled manpower in the aviation industry is much short of actual demand. With passengers and aircraft fleet likely to triple by 2025, the need to induct the more skilled manpower supply is the urgent requirement. Last but not least, aviation industry is typically estimated to generate indirect and induced employment of nearly six times the direct employment. With direct employment across airports and airlines to be more than 140,000 by 2016-17, the aviation sector in India is expected to provide an indirect and induced employment to additional 900,000 people by 2016-17.

[16] Brownfield airports are existing airports, Greenfield airports are airports developed at new sites.

CHAPTER 7

ECONOMICS OF LOW COST AIRPORT AND AIR CONNECTIVITY

7.0 Introduction

The economic regulation in airport infrastructure in India was implemented after privatization, which resulted into the adaptation of different regulatory approach for private and public airports? In the first cycle of revision of airport charges by Airport Economic Regulatory Authority (AERA) in 2009 the prices has been increased more than four-fold with the result that Indian airports has come in the category of costliest airports of the world i.e. consumer has not been benefited as has happened in case of competitive industry such as telecommunication (Singh, Dalei and Raju, 2015). However, it has recently been increasingly recognized that aviation is not only a mere mode of transportation for an elite group but is crucial for middle and low income group along with sustainable development of trade and tourism. Airports facilitate business tourism, medical tourism, educational tourism, ethnic tourism, leisure tourism etc. (MOCA, 2012). The International Civil Aviation Organization (ICAO) estimated that $100 spent on air transport produce benefits worth $325 for the economy and 100 additional jobs in air transport result in 610 new economy wide jobs. The ICAO study attributes over 4.5% of global GDP to the air transport component of civil aviation.[17] An efficient aviation sector is essential to support tourism, an industry with immense employment opportunity. As this is a capital intensive sector, there is an obvious need for perspective planning with a vision for the future and to muster the combined resources of the public and private sectors, both domestic and international.

Over the past two decades, there has been a trend towards the ownership and management of airports with emergence of regional patterns of ownership. Privatized airports are common in Australia and New Zealand, while partial privatization is more common in Europe. In many cases, an airport may be owned by one entity and operated by another. In the event that an airport is publicly owned and operated or publicly owned and operated by a not-for-profit

[17] Report on Airport Economics of ICAO Doc 9562

organization, it is highly likely that the airport will pursue non-monetary objectives in addition to earning a return for shareholders.

The charges levied by Airports Authority of India (AAI) are under two broad heads viz., Air Navigation Services (ANS) and Airport Services. However, AAI (2013) mentioned only the updated ANS charges for the AAI airports. ACRP (2013) studies how to identify the compliance requirements applicable to small hub and non-hub airports during the period from 2000 to 2010 (study period) and to quantify the costs, including initial costs and recurring costs, of federal requirements on small airports. Airports Economic Regulatory Authority of India has determined aeronautical tariffs in 2014 and proposed multiyear traffic of cargo handling services in 2013 for Bangalore international airport (AAI, 2013; AERA, 2014). Aeronautical Tariffs of Chatrapathi Shivaji International Airport has been determined by Airport Economic Regulatory Authority during 2014 (AAI, 2014). The current regulatory regime for airports in UK was established over 20 years ago under the Airports Act 1986. Since then, there have been a number of developments in the sector. (DoT, 2009).

In analyzing airport regulation there are several tasks. One of these is to observe the ownership and regulatory pattern in a city or country, and seek to explain it in terms of efficiency and other objectives. Another task is to outline which approaches to airport ownership and regulation are most likely to be conducive to efficient operation of airports- have some countries implemented promising models, and are the approaches taken by others flawed? Finally, there is the task of assessing what ownership and regulatory frameworks can best promote efficiency while recognizing the constraints imposed by the non-efficiency objectives imposed by governments- does a particular framework represent a good compromise between objectives and is it possible to meet the non-economic objectives at less cost in terms of efficiency (Gillen, 2007).

Air connectivity is a major function of all airports which already been studied by many scholars. However, hardly there exist any studies pertaining to air connectivity in order to meet the lower and middle income group’s aviation demand. This study is unique of its kind with the objective of purposing development of low cost regional airports in India which will help in bridging gaps in aviation literature.

At the outset we provided introduction and touched upon some relevant literature along with highlighting the objectives pertaining to the study. The remaining part of this study is as follows. The data and methodology are presented in section 7.1. Section 7.2 contains analysis and discussion followed by achievement of development of low-cost regional airports in section 7.3. The concluding remark is given in section 7.4.

7.1 Data and Methodology

This chapter identifies the initiatives taken by Government of India to develop the airports as greenfield/low cost airport to improve regional air connectivity. In this context an in depth exploratory interview of state and central officials of civil aviation, the expert of civil aviation consulting organizations and other related organization were carried out. The XII five year plan document of MOCA (Ministry of civil Aviation) and other reports of the consultants and committees set by MOCA were reviewed in detail to know such initiatives adopted so far. The suggested solutions and point of view of different organizations have been discussed and finally the region wise airports have been identified for development as Greenfield/Low cost airport to improve the regional connectivity.

7.2 Analysis and Discussion

Followings are the analysis and discussion which highlights importance of developments of low cost regional airports in order to meet the growing aviation demand of middle and low income groups in India.

7.2.1 Indian Aviation Sector

During the last one decade the civil aviation sector has grown at a phenomenal pace and India has emerged as the 9th largest civil aviation market in the world. As regards to domestic market, India is the 4th largest market after US, China and Japan. During 2012-13, Indian airports handled about 159.40 million passengers as against 162.31 million passengers. Number of passengers handled at Indian airports was about 73.34 million per annum during 2005-06. Passengers handling capacity has increased from 72 MPPA in 2005-06 to 197.77 MPPA in 2012-13. Scheduled air services are operating from 81 airports connecting 26 States and 4 Union Territories. 17 state capitals are connected to National Capital by direct flights. For these operations Indian Aviation has 437 scheduled aircraft and 500 General Aviation aircraft (Singh, Batra, Grover, Parate, & Chand, 2012-13). In the cargo front, 2.19 million metric tons of cargo had been handled at Indian airports during 2012-13 as against 1.40 million metric tones during 2005-06. Investment on Airport Infrastructure during XI five year plan was Rs. 36,371 Crores.

By the year 2020, India is expected to be 3rd largest aviation market by handling 384 million passengers (305 million domestic passengers and 79 million international passengers). India will be the fastest growing aviation market, expected to be within 4-5 big aviation markets by 2020, 3rd in terms of domestic market after US and China and expected to have 1030 scheduled aircraft and 2000 GA aircraft. (ACI, 2012). To support this growth, investment of Rs.71,000 Crores is envisaged on airport infrastructure during XII Five Year Plan.

7.2.2 Need for the development of airports in Tier-II & III Cities

Air Trips per capita per annum for India is 0.04 whereas for US & Australia is 2.0; Malaysia is 0.54; Brazil is 0.25 and China is 0.15 showing a very high potential for Indian Aviation Market (AIF, 2013). According to Air Bus Industries forecast, share of GDPs contribution to world's GDP by 2030 will be 40% by advanced economies (31 Countries), 39% by BRIC economies (4 Countries viz., Brazil, Russia, India & China) and 21% by other emerging & developing economies. Also Air Bus Industries forecasted that global middle class population is expected to rise by 2.5 times by 2030 with 66% in Asia Pacific. Increasing wealth is expected to move these countries (countries with low air trips per capita) along with the flight curve. With these inputs, aviation growth in India is pegged at CAGR of 10.3% up to 2020 as compared to 8% in South Asia (Singh, Batra, Grover, Parate, & Chand, 2012-13). To facilitate aviation growth, airports have to be come up in order to meet the market demand.

Air traffic in India at Tier-II & III cities are expected to grow faster than Tier-I cities because of shifting of IT, BPO, MNCs & other industries to Tier-II & III cities due to availability of cheaper land, manpower & other logistics. As the Head Offices of these companies still operate in Tier-I cities, requires frequent travel from Tier-II / III to Tier-I and vice versa with considerably stabilization in air travel cost. Also airports in Tier-I city has been bursting, as there is little scope for further expansion and train reservations in higher class i.e. 1st AC / 2nd AC / 3rd AC generally not available before two months.

According to MOCA, development of airports in Tier-II & III cities are necessitated because large number of non-operational airports are situated in the Tier-II & III cities viz., Agra, Salem, Tanjavur, Vellore, Kishangarh, Warangal, Rae-Bareilly etc., which is either industrial hubs or tourist hubs or both. These airports can be made operational with relatively little investment. In remote, hilly and inaccessible areas of the country, air transport is the quickest and sometimes the only option of mode of transport. Thus development of regional airports in the Tier-II & III cities is essential to sustain the future aviation growth.

7.2.3 Regional Airports in India

In India, there are 457 Airports / Airstrips. Of these, AAI owns and manages 91 airports; 125 airports are managed by Ministry of Defence; 160 are managed by State Governments; 57 airports are managed by private parties and 6 airports are managed by Joint Venture companies. AAI has already taken up the development of 35 non-metro airports. While the development of 27 airports has already been completed; development of 4 airports at Ranchi, Raipur, Bhubaneswar and Khajuraho shall be completed soon.

Development of 27 other non-metro airports at Tier-III cities has been taken up by AAI. While the development of 15 airports has been already completed; development of 5 other airports at Kadappa, Puducherry, Bikaner, Jaisalmer & Bhatinda is expected to be completed soon. Airports have been developed in the Tier-III cities - Mysore, Pantnagar, Cooch Behar, Jalgaon, and Akola; but as of now no schedule flight operations have been undertaken. AAI has a plan to activate 13 non-operational airports at Behala, Jharsuguda, Deoghar, Malda, Along, Daparizo, Pasighat, Tura, Rae-Bareilly, Kishangarh, Warangal, Thanjavur and Vellore. Development of 3 Greenfield airports is also undertaken by AAI at Pakyong (Sikkim), Cheithu (Nagaland) & Itanagar (Arunachal Pradesh).

7.2.4 Low Cost Airports: Suggested Models

We know that the first generation of Indian aviation boom was due to low cost carriers. Low cost carriers made air traveling affordable to a vast majority of Indians and catalyzed passengers' growth un-precedent. Similarly the second generation of aviation boom is likely to take place due to low cost airports and regional airports.

Low cost, no-frills airport will focus on quality and efficiency of services. Airport Design is to permit 25-30 minutes of turnaround time. The net result is that the airlines operating at these airports often require around half the space per passengers as the legacy airlines. General feature of low-cost airports is also the absence of a large amount of expensive commercial space. These airports will be developed in a phased manner, initially to cater the needs of 20/40/80 seater aircrafts depending on traffic forecast. Smaller aircraft should be treated as the main demand driver for the future growth of low cost airports. Initially these airports may function on the basis of VOR only with or without Night Operations facilities. These airports can have a Runway Length of 1400m to 1700m with 2 parking bays. Perimeter may be provided with chain link fencing instead of permanent wall.

The development of Low-cost Regional Airports would also require a separate regulatory framework both for safety and security. For example Airports with less than 50 passengers in a day may be exempted from X-ray screening and it may be replaced by physical checking. Wherever expensive sophisticated equipments can be replaced by manual or low cost systems without compromising on their original purpose, they may be acceptable. The DGCA and BCAS should examine regulatory regimes available in countries where low-cost airports have developed and adopt a similar minima based systems.

These airports will have shared hold rooms instead of individual gates and will not have PBBs, Escalators, Carousels, etc. These airports will use low-cost energy efficient sustainable technology for ventilation / air-conditioning, waste water management, water management, STP, etc. and software solutions to meet functional needs.

7.2.4.1 Commercial Viabilities of Low Cost Airports

Introduction of air connectivity or increased air connectivity enables manufacturing enterprises to exploit the speed and reliability of air transport to ship components across firms that are based in different and distant locations thereby minimizing the inventory cost. Therefore the low cost airports are likely to harvest the huge untapped industrial and commercial capacities in Tier-II and Tier-III cities and open up the opportunities for investments. The resultant economic growth of Tier-II and Tier III cities will increase in disposable income of middle class people living in such cities, which in turn will increase the propensity to travel by air to distant places for pilgrimage, tourism, business, education, training, etc. With the emergence of low cost carriers and with the purchase of small aircraft (20/40/ 80 seaters) augmented with the low cost of operations will result in the affordability in aviation sector. These factors are further strengthened by the interest shown by private promoters and developers to develop airports in Tier-II & III cities.

7.2.4.2 Low Cost Airports – Concerns, Issues and Solutions

In spite of the progressive commercial viabilities of the low cost airports, the following concerns and issues need to be addressed.

- Limited aero & non-aero revenue sources over short to medium term due to limited traffic.
- Mandatory expensive safety and security requirements.
- High cost of mandatory infrastructure may make airports unsustainable thus there need flexible regulation in licensing norms for scheduled operations.
- ANS Charges
- There is risk of undermining the viability of the project due to delay in getting large number of clearances required from various authorities / agencies viz. DGCA, AAI, Defense, Environment Ministry, State Authorities & Local Municipalities.
- Difficulties and delays in land acquisition, no proactive policy on rehabilitation and resettlement of displaced inhabitants.
- Access to airports and connecting infrastructure generally has not been factored by City Urban Planning Departments.

Operating costs of low cost regional airports may be curtailed by outsourcing of non-core activities. Further it is suggested to enact enabling policies and create regulatory environment (including licensing criteria, security & safety norms) to encourage private sector investment and to induce management skills in regional airport infrastructure and regional airlines to ensure sustainability. Increased assistance under Viability Gap Funding scheme or India Infrastructure Project Development Fund will ensure the success of low cost airports. In addition, some monetary interventions by Government viz., *Establishment of Regional Airport Connectivity Fund (RACF)* through collections made from passengers to provide subsidies to airlines and for establishment of regional low cost airports and heliports. This is in line with Regional Development of Airports Scheme (RDAS) and Remote Area Subsidy Scheme (RASS) both of which are in vogue in Australia and Essential Air Services (EAS) Program which is in vogue in US. These measures will supported by IT solutions by operators to focus on supporting processes and functionality, to facilitate Airport operations, baggage claims, flight check-ins and delivery of services. Removal of restriction of 150 km for revival of non-operational airfields / airstrips, as these are not greenfield airports will support and benefit the activation of existing non-operational airports. NSOPs may be permitted to announce schedules on category II and III routes and encouraged to operate to low cost regional airports.

7.2.5 Initiatives by various Stake Holders for Development of Low Cost Airports

Stake holders such as Central Government, State Governments, Airport Developer, Airline Operators, Commerce and Industry Bodies need to take the following initiatives to strengthen the commissioning and operation of low cost regional airports.

7.2.5.1 Initiatives by Central Government

It is necessary to enact enabling policy and regulatory framework to encourage private sector's investment in the low cost regional airport. Enacting National Policy on Regional Airport Development will further strengthen the development of low cost regional airports. Re-categorization of Routes under Routes Dispersal Guidelines will facilitate operation of regional airlines to low cost regional airports. Essential Air Service Fund (EASF) / Regional Air Connectivity Fund (RACF) are to be created to support air access to Tier-II and III cities. Guidelines for development of no-frills airport model without compromising on safety and security is also suggested. Facilitating airport development fee for pre-funding of airports would help in keeping tariffs down. Faster, single window mandatory clearances – facilitation support; Fiscal incentives – infrastructure status & IT exemption be extended to Brownfield airport expansion and notification of ATF under 'Declared Goods' category with uniform 4% sales tax are the other few initiatives suggested to facilitate the successful operation of low cost regional airports.

7.2.5.2 Initiatives by State Governments

Since aviation growth creates business and employment opportunities, promotes tourism and boosts economy of the region, state governments may be encouraged to develop State owned airstrips / airfields either by itself or through management contracts, JVs with private promoters and AAI. Lowering sales tax on ATF will go in the long way in promoting the aviation in the state and the region. State may try to subsidies land for airport construction and up gradation and also provide active assistance in land acquisition. State government may offer either tax free or lower tax on inputs for Airport construction & operations. State governments may offer direct subsidy to airlines to promote connectivity by the way of underwriting of seats in sectors with low occupancy to till such time when sector stabilizes, say 3-5 years. State governments may also promote the tourism places by giving impetus to *Incredible India* movement. A classic example is a Kerala Tourism Development Corporation (KTDC). KTDC has promoted the state as “God’s own Country” with a direct focus on tourism development. In addition, provision of utilities i.e. water supply, power at subsidized rates; promotion of flying schools, aviation colleges, etc. and real estate development funding in and around airport to private developers are the other few initiatives suggested to facilitate the successful operation of low cost regional airports.

7.2.5.3 Initiatives by Airline Operators

At the outset airlines must try to offer affordable airfares to cater to price conscious regional passengers. Airlines must try to use the regional airports as inter-region & intra-region Regional Hubs. Airlines must try to develop the concept of code sharing in order to provide better connectivity with less time & cost and to minimize leakage of passengers from the catchment areas. Regular ‘on time’ connectivity with Hub & Spoke approach will facilitate to reduce the operational cost with retention of passengers. Leveraging Technology (ICT, Software Solutions) to economies operational cost and deployment of smaller aircraft with outsource non-core activity are the other few initiatives suggested to facilitate the successful operation of low cost regional airports.

7.2.5.4 Initiatives by Airport Operators

Airport Operators must explore the possibility of JV with State Government / AAI to develop the low-cost no-frills airports. In co-ordination with state government, airport operators may try to develop the fast connectivity (rail, road) to the airport. Airport operators may try to keep airport charges, including night parking charges at the reasonable level to incentives the airlines and the passengers. Airport operators may provide facilities for ancillary aviation, like MRO facilities, Flying Schools, etc., to enhance the commercial viability of the airport. Airport operators may adopt green sustainable, environment friendly technology, in order to reduce carbon foot print. They may also develop sustainable business model to offer aviation-related non-aero services –viz., General Aviation, HRD, Hangars facility for aircraft parking, Flying / Aviation training academy, aero sports, cargo etc. and provide services for warehousing, cold storage, food processing, agro tourism, retail outlets / chains, multiplexes, IT hubs, medical services, etc. Leveraging Technology (ICT, Software Solutions, etc.) to economies operational cost; Multi-tasking staff and outsource non-core activity are the other few initiatives suggested to facilitate the successful operation of low cost regional airports.

7.2.5.5 Initiatives by Commerce and Tourism Industry

India has lot of tourists' places in every state from Kashmir to Kanyakumari. Commerce & Tourism Industry may try to promote tourist places in co-ordination with the state governments to generate tourists' arrivals in their respective states. This may be done by developing tourist attraction avenues along with travel packages at budget rates, casinos, etc. Commerce ministry may attempt to develop industry clusters in airport catchment area; use of Air Cargo to the extent possible; encouraging employees to travel by air.

7.2.5.6 Initiatives by Airports Authority of India

AAI may try to revive the non-operational airports in Tier-III cities by JV with the respective State Government or Private entities. AAI may try to rationalize aeronautical and airport charges. It is important to develop separate policy for regional airports. AAI may facilitate reduction in airlines' operating costs to incentivize airlines to serve regional airports, till traffic reaches break-even level. Free Night Parking Charges in initial years may also be considered. It is important that AAI must take a lead in building low-cost and no-frills airports.

7.2.6 Business Models in developing Low Cost Regional Airports

The business models such as Hub-spoke Model, Tier-II & III Model, Low-Cost No-Frill Airport Model, and Helipad Development are suggested in developing low cost regional airports. These models are described below.

7.2.6.1 Hub-Spoke Model

In Hub-Spoke model, Tier-I city may be connected with Tier-II & III cities. However it is very early to conclude on the viability of this model. Refer figure 7.1 below.

Figure 7.1 Hub Development

Source: Adapted from GMR (2014)

7.2.6.2 Tier-II & III Model

In this model there is no hub and no tier-I city is involved. Under this model Tier-II cities are connected with Tier-II cities and Tier-III cities are connected with Tier-III cities. Advantages of this model are

- No Cost Load viz., Airport Development Fees; Airport Charges etc.
- No Congestion
- No Restriction of Slots

7.2.6.3 Helipad Development

Helicopter operations for short distance could be considered by developing Helipad where aircraft operation may not justify the cost and concept. Emerging corporate travelers who value time as a precious asset could be the target travelers. Less land requirement makes helicopter operation a successful model, where land is a constraint, for an airport. Minimum investment advantage makes helipads financially viable. For sight-seeing, adventure tourism and medical emergencies helicopter operations could be capitalized. Helicopter operations could be for Remote Area Accessibility. Remote, hilly and inaccessible areas of the country could be connected by helicopter operations.

7.3. Achievement of Development of Low-Cost Regional Airports

Table 7.0-1 Development of Low-Cost Regional Airport projects in anvil through PPP

Developers	Region	Airports
M/s. Reliance	Maharastra	Nanded, Latur, Baramati, Yavatmal and Osmanabad
M/s. Rahi Developers	Karnataka	Gulbarga & Shimoga (Expected to roll-out in the current year)
M/s. Bengal Aerotropolis Projects Ltd.(BAPL)	West Bengal	Durgapur Aerotropolis (Stake of Changi-Singapore)
M/s.MARG Group	Karnataka	Bijapur & Bellary
M/s. Super Airports	Puducherry	Karaikal

Source: Compiled by authors in consultation with various developers

In addition task force on development airports has recommended 32 airports to be developed under PPP model at the cost of Rs.6000 Crores (see annex I). There are also 9 Tier-III Brownfield Airports proposed to be developed in any region of the country (see annex 7.2). There are 15 Greenfield Airports proposed to be developed for which in-principle approval has been granted (see annex III). Site clearance for 4 Greenfield Airports has been granted (see annex IV) and 12 Greenfield Airports is under process (see annex 7.4).

7.4 Concluding Remarks

During the last one decade the civil aviation sector has grown at a phenomenal pace and India has emerged as the 9th largest civil aviation market in the world. As regards to domestic market, India is the 4th largest market after US, China and Japan. By the year 2020, India is expected to be 3rd largest aviation market by handling 384 million passengers (305 million domestic passengers and 79 million international passengers). To support this growth, investment of Rs.71,000 Crores is envisaged on airport infrastructure during XII Five Year Plan.

Air traffic in India at Tier-II & III cities are expected to grow faster than Tier-I cities because of shifting of IT, BPO, MNCs & other industries to Tier-II & III cities due to availability of cheaper land, manpower & other logistics. Also airports in Tier-I city has been bursting, as there is little scope for further expansion and train reservations in higher class i.e. 1st AC / 2nd AC / 3rd AC generally not available before two months. In remote, hilly and inaccessible areas of the country, air transport is the quickest and sometimes the only option of mode of transport. Thus development of regional airports in the Tier-II & III cities is essential to sustain the future aviation growth.

AAI has already taken up the development of 35 non-metro airports. While the development of 27 airports has already been completed; development of 4 airports at Ranchi, Raipur, Bhubaneswar and Khajuraho shall be completed soon. Development of 27 other non-metro airports at Tier-III cities has been taken up by AAI. While the development of 15 airports has been already completed; development of 5 other airports at Kadappa, Puducherry, Bikaner, Jaisalmer & Bhatinda is expected to be completed soon.

The development of Low-cost Regional Airports would require a separate regulatory framework both for safety and security. The low cost airports are likely to harvest huge untapped industrial and commercial capacities in Tier-II and Tier-III cities and open up the opportunities for investments. The resultant economic growth of Tier-II and Tier III cities will increase in disposable income of middle class people living in such cities, which in turn will increase the propensity to travel by air to distant places for pilgrimage, tourism, business, education, training, etc.

Stake holders such as Central Government, State Governments, Airport Developer, Airline Operators, Commerce and Industry Bodies need to take the initiatives to strengthen the commissioning and operation of low cost regional airports. The business models such as Hub-spoke Model, Tier-II & III Model, Low-Cost No-Frill Airport Model, and Helipad Development are suggested in developing low cost regional airports.

CHAPTER 8

ROLE OF GREENFIELD AIRPORTSIN ENVIRONMENTAL SUSTAINABILITY

8.0 Introduction

Greenfield airports are airports, which are developed at a new site- on the agricultural lands and in some cases on forest land, either partly or fully. Government of India announced the development of 100 green field airports during UPA II government to give boost to the economic development of the country and improve the air connectivity to Tier II and Tier III cities. Green field airports play a significant role in accelerating the urbanization of the country although at the same time; development of green field airports has some adverse environmental impacts such as use of agricultural land, deforestation, cutting of hills, diversion of rivers and erosion of the sea shores etc. All these adverse environmental impact have significant ramification on the environment. On the other hand airports are needed for development of economy, trade and tourism, urbanization and for cultural and religious integration. In view of the above GoI is adopting a balanced approach between positive and negative impacts of development of Greenfield airports.

Increase in air-traffic demand, increase in level of urbanization and growth of small towns into bigger cities has led to increased pollution and as a result necessitated the need for development of green field airports. The impact of the green field airports and urbanization has significant impact on economic growth. It has also been decided by government of India that during next 20 years the number of airports will be increased from existing 133 to 500 airports and among them 367 airports will be green field airports. Searching sites for a green field airport involves a number of activities such as identification of site, obstruction clearance within 30 nautical miles etc. Obstructions such as high rising building, hills, HT lines, forest, industrial chimneys, railway tracks, roads/highways etc. should not create obstacles for landing and takeoff. Besides, factors such as wind rose diagram, rainfall, temperature, wind speed, elevation of site above mean sea level of the proposed site are analyzed for last 5 years. In addition to the above constraints, the site should have adequate traffic potential and be economically viable.

Land acquisition for a green field airport has become more difficult in the light of the new land acquisition act. A new site requires clearances from Ministry of Environment and Forest, Ministry of Finance, Ministry of Home Affairs, Ministry of Defense, BCAS, DGCA, AAI, Ministry of Civil Aviation, Ministry of External Affair (in case the site is closed to international border) and from authority of coastal zone regulation etc. Among all these, clearances from Ministry of Environment are most difficult. The major consideration for environmental clearance is that the site should not encroach upon the forest land. Many times the site involves tree felling, hill cutting, diversion of river, elimination of natural water ponds, demolition of structure of archeological importance, places of worship etc. Also the pollution because of engine emission, noise pollution, soil pollution, water pollution etc. is also considered.

However, the public authorities in India are trying to maintain a balance between urbanization and environmental pollution while implementing development of Greenfield airports. In view of this, the paper examines the impact of development of green field airports on environment and urbanization in India. The paper discusses impact of air traffic on environmental degradation, some of representative Greenfield airports plans to be developed by Ministry of Civil Aviation, and environmental implications of such airports.

The remaining part of the study is as follows: section 2 contains literature review and section 3 contains methodology adopted for the study. Section 4 describes description of variable used. Section 5 contains result and discussion followed by concluding remarks in section 6.

8.1 Literature Review

The United States General Accounting Office (2000) and the Congressional Research Service (2007) outlined some of the impacts of operation of airports on the environments. These impacts mostly related to air and water quality and noise pollution issues likely to be caused by activities like deicing and anti- icing activities, fuel storage problems and emissions of toxic air pollutants. The latter also so outlined were potential regulatory changes and incentives for airports to invest in suitable abatement technologies.

In a study on assessing the environmental impact of the addition of 3rd Airport at Istanbul, Byrakdar and Durmaz observed that the City and its nearby areas are likely to suffer significant environmental damage in terms of loss of productive agricultural land, meadows, wetlands along with loss of habitat and ecosystem of migratory birds. It is anticipated that such damage will lead to environmental devastation in the form of air pollution, drought and climate change.

Corpus et al. (2012), on the potential impact of the expansion of Hong International Airport, have demonstrated that despite the negative impact of such a development in the form of higher quantum of noise and air pollution, local residents are likely to support such initiatives in anticipation of greater economic benefits in the form of more jobs and better access to transport.

Mullen -Gray has observed that air quality and noise pollution remain key concerns in the development of airports. Advocating the benefits of development of airports on environment he opined that airports are likely to function as preserves or conservation areas for natural resources that may be threatened by development “beyond the fence.” Even now, perhaps inadvertently, managers of large air carrier airports in urban areas might find themselves effectively serving as custodians of special-status species (plant and animal), remnant landscape units, rare geological formations, wetlands of various types, aquifers, and surface water bodies.

In a study on health and environmental impact of upgradation of airport infrastructure with the expansion of Kuala Lumpur Airport, Sahrir et al. (2014) have found that increase in construction and land use intake had significant relations with the noise and particulate matter (PM) levels. It was observed that PM levels at the surrounding living area were above the recommended levels.

Celikel et al. have highlighted the importance to carry out trade-off assessments to understand the interrelation of different environmental impacts of proposed operational decisions in the aviation sector and to determine the economic effects of each decision. The feasibility of such an approach has been demonstrated through an example using Preferred emissions route (PER) and Preferred noise route (PNR) scenarios. One of the important aspects of the study has been to demonstrate that the combined use of airspace simulation, environmental and economic tools, makes trade-off assessment feasible for any kind of scenarios, and adds value to operational project evaluation.

8.2 Research Methodology

The paper is based on study of secondary data collected from World Bank on air traffic, economic growth and environmental degradation for the period 1971-2014 and six case studies on representative Greenfield airports through focus group discussion and consultations with AAI.

In order to capture the impact of air traffic and economic growth on environment we introduced Cobb-Douglas production function, where carbon emission is taken as output variable with input of air traffic and economic growth. Thus the model can be written as:

$$Q = f(X_1, X_2, X_3) \quad \ldots(1)$$

$$Q = AX_1^{\beta_2} X_2^{\beta_3} X_3^{\beta_4} e^{\varepsilon} \quad \ldots(2)$$

Now taking log to both side of eq.2, we have,

$$\ln Q = \ln A + \beta_2 \ln X_1 + \beta_3 \ln X_2 + \beta_4 \ln X_3 + \varepsilon_i \quad \ldots(3)$$

Where, $\ln Q$: natural log of carbon emission

$\ln A$: intercept of the production function (β_1)

lnX_1 : natural log of air cargo traffic per air craft movement

lnX_2 : natural log of air passenger traffic per air craft movement

lnX_3 : natural log of per capita GDP

ε_i : Stochastic random term

Similarly, to know the impact of regulation in terms of either economic regulation or privatization or both and trade openness on environmental degradation, we have estimated the following model.

$$\ln Q = \alpha_1 \ln Y_1 + d_1 Y_2 + d_2 Y_3 + d_3 Y_4 + \mu_i \quad \ldots(4)$$

Where, $\ln Q$: natural log of carbon emission

lnY_1 : natural log of trade openness

Y_2 : no regulation (neither economic regulation nor privatization) dummy

Y_3 : privatization dummy

Y_4 : privatization and economic regulation dummy

μ_i : Stochastic random term

The following green field airports were selected for their environmental implication:

- Bombay II airports,
- MOPA Airports,
- Aranmulla Airports,
- Sirdi Airport,
- Kanoor airport and
- Pune Greenfield Airport.

In order to explore the environmental implications of development of Greenfield airports we visited these airports, conducted focus group discussions and developed case studies based on focus group discussions.

8.3 Descriptive Data Analysis

8.3.1 Cargo Traffic per Aircraft Movement (CTM)

The cargo traffic per aircraft movement (CTM) is obtained by dividing total air freight traffic by aircraft movement. According to World Bank, air freight is the volume of freight, express, and diplomatic bags carried on each flight stage (operation of an aircraft from takeoff to its next landing), measured in metric tons times kilometers traveled, whereas the registered carrier departures worldwide, known as aircraft movements are domestic takeoffs and takeoffs abroad of air carriers registered in the country.

Table 8.0-1 Descriptive Statistics of Air Traffic, Environmental Degradation & Economic Growth

Variable	Obs	Mean	Std. Dev.	Min	Max
CO_2P (in metric tons per capita)	41	-0.24	0.46	-1.01	0.51
CO_2K (in kt)	41	13.43	0.70	12.24	14.55
CO_2I (kg per kg of oil equivalent energy use)	41	0.74	0.24	0.27	1.04
CTM (in metric tons times km traveled per	44	-5.86	0.31	-6.60	-5.25
PTM (in number of passengers per aircraft	44	4.33	0.30	3.53	4.74
PGDP (in per capita)	44	6.15	0.47	5.58	7.12
TOPN	44	0.24	0.15	0.09	0.55
Dummy Variables	Dummy Category			1	0
RD1 (presence of neither economic regulation nor privatization =1, otherwise=0)	Freq.			29	15
RD2 (presence of privatization =1, otherwise=0)	Freq.			15	29
RD3 (presence of privatization and economic regulation =1, otherwise =0)	Freq.			6	38

Source: Compiled by authors from World Bank Database

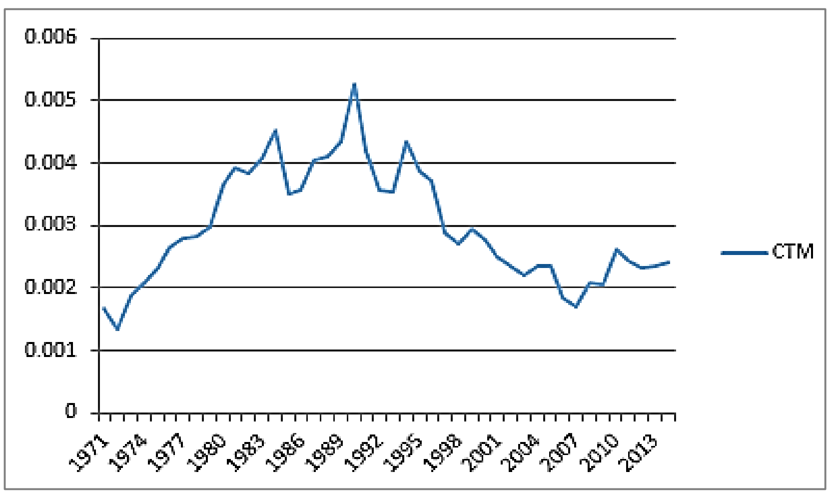


Figure 8-1 Growth Trend of Cargo Traffic

Source: Drawn by authors from World Bank Database

The growth rate of CTM of India declined to -23.45% during 1972, however increased to 27.49% during 1973. During last 44 years the maximum growth of CTM of India stood at 27.49% during 1973 and the minimum growth stood at -29.44 during 1985 (see Fig.8.11). It has been observed from Fig.1 and Table 8.1 that out of last 44 years 19 years registered a negative growth rate while all remaining years registered positive growth rate of CTM.

8.4.2 Passenger Traffic per Aircraft Movement (PTM)

The passenger traffic per aircraft movement (PTM) is obtained by dividing total air passenger traffic by aircraft movement. As explained above, according to World Bank, air passengers carried include both domestic and international aircraft passengers of air carriers registered in the country., whereas the registered carrier departures worldwide, known as aircraft movements are domestic takeoffs and takeoffs abroad of air carriers registered in the country.

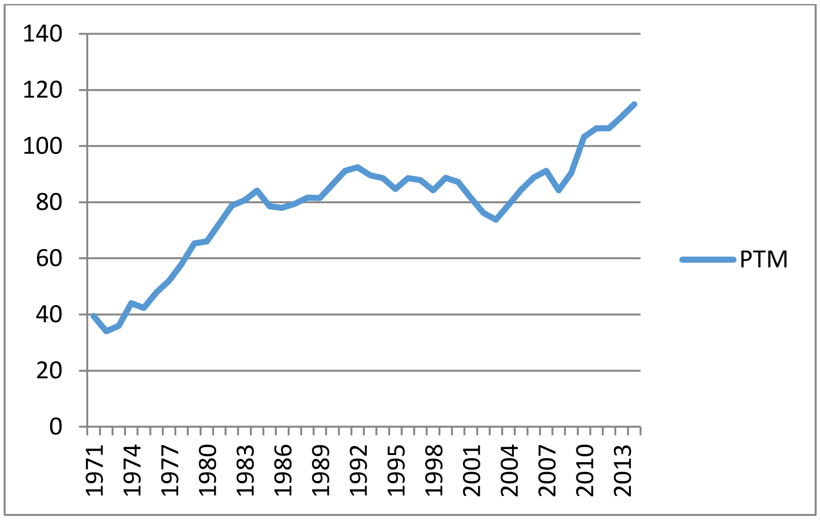


Figure 8-2 Growth trend of passenger traffic

Source: Drawn by authors from World Bank Database

The maximum growth rate of PTM of India as observed from Fig.2 stood at 18.29% during 1974 followed by 12.44% during 2010 and 11.48 during 1976. The year 1972 registered a minimum PTM growth rate of -16.05%. The year 1978 and 1979 registered a PTM growth rate of 10.24% and 11.43% respectively. All the remaining years except the above mentioned years during last 44 year stood at PTM growth of below 9% in India (see Fig.8.2 and Table 8.1).

8.4.3 Per capita GDP (PGDP)

Per capita GDP is the gross domestic product divided by midyear population. During last 44 years Indian economy registered a maximum per capita GDP growth of 8.05% during 2010 and a second highest growth of 7.55% during 2007 (see Fig.3 and Table 1).

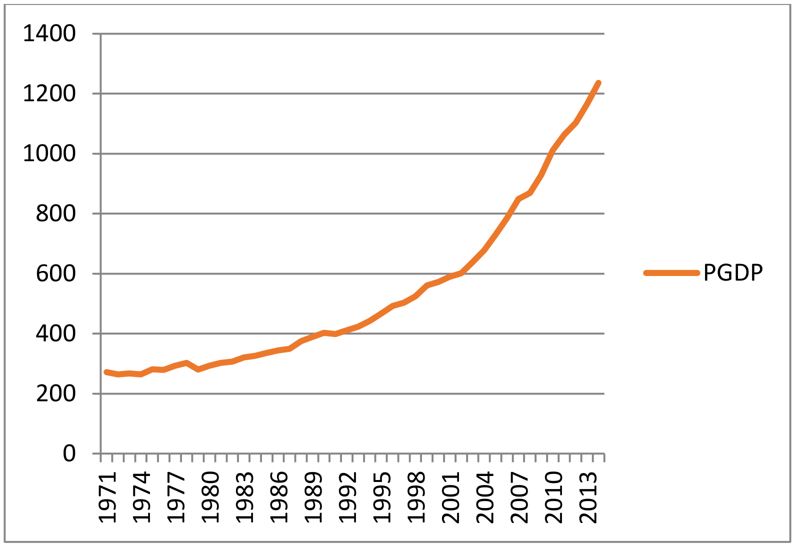


Figure 8-3 per capita GDP

Source: Drawn by authors from World Bank Database

Also Fig.8.3 and Table 8.1 depicts that during last 44 years Indian economy registered a minimum per capita growth rate of -7.97% during 1979. The years 1972, 1974, 1976, 1979 and 1991 registered negative per capita GDP growth rate and the remaining years registered positive per capita growth rate during last 44 years of Indian economy.

8.4.4 Environmental Degradation

We have considered carbon dioxide emission indicators such as Per Capita CO_2 (CO_2P), Carbon Dioxide measured in kilotons (CO_2K) and Carbon Intensity (CO_2I) as proxy variables for environmental degradation in this study. According to World Bank, carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

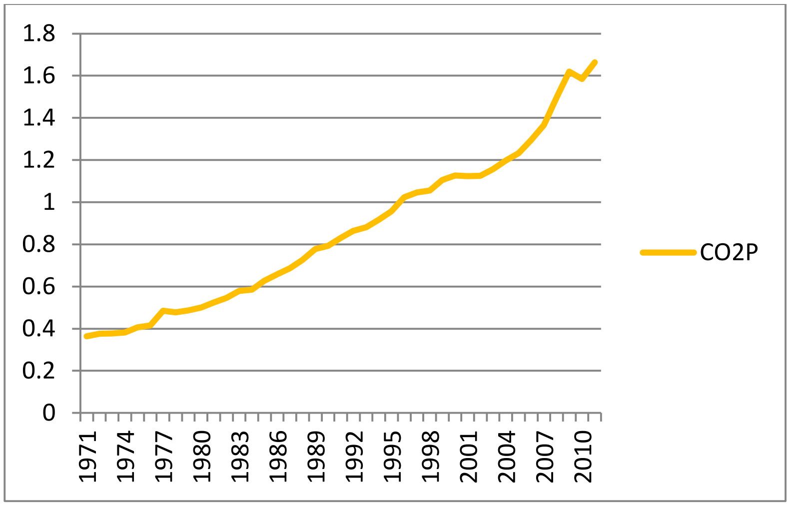


Figure 8-4 Growth trend of Per Capita Carbon Emission

Source: Drawn by authors from World Bank Database

The growth rate of per capita carbon emission (CO_2P) as seen from Table 8.1 and Fig.8.4 has been rising continuously except few years where the same has registered a negative growth rate. The years 1978, 2001, and 2010 registered negative per capita carbon emission whereas the remaining years registered positive per capita carbon emission growth during last 44 years of the Indian economy. During 1977 the growth rate of CO_2P stood at a maximum of 14.51% whereas it registered a minimum growth rate of -2.16% during 2010.

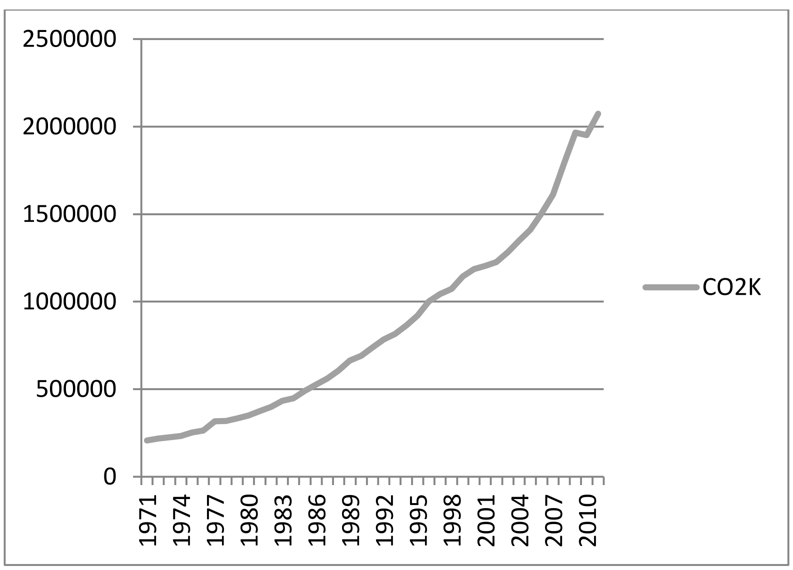


Figure 8-5 Growth trend of Carbon Emission (kt)

Source: Drawn by authors from World Bank Database

The growth rate of absolute carbon emission measured in kilotons (CO_2K) as seen from Table 8.1 and Fig.8.5 has also shown a rising trend though it declined during few years. During 1977 the growth rate of CO_2K stood at a maximum of 16.44% whereas it registered a minimum growth rate of -0.76% during 2010. The growth trend of CO_2P and CO_2K remained more or less same during last 44 years though they differ in magnitude due to the former being per capita emission and the latter being absolute emission.

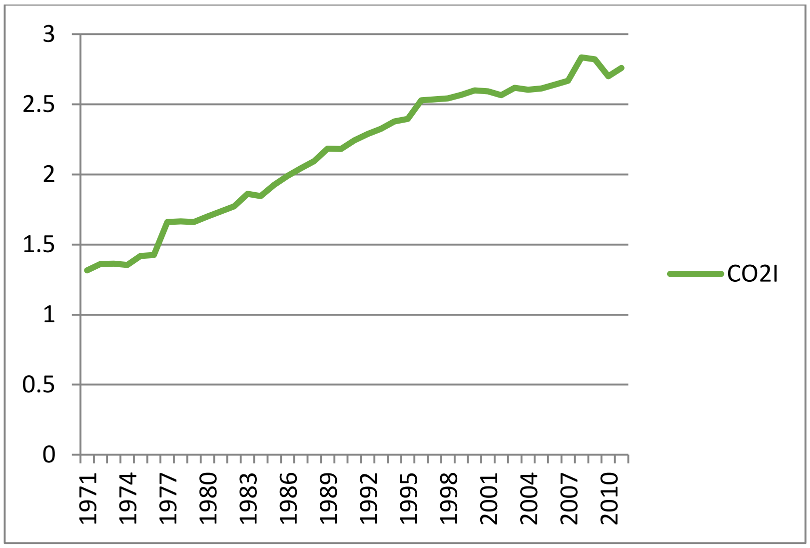


Figure 8-6 Growth trend of Carbon Emission (kt)

Source: Drawn by authors from World Bank Database

According to World Bank carbon emission intensity is measured as kg per kg of oil equivalent energy use. The trend of growth rate of carbon emission intensity (CO_2I) as seen from Table 8.1 and Fig.8.6 has also been rising continuously except years 1974, 1979, 1984, 1990, 2001, 2012, 2004, 2009 and 2010 where the same has registered a negative growth rate. The remaining years registered positive intensity of carbon emission growth during last 44 years of the Indian economy. During 1977 the growth rate of CO_2I stood at a maximum of 14.11% whereas it registered a minimum growth rate of -4.53% during 2010.

8.4.5 Airport Economic Regulation, Privatization and Trade Openness

Privatization of Indian airports started in 2000 with the privatization of Cochin International Airport. Subsequently, Bangalore, Hyderabad, Mumbai, Delhi and Nagpur airports were also privatized with PPP mode under BOT approach. The additional four airports are on way to privatization. With the privatization of above mentioned airports, necessity for economic oversight/ regulation was felt and a frame work for this was established in December 2008 by creating Airport Economic Regulatory Authority (AREA). The Airports Economic Regulatory Authority of India Act, 2008 was enacted on 5.12.2008. Under the Act, AERA's mandate covers determination of tariffs for aeronautical services, user charges and monitoring of set performance standards in respect of major airports. Presently 17 airports in the country have annual passenger throughput in excess of one and a half million. These 17 airports include 6 joint venture airports and 11 public airports. The other 73 minor airports are regulated by Ministry of Civil Aviation (MOCA), Government of India (Singh, Dalei and Raju, 2015).

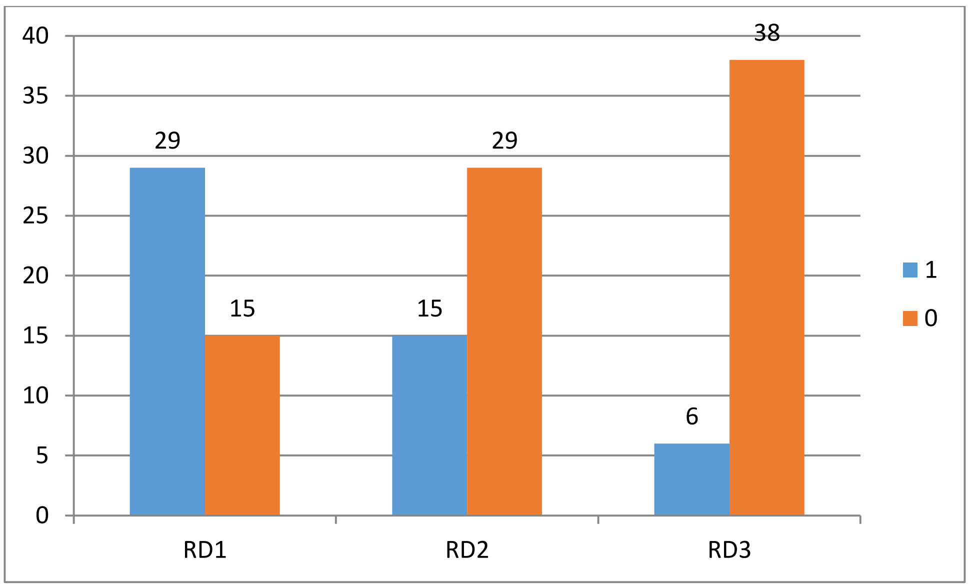


Figure 8-7 Economic Regulation and Privatization

Therefore, in view of this we have introduced three dummy variables in airport sector viz. neither regulation nor privatization (RD1), privatization (RD2) and both economic regulation and privatization (RD3). The frequency of years of presence of neither economic regulation and nor privatization is 29. Similarly, the frequency of years of aviation activities with presence of privatization is 15 whereas the frequency of presence of both economic regulation and privatization is 6 (see Table 8.1 and Fig.8.7).

We defined trade openness (TOPN) by taking into account the real export (RX), real import (RM) and real GDP (RGDP) as given in Eq. 5.

$$TOPN = \frac{RX + RM}{RGDP} \qquad \ldots(5)$$

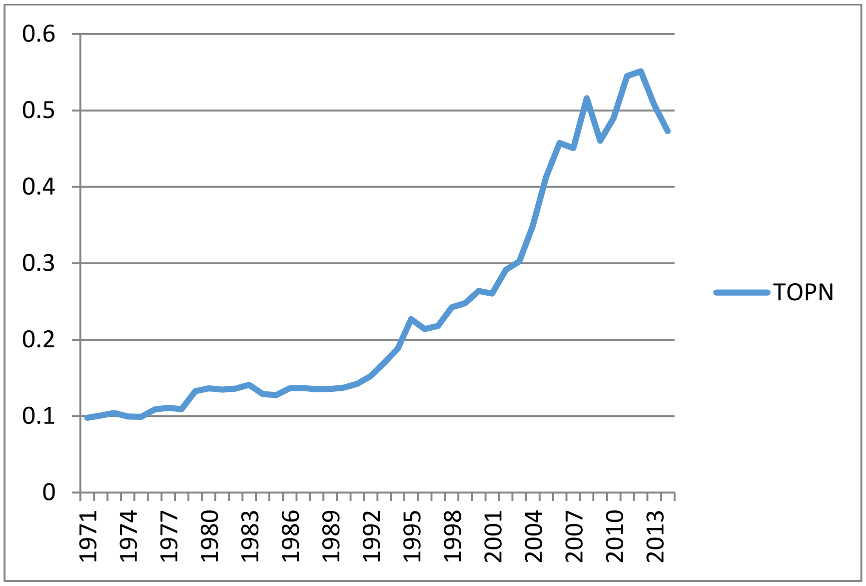


Figure 8-8 Trend of Trade Openness

Since 1971 the trend of India's trade openness as shown in Table 8.1 and Fig. 8.8 is showing on an average rising trend except 2013 and 2014 where it has shown a drastic fall of around 8 and 7 % respectively. The mean trade openness is around 0.24 with minimum growth rate of -10.81 % during 2009 and maximum growth rate of 21.37% during 1979 as shown in Fig.8.8.

8.5 Result and Discussion

8.5.1 Impact of Air Traffic and Economic Growth on Environmental Degradation

Airports are generally located in urban areas and cities. Aviation activities directly and indirectly affects natural environment and contribute in its degradation substantially. In this study we have considered various indicator of carbon dioxide as proxy for environmental degradation. Say for example result depicted in Table 8.2 indicates that cargo traffic per aircraft movement is significantly and positively affecting per capita carbon emission, absolute carbon emission and carbon intensity each at 10% significant level. With rising cargo traffic per aircraft movement, per capita carbon emission, absolute carbon emission and carbon intensity are also rising significantly keeping all other factors constant. Passenger traffic per aircraft movement also affects per capita carbon emission, absolute carbon emission and carbon intensity significantly and positively each at 5% significant level.

Passenger traffic per aircraft movement also helps in increasing the per capita carbon emission, absolute carbon emission and carbon intensity substantially and statistically each at 5% significant level keeping all other factors constant.

Table 8.0-2 Result of Impact of Air Traffic and Economic Growth

Explanatory Variables	**LnCO_2P**	**LnCO_2K**	**LnCO_2I**
LnCTM	0.1100475* (0.076911)	0.16986* (0.114743)	0.092768* (0.062988)
LnPTM	0.2414581** (0.114282)	0.3990004** (0.170496)	0.210713** (0.093593)
LnPGDP	1.136266*** (0.08936)	1.682761*** (0.133316)	0.571682*** (0.073183)
_cons	-7.512912*** (0.563182)	2.521396*** (0.840207)	-3.06869*** (0.461228)
R-Square	0.9867	0.9872	0.9674
Prob > F	0.0000	0.0000	0.0000

Note: (i) Standard errors are given in the parentheses

(ii) * sig. at 10% level, **sig. at 5% level, ***sig. at 1% level

In this study we have considered per capita GDP as the proxy for economic growth, which affects per carbon emission, absolute carbon emission and carbon intensity statistically and positively each at 1% significant level other things remaining constant. That is raising economic growth helps in increasing per capita carbon emission substantially at 1% significant level keeping all other things constant. For data refer annexure 8.1 to 8.2

8.5.2 Impact of Airport Economic Regulation, Privatization and Trade Openness on Environmental Degradation

Airport economic regulation, privatization of airports and trade openness are believed to be helping in reduction of pollution because the firms, industries, export and import houses strictly follow environmental regulations to keep their business in running order. Thus in order to know the impact of these factors on environmental quality we used OLS method to estimate environmental degradation considering trade openness and three regulation dummy variables for airport economic regulation and privatization as explanatory variables.

Table 8.0-3 Result of Impact of Economic Regulation, Privatization and Trade Openness

Explanatory Variables	$LnCO_2P$	$LnCO_2K$	$LnCO_2I$
LnTOPN	1.03243*** (0.0866887)	1.562447*** (0.1317466)	0.588433*** (0.0603127)
RD1	1.560776*** (0.1702735)	16.16004*** (0.2587761)	1.793654*** (0.1184659)
RD2	1.244345*** (0. 1010656)	15.71279*** (0.1535963)	1.556375*** (0.0703153)
RD3	-0.0395161 (0.1042708)	-0.114549 (0.1584673)	-0.1300548* (0.0725452)
R-Square	0.9244	0.9997	0.9839
Prob > F	0.0000	0.0000	0.0000

Note: (i) Standard errors are given in the parentheses

(ii) * sig. at 10% level, **sig. at 5% level, ***sig. at 1% level

The openness elasticities of carbon emission per capita, absolute carbon emission and carbon intensity presented in table 8.3 are all statistically significant each at 1% significant level. Keeping regulation and privatization constant the openness elasticities envisaged that if openness goes up by 1%, on an average the carbon emission per capita, absolute carbon emission and carbon intensity each goes up by 1.03 per cent, 1.56 per cent and 0.59 per cent respectively. The carbon emission per capita and absolute carbon emission are very responsive (elasticities>1) to change in openness whereas carbon intensity is not so much responsive due to its elasticity being less than one. Thus trade openness increases pollution because if the country is more open to international trade then lax pollution policy motivates dirty goods to be produced and traded internationally.

There was no regulation (RD1) in terms of privatization and economic regulation in Indian airports prior to the year 2000. Privatization (RD2) in Indian airports started during 2000 when Cochin International Airport was privatized. However, along with privatization economic regulation (RD3) of Indian airports came into existence during December 2008 when Airport Economic Regulatory Authority was formed. During these phases of regulation per capita carbon emission, carbon emission in absolute term and carbon intensity has reduced considerable in India. The results in table 3 envisaged that keeping trade openness constant there is a statistically significant reduction of per capita carbon emission, absolute carbon emission and carbon intensity each in India from no regulation period to privatization period in airport sector. The per capita carbon emission, absolute carbon emission and carbon intensity during no regulation period were on an average 4.76 metric tons[18], 10.43 million kilo ton (kt)[19], 6.01 kg per kg of oil equivalent[20] which reduced statically and significantly to 3.47 metric tons, 6.67 million kilo ton (kt), 4.74 kg per kg of oil equivalent during airport privatization period each at 1% significant level. However, per capita carbon emission and absolute carbon emission are not statistically significant during the period of presence of airport privatization and airport economic regulation. Keeping trade openness constant, only carbon intensity in India has reduced statistically and significantly to 0.89 kg per kg of oil

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[18] 4.76=exp1.561

[19] 10.43= exp16.16004

[20] 6.01=exp1.793654

equivalent during the period of presence of airport privatization and airport economic regulation.

Thus, while factors like cargo and passenger traffic economic growth and trade openness helps in increasing environmental degradation significantly, public policies like economic regulation and privatization try to reduce it significantly at various statistically significant levels. Therefore, more similar kind of policies must be implemented in India in order to reduce environmental degradation to considerable level. Such an initiative of Government of India is development of Greenfield airports, where the intention is diversion of air traffic from existing airports located in urban areas to outskirt of urban city centers. Many of the airports are either in saturation stage or will be saturated in near future. Therefore, over burden of traffic will generate pollution along with many other problems and the pollution in the environment will be accumulated leading to problem of climate change. Thus development of Greenfield airports will share air traffics of existing airports and the excess pollution will be shifted to outskirt of urban city centers, where its impact will be very less due to natural environment or creation of such environment through green initiatives. Case studies on development of Greenfield airports in India are given below for reference.

8.5.3 Case Studies of Greenfield Airports

8.5.3.1 Bombay II Airports

Development of Bombay II green field airport is under the consideration of the GOI since 1980. The airport authority of India had taken the responsibility of assessing traffic potential for Bombay II airport in 1982. Because of long delay in finalization of the site the Bombay traffic had been diverted to Bangalore, Hyderabad, Trivandrum, Calicut, Kochi, Mangalore, Goa, Pune, Ahmedabad and Nagpur. The existing airport has ultimate capacity of 40 MPPA which will saturate in next 2-3 years. The site for Bombay II airport has been finalized in Navi Mumbai, which has ultimate capacity of 60 MPPA and will saturate by 2030. In fact the site for 2nd airport should have ultimate capacity of 200 MPPA instead of 60 MPPA. However no such site was found in Mumbai which could be developed for 200 MPPA. Even the land acquisition faced lot of hassles such as farmers were asking for higher compensation and obstruct the acquisition by a write petition in Mumbai High Court. The government of Maharashtra offered attractive compensation to the farmers and thus made them agree to the proposal. The CRZ clearance also delayed the project. The cutting of Mangrove trees was involved in the site finalized which delayed the process further and also reduced the size of the site. The Maharashtra government identified a separate site for commercial development to minimize the cutting of mangrove trees. PIL was also filed in Mumbai High Court against cutting of mangrove trees but ultimately the honorable court decided in favor of development of airport in view of the pressing transportation needs of Mumbai. So far the investors/developers have not been identified by Government of Maharashtra. The above case reveals that the development of green field airport is also necessary to meet increase in the demand of air transport and therefore a compromise has to be made on the adverse environmental impact of the green field airports. Also the development of green field airport is a long run process which may involve a period of up to 30-35 years.

8.5.3.2 MOPA (Goa) Airports

The site for GOA II airport has been finalized by Government of Goa after facing lot of problems in land acquisition. The land for access roads has not been acquired so far because of opposition from land owners and general public. The ultimate capacity of MOPA airport is 11 MMPA only in way of the availability of land constraints, whereas Goa required the second airports with an ultimate capacity of 50 MMPA or above. The existing Goa airport being a defense airport has no space for night parking of aircrafts on air side and also there is no space of car parking on the city site. Also the existing terminal building is near saturation and no further land was available for expansion of existing terminal or construction of new terminal and therefore airport authority of India wanted to close this airport. The north Goa people strongly opposed this move and ultimately government has to change its decision to continue the existing airport also in-spite of the fact that Goa attract lot of charted flights, which necessarily require night parking.

On start of development of airport at MOPA local people and politicians started opposing this airport on the ground that the farmers/land owner will lose their bread and butter because their precious land has been acquired by the airport. The politicians including ex-chief minister gave a lot of representation through governor to Government of India stating that this airport will have adverse environmental impact besides the loss of land of farmers, therefore the existing airport should continue and the development of new airport may be dropped.

Government of Goa had to make lot of efforts in convincing the local people for allowing the government to develop the second airport. Even the environmental clearance was obtained after lot of persuasion by government of Goa due to pressing air transportation need.

8.5.3.3 Aranmulla Airport

Aranmulla airport was proposed by K.G.S Developers Ltd. for development to meet the air transportation needs of pilgrimage tourist of Sabarimala. K.G.S Groups owned a plot of land of about 500 acres and proposed to purchase additional land required from the farmers. This site clearance faced lot of problem because of the following-

a) A river was flowing through the middle of the site which requires either diversion or construction of culvert over the river.

b) The expansion of basics trip involve cutting of rubber plantation.

c) On one funnel of the runway require hill cutting having thick rubber plantation.

d) The other side of the runway required lowering of the tomb of ancient lord Krishna Temple.

e) The nearby air-force airspace was overlapping with the air space of the proposed green field airport.

In spite of the above constraints K.G.S Group managed to get a principal approval for the proposed airport by giving an undertaking that the above constraints will be resolved amicably. On commencement of the development work local people and the politician came to know about the principle of approval of the proposed airport and strongly opposed and submitted representation to president/prime minister/minister of defense etc. The Ministry of Civil Aviation and Ministry of Defense was forced to withdraw the approval. This shows how difficult it is to get approval of green field airports.

8.5.3.4 Shirdi Airport

The development of Shirdi airport was proposed by government of Maharashtra to meet the air transportation need of pilgrimage tourists to visit SAI Temple in Shirdi. SAI trust also proposed the financial assistants of Rs. 300 crores for development of this airport. On commencement of the development work local people and hoteliers went on protest for use of SAI trust money for development on airport. The protesters argued that the pilgrims will come by morning flight and return back by evening flight and therefor hotel business will suffer.

With the mounting of agitation’s SAI trust withdrew the proposal for financial assistance. MOCA also commissioned a study on the impact of Shirdi airport on the traffic of Aurangabad airport. The findings of the study were that there will be no ad versed impact on the traffic of Aurangabad airport. In view of these findings the approval was accorded by MOCA for development of green field airport at Shirdi and the runway was constructed however the terminal could not be constructed due to lack of investible funds and withdrawal of financial assistance by SAI trust.

8.5.3.5 Kannur Airport

Kannur airport was proposed by government of Kerala to be developed jointly by NRI’s and government of Kerala on the pattern of CIL (Cochin International airport Limited). The proposal was rejected twice by ministry of civil aviation on the ground that the traffic potential is not enough to justify the development of Kannur airport. Government of Kerala again pursued with MOCA and finally the in principle approval was accorded by MOCA. KIAL (Kannur International airport Limited) wanted to develop this airport with 3400 meter runway length and the work of its development was awarded to Airport Authority of India (AAI). The AAI after inspection of the site informed State government that the length of the plot is 3400 meter and therefore the 3400 runway is not feasible because 1000 meter additional space is required on each side of the runway to accommodate perimeter wall, drainage, perimeter road, runway approach lighting etc. This 2000 meter was not available because there is deep valley on both side of the runway. On this State government withdraw work from AAI and awarded this to KIAL, also the surrounding land was full of coconut trees and the MOEF won’t allow acquiring and using for development of airport. In view of the above KIAL decided to develop it with a smaller runway and with the provision to develop 3400 meter runway later stage.

8.5.3.6 Khed Goan(Pune) Greenfield Airport

Existing Pune airport is a civil enclave and therefore no space is available for its further expansion. The existing site is saturated which need to be expanded to accommodate the growth of traffic. Besides, Pune had lot of cargo traffic potential but the existing site does not have space for cargo terminal also. The state government offered alternative site at Chakan and Rajgurunagar but because of farmer’s reluctance to contribute the land, both this sites could not be undertaken for development of airport. Finally the state government offered a site at Khedgoan, which was a hilly terrain and a part of SEZ. AAI discussed the site with SEZ owner who agreed to provide the land for the airport though the site involves lot of filling and cutting cost. AAI agreed to develop it in the absence of suitable alternate sites. Subsequently the SEZ owner declined to part with the land and therefore the proposal for the development of airport was further referred till a suitable site is made available by state government in addition to above. In this case also the environmental clearance was a big issue because it involves the cutting of the hill.

8.6. Conclusion

Airports are generally located in urban areas. Aviation activities directly and indirectly affects natural environment and contribute in its degradation substantially. In this study we have considered various indicator of carbon dioxide as proxy for environmental degradation other things remaining constant. Our study finds that cargo and passenger traffic each per aircraft movement is significantly helps in increasing environmental degradation in the country especially in urban areas. Rising economic growth and trade openness also helps in increasing environmental degradation significantly keeping all other things constant. Economic regulation and privatization have statistically and significantly negative impact on per capita carbon emission, absolute carbon emission and carbon intensity other things remaining constant. While factors like cargo and passenger traffic, economic growth and trade openness helps in increasing environmental degradation significantly, public policies like economic regulation and privatization try to reduce it significantly at various statistically significant levels. Therefore, more similar kind of policies must be implemented in India in order to reduce environmental degradation to considerable level. Such an initiative of Government of India is development of Greenfield airports, where the intention is diversion of air traffic from existing airports located in urban areas to outskirt of urban city centers. Many of the airports are either in saturation stage or will be saturated in near future. Therefore, over burden of traffic will generate pollution along with many other problems and the pollution in the environment will be accumulated leading to problem of climate change. Thus development of Greenfield airports will share air traffics of existing airports and the excess pollution will be shifted to outskirt of urban city centers, where its impact will be very less due to natural environment or creation of such environment through plantation.

However, the identification of the green field airport site, free from obstruction is extremely difficult in view of the fact that each site may have some obstruction within 30 nautical miles involving hills, forest, agricultural land, high rising buildings, factories, chimney of high rising buildings, rivers, water ponds, religious places like temples, mosques, proximity with the international border, proximity with the sea shore, proximity with air force, defense airspace etc. All these issues involve adverse environmental impact again and therefore even if the site is available the environmental clearance may not be possible. In fact majority of the existing Indian airports are either saturated or near saturation and therefore the alternative sites needs to be developed to maintain the pace of economic development as well as reduction of environmental pollution in urban areas. Therefore a balance approach needs to be maintained between development of airports for economic growth and their adverse impact on environment. Also the existing airports are either surrounded by dense population or are close to the residential areas and therefore add to the mounting pressure of air pollution and noise pollution of the existing cities. Therefore these airports need to be shifted outside the city. The case studies of the paper also reveal the scale of difficulties involved in development of Greenfield airports and there is a constant pressure on the Ministry of Civil Aviation to identify sites for development of Greenfield airports. Government of India has already introduced the policies of development of 500 airports in the country. Only the future will say whether it is possible or not.

CHAPTER 9

SUMMARY AND CONCLUSION

9.0 Introduction

This chapter summaries the whole thesis and conclude with major findings, providing policy implication, contribution to literature, limitation of study and finally highlights future scope of work. This chapter presents concluding remarks and creates a platform for other researcher to continue the work further in performance analysis/efficiency analysis of airports and their comparison with major world airports.

This research study has been undertaken with the following objectives:

i. To give overview of Privatization and economic regulation

ii. To undertake the performance analysis of 17 major Indian airports through efficiency analysis in post privatization and post economic regulation era

iii. In view of efficiency trends to forecast traffic growth , capacity addition in airports and investment required in airport infrastructure for next 20 years

iv. To study the development of low-cost airports to improve air connectivity

v. To study the role development of green field airports in improving environment/sustainability of airports

9.1 Major findings

On the above objectives following are the major findings

9.1.1 Privatization and economic regulation

The economic regulation in airport infrastructure in India was implemented after privatization which resulted into the adoption of different regulatory approaches for private and public airports. In the first cycle of revision of airport charges by AERA in 2012 the prices has been increased more than four-fold with the result that Indian airports has come in the category of costliest airports of the world i.e. consumers have not been benefited as has happened in case of competitive industry such as telecommunication. Also the high traffic growth of Indian aviation sector, which started after introduction of low cost airports in 2003-04, was adversely affected by steep hike in prices by private airport operators. However, the aviation has been benefited out of privatization in terms of creation of adequate capacity and quality of world class infrastructure. The efficiency in use of resources has also been improved after privatization but it is established that the same is because of economies of scale and not because of privatization which has been researched in chapter-5. The policy implication of this study suggests that the privatization and economic regulation is good for capacity addition and improving the quality of infrastructure but increases cost operation due to over investment and application of over debt. However, the price control should be implemented rigorously to keep them within reasonable limit and at the same time growth in traffic should not be adversely affected. The pricing should be matching with Indian cost structure and should be capable of attracting investment in airport infrastructure. The leakage of public revenue by creating number of subsidiaries by private operators may be checked

9.1.2 Performance/efficiency analysis of 17 major Indian airports

The efficiency analyses of 17 major Indian airports[21] have been undertaken based on last 3 years data (2011-2012 to 2013-2014). These 17 airports include 6 Joint Venture/Private Airports viz. Delhi Airport, Mumbai Airport, Bangalore Airport, Hyderabad Airport, Cochin Airport & Nagpur Airport.

Delhi & Mumbai airports have been leased on Build, Operate & Transfer (BOT) basis for 60 years[22]. Bangalore and Hyderabad Airports have been developed on Build, Own, and Operate & Transfer (BOOT) basis by Private Operators. Cochin Airport is developed on Build, Own & Operate (BOO) basis. Nagpur Airport is managed by a joint venture 'Multimodal International Cargo Hub at Nagpur (MIHAN)' and Airports Authority of India (AAI). The Remaining 11 Airports managed and owned by AAI, a government owned public sector undertaking, are Chennai, Kolkata, Trivandrum, Ahmedabad, Goa, Calicut, Guwahati, Jaipur, Srinagar, Amritsar, and Port Blair. The outcomes of DEA analysis is given below:

Five categories of efficiencies have been computed using DEA Techniques with combination of four output variables viz. Revenue, Aircraft Movements, Passengers & Cargo Traffic and

[21] Airports handling more than 1.5 million passengers per year are defined as major airports.

[22] 30+30

four input variables viz. manpower, operating expenses, capital investment & debt. The following five categories of efficiencies are:

(i) Combined efficiency: Efficiency in production of all the four outputs with use of all the four inputs i.e. Manpower, Operating Expense, Depreciation as shadow variable for Investment and Interest as shadow variable for Debt management.

(ii) Manpower Efficiency: Efficiency in use Manpower for production of all the four outputs.

(iii) Operating Expenses Efficiency: Efficiency in use Operating Expenses for production of all the four outputs.

(iv) Investment Efficiency: Efficiency in use Investment for production of all the four outputs.

(v) Debt Efficiency: Efficiency in application/use of Debt for production of all the four outputs.

Prior to adjustment to scale the efficiency of all the above five categories were higher for private airports as compared with efficiency of Government Airports. However to make fare comparison, it is essential to bring all the airports at common base by eliminating the effect of economies of scale. It is also necessary to compute the marginal efficiencies to know the effect of privatization, economic regulation and ownership on efficiency.

Marginal efficiency analysis was also undertaken which brings out that the marginal efficiency of Airport size measured in million Airport Throughput Unit(ATU)is 0.008066, which is highly significant at 1% level of significance. The differential co-efficient for JV airports is -.18325(negative) significant at 3% level of significance which means that there is a decrease in efficiency due to privatization i.e. privatization leads to over consumption of inputs for given outputs. The differential co-efficient for remaining variables were not found significant. The detailed findings of marginal efficiency analysis are.

Overall Efficiency: Efficiency increases significantly with increase in size of airport i.e. Economies of Scale is most significant factor influencing efficiency. The efficiency decreases significantly with privatization of airport i.e. privatization leads to over consumption of inputs for given outputs. There is no significant difference in efficiency for use of different regulatory approaches individually.

Manpower Efficiency: Efficiency increases significantly with the increase in size of airport only. There is no significant difference in efficiency due to private ownership and government ownership. There is no significant difference in efficiency due to difference in regulatory approach also.

Operating Expenses Efficiency: Efficiency increases significantly with the increase in size of airport only. There is no significant difference in efficiency due to private ownership and government ownership. There is no significant difference in efficiency due to difference in regulatory approach also.

Investment Efficiency: Efficiency increases with size of airport significantly but decreases significantly with the combination of privatization and hybrid till i.e. privatization with hybrid till leads to overinvestment for given outputs.

Debt Efficiency: Increases with size of airport at 10% level of significance and also increases with privatization at 10% level of significance but decreases with the combination of privatization and hybrid till significantly i.e. privatization with hybrid till leads to use of over debt for given outputs.

Govt. Ownership: Efficiency increases significantly with government ownership and single till regulation in all of the above cases.

Private Ownership: Combined efficiency decreases significantly with private ownership but debt efficiency increases at 9% level of significance. Private ownership in combination with hybrid till decreases debt efficiency significantly.

Comparison of Efficiencies before and after adjustment to scale

It has been established in section above that economics of scale is the highly significant factor affecting each category of efficiency and also all the 17 airports under study are very Heterogeneous with reference scale (ATU). Therefore efficiencies have been compared after adjustment to scale which reveals as under.

(i) After adjustment to scale, efficiency of Govt. Airports is higher than the efficiency of private airports

(ii) After scale adjustment smaller airports which are under government management are more efficient as compared with larger or medium size airports.

(iii) Regulatory approaches do not have significant difference in efficiency.

(iv) The scale adjusted average combined, manpower and debt efficiency of Govt. airports is higher than scale adjusted efficiency of JV airports which was lower before adjustment. But the position remains unchanged in case of operating expenses and investment efficiency.

(v) The overall average adjusted combined and debt efficiency is higher than unadjusted efficiency. But relative comparative position of efficiency for manpower, operating expenses and investment efficiency, after adjustment and before adjustment remain unchanged.

(vi) Relative position of efficiency, before and after adjustment, do not change for price cap (hybrid till and single till), and light touch regulation, because regulatory approaches do not have significant difference in efficiency.

(vii) The average adjusted efficiency of smaller airports has become higher than the average unadjusted efficiency of medium and large airports for combine, manpower and investment efficiency. But relative efficiency position remains unchanged after adjustment for operating expenses and debt efficiency.

Findings of efficiency analysis may be summed up as below:

Privatization of airports has caused over utilization of scarce resources such as investible financial resources, debt, manpower and operating expenses.

Privatization in combination with hybrid till has caused the consumption of excess capital resources/use of higher operational leverage and use of more debt/higher financial leverage.

Economies of scale are most important factor in minimization of consumption of input resources for given outputs.

Government ownership in combination with single till regulation also minimizes use of input resources for given output and needs to be encouraged in airport sector.

9.1.3 Forecast of Traffic Growth, Capacity Addition and Investment in Airports

Traffic Growth, Capacity Addition and Investment reveal the following.

Domestic and international passenger traffic is responding well to economic growth and in each case other economic factors and government intervention policies also play an important role. Similarly, domestic and international cargo traffics are also responding well to growth in industrial production with the help of other economic factors and government intervention policies.

Total passengers' movement had registered a maximum growth from 1995-96 to 2005-06. During the same period the international and domestic passenger traffic has increased substantially.

The international and domestic cargo traffic has also increased substantially. However, domestic cargo traffic has increased at a faster rate as compared to growth rate of international cargo traffic due to its smaller base, faster economic development and effort of GoI to restrict the import in the country.

In absolute terms the international and domestic aircraft movements has increased substantially. International passenger are projected to grow at the rate of 7 - 8 % and will reach 176.11 million at the end of XV Plan (2031-32) where as domestic traffic is projected to grow at 8-9% and will reach 565.17 million at the end of XV Plan (2031-32). Thus the total passenger traffic will become 741.29 million by the end of XV Plan. The international cargo has been projected to grow at the rate of 7 % and will become 4872.44 thousand MT by 2031-32 and the domestic cargo traffic has been projected to grow at a relatively higher growth rate of 8% and will become 3649.59 thousand MT by the end of 2031-32. Similarly, the international aircraft movement are projected to grow between 6 -7% and will reach to 1021.83 thousands at the end of 2031-32. The domestic aircraft moment will touch 4359.66 thousand in 2031-32 with a projected growth of 7-8%.

It has been estimated that investment of Rs.300 crores per million passengers is required for brown field airports and Rs.205 crores per million passengers is required for green field airports. Similarly investment of RS.1250 crores per million metric tons of cargo is required. Thus to meet the airport infrastructure development plans during the next 20 years, an investment of about Rs. 168578 Crores is envisaged. The cost excludes addition of 1200 Aircraft to the fleet and other expenditure on airlines.

It has been projected that during next 17-20 years, an additional capacity of about 551.19 MPPA will be required besides the existing capacity of 233 MPPA. Out of 551.19 MPPA capacities, the 125 MPPA is envisaged to be added by end of 13^{th} Five Year Plan. This will require the augmentation of the capacity by expanding the existing terminals, creating new terminals at Brownfield airports[23] and creation of 30-35 Greenfield airports.

During next 17-20 years, 6 million metric tons per annum (MMTPA) Cargo Capacity is projected to be added. Out of the 6 MMTPA, 1.5 MMTPA cargo capacities are envisaged to be added by the end of XIII Plan Period.

The supply of available skilled manpower in the aviation industry is much short of actual demand. With passengers and aircraft fleet likely to triple by 2025, the need to induct the more skilled manpower supply is the urgent requirement. Last but not least, aviation industry is typically estimated to generate indirect and induced employment of nearly six times the direct employment. With direct employment across airports and airlines to be more than 140,000 by 2016-17, the aviation sector in India is expected to provide an indirect and induced employment to additional 900,000 people by 2016-17.

9.1.4 Development of low cost airports and improvement in air connectivity

Analysis of development of low cost airports to improve regional connectivity brings out the following.

During the last one decade the civil aviation sector has grown at a phenomenal pace and India has emerged as 9th largest civil aviation market in the world. As regards to domestic market, India is the 4th largest market after US, China and Japan. By the year 2031, India is expected to be 3rd largest aviation market by handling 384 million passengers (305 million domestic passengers and 79 million international passengers). To support this growth, investment of Rs.168578 Crores is envisaged on airport infrastructure during XII to XV Five Year Plan. Air traffic in India at Tier-II & III cities are expected to grow faster than Tier-I cities because of shifting of IT, BPO, MNCs & other industries to Tier-II & III cities due to availability of

[23] Brownfield airports are existing airports, Greenfield airports are airports developed at new sites.

cheaper land, manpower & other logistics. Also airports in Tier-I city has been bursting, as there is little scope for further expansion and train reservations in higher class i.e. 1st AC / 2nd AC / 3rd AC generally not available before two months. In remote, hilly and inaccessible areas of the country, air transport is the quickest and sometimes the only option of mode of transport. Thus development of regional airports in the Tier-II & III cities is essential to sustain the future aviation growth. AAI has already taken up the development of 35 non-metro airports. While the development of 27 airports has already been completed; development of 4 airports at Ranchi, Raipur, Bhubaneswar and Khajuraho shall be completed soon. Development of 27 other non-metro airports at Tier-III cities has been taken up by AAI. While the development of 15 airports has been already completed; development of 5 other airports at Kadappa, Puducherry, Bikaner, Jaisalmer and Bhatinda is expected to be completed soon. The development of Low-cost Regional Airports would require a separate regulatory framework both for safety and security. The low cost airports are likely to harvest huge untapped industrial and commercial capacities in Tier-II and Tier-III cities and open up the opportunities for investments. The resultant economic growth of Tier-II and Tier III cities will increase in disposable income of middle class people living in such cities, which in turn will increase the propensity to travel by air to distant places for pilgrimage, tourism, business, education, training, etc. Stake holders such as Central Government, State Governments, Airport Developer, Airline Operators, Commerce and Industry Bodies need to take the initiatives to strengthen the commissioning and operation of low cost regional airports. The business models such as Hub-spoke Model, Tier-II & III Model, Low-Cost No-Frill Airport Model, and Helipad Development are suggested in developing low cost regional airports.

9.1.5 Development of green field airports for improving environment/sustainability

Sustainability of future growth may be summed up as under.

Airports are generally located in urban areas. Aviation activities directly and indirectly affects natural environment and contribute in its degradation substantially. In this study we have considered various indicator of carbon dioxide as proxy for environmental degradation other things remaining constant. Our study finds that cargo and passenger traffic each per aircraft movement is significantly helps in increasing environmental degradation in the country especially in urban areas. Rising economic growth also helps in increasing environmental degradation significantly keeping all other things constant. Economic regulation and privatization have statistically and significantly negative relationship with per capita carbon emission other things remaining constant. While factors like cargo and passenger traffic and economic growth helps in increasing environmental degradation significantly, public policies like economic regulation and privatization try to reduce it significantly at various statistically significance levels. Therefore, more similar kind of policies must be implemented in India in order to reduce environmental degradation to considerable level. Such an initiative of Government of India is development of Greenfield airports, where the intention is diversion of air traffic from existing airports located in urban areas to outskirt of urban city centers. Many of the airports are either in saturation stage or will be saturated in near future. Therefore, over burden of traffic will generate pollution along with many other problems and the pollution in the environment will be accumulated leading to problem of climate change. Thus development of Greenfield airports will share air traffics of existing airports and the excess pollution will be shifted to outskirt of urban city centers, where its impact will be very less due to natural environment or creation of such environment through plantation.

9.2 Policy Implication

In view of the above analysis and findings following are the policy Implication:

(i) The price control should be implemented rigorously to keep them within reasonable limit and at the same time growth in traffic should not be adversely affected. The pricing should be matching with Indian cost structure and should be capable of attracting investment in airport infrastructure. The leakage of public revenue by creating number of subsidiaries by private operators may be checked

(ii) Privatization in combination with hybrid till leads to overinvestment due to negative marginal efficiency of investment.

(iii) Privatization in combination with hybrid till leads to use of excessive debt due to negative marginal efficiency of Debt.

(iv) Government Ownership in combination with single till regulation minimize the use of inputs due to positive marginal efficiency and may be promoted in airport sector

(v) Privatization leads to inefficient use of resources due to negative marginal efficiency and needs to be discouraged in monopoly sector such as airports.

(vi) Government may plan to meet the airport infrastructure development plans during the next 20 years, an investment of about Rs. 168578 Crores as envisaged.

(vii) It has been projected that during next 17-20 years, an additional capacity of about 551.19 MPPA will be required besides the existing capacity of 233 MPPA. Out of 551.19 MPPA capacities, the 125 MPPA is envisaged to be added by end of 13th Five Year Plan. This will require the augmentation of the capacity by expanding the existing terminals, creating new terminals at Brownfield airports[24] and creation of 30-35 Greenfield airports. Government may plan accordingly

(viii) During next 17-20 years, 7.53 million metric tons per annum (MMTPA) Cargo Capacity is projected to be added. Out of the 7.53 MMTPA, 3.18 MMTPA cargo capacities are envisaged to be added by the end of 2021-22. Another 4.37 MMTPA will be added by end of 2031-32. This needs to be planned.

(ix) The development of Low-cost Regional Airports would require a separate regulatory framework both for safety and security. The low cost airports are likely to harvest huge untapped industrial and commercial capacities in Tier-II and Tier-III cities and open up the opportunities for investments. The resultant economic growth of Tier-II and Tier III cities will increase in disposable income of middle class people living in such cities, which in turn will increase the propensity to travel by air to distant places for pilgrimage, tourism, business, education, training, etc. Stake holders such as Central Government, State Governments, Airport Developer, Airline Operators, Commerce and Industry Bodies need to take the initiatives to strengthen the commissioning and operation of low cost regional airports. The business models such as Hub-spoke Model, Tier-II & III Model, Low-Cost No-Frill Airport Model, and Helipad Development are suggested in developing low cost regional airports.

[24] Brownfield airports are existing airports, Greenfield airports are airports developed at new sites.

(x) Many of the airports are either in saturation stage or will be saturated in near future. Therefore, over burden of traffic will generate pollution along with many other problems and the pollution in the environment will be accumulated leading to problem of climate change. Thus development of Greenfield airports will share air traffics of existing airports and the excess pollution will be shifted to outskirt of urban city centers, where its impact will be very less due to natural environment or creation of such environment through plantation. Therefore, Government should promote development of green field airports

9.3 Contribution to Literature

The outcome of this unique research will help aviation planners and policy makers to take appropriate decision on regulatory policies and to adopt the suitable airport structure in India. As of now major airports in India (having annual traffic more than 1.5 million) are regulated by AERA on uniform basis. Thus, the proposed study will also help aviation planners to categorize regulated airports as heavily regulated, lightly regulated and non-regulated airports. The proposed research will also help policy makers to adopt the appropriate approach to privatization and economic regulation.

The proposed impact evaluation study of privatization and regulation of Indian airports on efficiency, capacity generation, output, pricing and quality of service have rarely been observed in the literature of aviation economics, specially Comparison of efficiency after eliminating the effect of size of airport, which completely revers the conclusion i.e. efficiency of private airports is lower than the efficiency of Government airports. The marginal efficiency of investment and debt for private airports is negative which leads to over investment and over debt as result of privatization. Government ownership with single till regulation is superior as compared to private ownership with hybrid till. The present study will be unique of its kind by performing impact evaluation of economic regulations and privatizations on Indian airports. Thus, along with contribution to the aviation economics literature the proposed study will have some academic importance.

9.4 Limitation of this research

First round of regulation was undertaken in 2012 and therefore data for only 3 years was available. Effect of technology on efficiency could not be studied due to short period data.

9.5 Scope for future research

i. This research may be undertaken after 5-10 years when data for longer period is available.

ii. Efficiency analysis of Indian airports vis-à-vis foreign airports may be undertaken

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ANNEXURES

Annexure 4.1 Comparison of airport charges

1.) COMPARISON OF AIRPORT CHARGES WORLD-WIDE (ICAO DOC 7100-2011) **B747 (Long Haul))**

Sl. No.	**Airport**	**State**	**Aircraft Related Charges**	**Passenger Related Charges**	**Charges in US$**	**Sl. No.**	**Airport**	**State**	**Aircraft Related Charges**	**Passenger Related Charges**	**Charges in US$**
			B747	**B747**	**B747**				**B747**	**B747**	**B747**
1	Senegal		3480	26833	30313	202	Botswana		603	4019	4622
2	Guinea		5881	22100	27981	203	Oman		1130	3385	4515
3	Venezuela		2368	24991	27359	204	Costa Rica		2130	2348	4478
4	Cote d'Ivoire		3547	23699	27246	205	Yemen		601	3641	4242
5	Madagascar		11998	13437	25435	206	Pago Pago, American Samoa	United States	3063	1170	4233
6	Honduras		1256	24063	25319	207	Los Angeles Intl	United States	4209	0	4209
7	***IGI Airport***	***India***	***6407***	***18655***	***25062***	208	Myanmar		1518	2600	4118
8	Cameroon		4945	18490	23435	209	Luxembourg		2520	1196	3716
9	Zurich	Switzerland	12314	11073	23387	210	Emirate of Ras Al Khaimah	United Arab Emirates	3438	0	3438
10	French Guiana	France	7220	15979	23199	***211***	***AAI Airports***	***India***	***2127***	***1300***	***3427***
11	Democratic Republic of the Congo		4016	18200	22216	212	San Francisco Intl	United States	3141	89	3230
12	Central African Republic		6521	15626	22147	213	Tampa Intl	United States	934	2185	3119
13	Poland		6328	15600	21928	214	Lesotho		1115	1952	3067
14	Burkina Faso		4436	16928	21364	215	Solomon Islands		1491	1310	2801
15	Kansai Intl	Japan	11068	10017	21085	216	Latvia		1721	1050	2771
16	Martinique	France	6498	14322	20820	217	Libyan Arab Jamahiriya		1241	1209	2450
17	Paris/CDG, Orly	France	4255	16529	20784	218	Syrian Arab Republic		1278	1116	2394
18	Toronto/Lester B.		12027	8681	20708	219	Kuwait		529	1828	2357
19	Guadeloupe	France	6578	13598	20176	220	Guatemala		990	1305	2295
20	Lithuania		13801	5936	19737	221	Papua New Guinea		608	1554	2162
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Annexure 4.2 Comparison of airport charges

2.) COMPARISON OF AIRPORT CHARGES WORLD-WIDE (ICAO DOC 7100-2011) **B767 (Medium Haul)**

Sl. No.	Airport	State	Aircraft Related Charges	Passenger Related Charges	Charges in US$	Sl. No.	Airport	State	Aircraft Related Charges	Passenger Related Charges	Charges in US$
			B767	B767	B767				B767	B767	B767
1	Senegal		1561	15997	17558	216	Bangladesh		1645	663	2308
2	Guinea		3193	13175	16368	217	Pago Pago, American	United States	1442	698	2140
3	Venezuela		1121	14879	16000	218	Los Angeles Intl	United States	1982	0	1982
4	Cote d'Ivoire		1590	14128	15718	219	Luxembourg		1194	713	1907
5	Honduras		591	14345	14936	220	Tuvalu		1880	0	1880
6	***IGI Airport***	***India***	***2913***	***11610***	***14523***	***221***	***AAI Airports***	***India***	***1074***	***775***	***1849***
7	Cameroon		2342	11023	13365	222	Lesotho		608	1164	1772
8	Madagascar		5344	8010	13354	223	Tampa Intl	United States	440	1316	1756
9	French Guiana	France	3480	9526	13006	224	Emirate of Ras Al Khaimah	United Arab Emirates	1629	0	1629
10	Democratic Republic of the Congo		1731	10850	12581	225	Saint Vincent and the Grenadines		475	1148	1623
11	Zurich	Switzerland	5793	6601	12394	226	San Francisco Intl	United States	1479	73	1552
12	Poland		2981	9300	12281	227	Latvia		893	626	1519
13	Central African Republic		2803	9315	12118	228	Solomon Islands		706	781	1487
14	Falkland Islands	U.K.	12114	0	12114	229	Kuwait		314	1103	1417
15	Burkina Faso		1955	10091	12046	230	Papua New Guinea		334	926	1260
16	Kansai Intl	Japan	5242	6624	11866	231	Guatemala		469	778	1247
17	Paris/CDG, Orly	France	1898	9854	11752	232	Libyan Arab Jamahiriya		516	721	1237
18	Martinique	France	3169	8538	11707	233	Syrian Arab Republic		511	666	1177
19	Guadeloupe	France	3236	8106	11342	234	Algeria	Algeria	736	125	861
20	Suriname		1028	10230	11258	235	Antigua and Barbuda		455	0	455
…	………..	……	…	……	……	……	……………	…………	……	……	………

Annexure 4.3 Comparison of airport charges

3.) COMPARISON OF AIRPORT CHARGES WORLD-WIDE (ICAO DOC 7100-2011) **A320 (Short Haul)**

Sl. N o.	**Airport**	**State**	**Aircraft Related Charges**	**Passenger Related Charges**	**Charges in US$**	**Sl N o.**	**Airport**	**State**	**Aircraft Related Charge s**	**Passeng er Related Charge**	**Charges in US$**
			A320	**A320**	**A320**				**A320**	**A320**	**A320**
1	Senegal		437	10114	10551	2 1	New Tokyo Intl	Japan	1237	120	1357
2	Venezuela		441	9414	9855	2	Brunei		395	908	1303
3	Guinea		1370	8330	9700	2	Myanmar		253	980	1233
4	Cote		442	8933	9375	2	Costa Rica		245	885	1130
5	Honduras		233	9070	9303	2 1	Pago Pago, American	United States	567	441	1008
6	Austria	Austria	5131	3127	8258	2 1	Bangladesh		578	419	997
7	Cameroon		691	6969	7660	**2 1**	**AAI Airports**	**India**	**501**	**490**	**991**
8	French Guiana	France	1334	6023	7357	2 1	Tampa Intl	United States	173	815	988
9	Democratic Republic of the		488	6860	7348	2 2 0	Lesotho		247	736	983
10	Paris/CDG, Orly	France	833	6230	7063	2 2 1	Saint Vincent and the Grenadines		221	726	947
11	Poland		1084	5880	6964	2 2	Luxembourg		469	451	920
12	Burkina Faso		548	6380	6928	2 2	Kuwait		197	710	907
13	Suriname		404	6468	6872	2	Latvia		401	396	797
14	Central African Republic		777	5890	6667	2 2 5	Los Angeles Intl	United States	779	0	779
15	Martinique	France	1252	5398	6650	2 2	Solomon Islands		278	494	772
16	Guadeloup e	France	1489	5125	6614	2 2	Papua New Guinea		184	586	770
17	Madagasca		1486	5065	6551	2	Tuvalu		740	0	740
18	Zurich	Switzer	2233	4174	6407	2	Guatemala		184	492	676
19	**IGI Airport**	**India**	**1059**	**5214**	**6273**	2 3	San Francisco Intl	United States	582	65	647
20	Kansai Intl	Japan	2062	4021	6083	2 3 1	Emirate of Ras Al Khaimah	United Arab Emirates	640	0	640
…	………..	………	……	………..	……	…	………………	…………	……	……	……

Annexure 5.1 Efficiency Models

1.Combined Efficiency

Regression Statistics	
Multiple R	0.808505
R Square	0.65368
Adjusted R Square	0.536608
Standard Error	0.132617
Observations	51

ANOVA					
	Df	*SS*	*MS*	*F*	*Significance F*
Regression	8	1.527006	0.190876	21.70625	1.31E-12
Residual	46	0.80901	0.017587		
Total	54	2.336016			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.565181	0.112902	5.00595	8.62E-06	0.337921	0.792441	0.33792	0.79244
TU(million)	0.008066	0.001465	5.50676	1.58E-06	0.005118	0.011014	0.00512	0.01101
D1	-0.18325	0.080364	-2.2803	0.02727	-0.34502	-0.02149	-0.34502	-0.02149
D2	0	0	65535	#NUM!	0	0	0	0
D3	0	0	65535	#NUM!	0	0	0	0
D4	-0.10752	0.108754	-0.98867	#NUM!	-0.32643	0.111389	-0.32643	0.11139
D1*D2	0.064539	0.099609	0.64793	0.52025	-0.13596	0.265041	-0.13596	0.26504
D1*D3	0	0	65535	#NUM!	0	0	0	0
D1*D4	0	0	65535	#NUM!	0	0	0	0

2.Manpower Efficiency

Regression Statistics	
Multiple R	0.660213
R Square	0.435881
Adjusted R Square	0.29987
Standard Error	0.232725
Observations	51

ANOVA					
	Df	*SS*	*MS*	*F*	*Significance F*
Regression	8	1.925046	0.240631	8.885759	5.05E-07
Residual	46	2.491405	0.054161		
Total	54	4.416451			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.1697	0.198128	0.856513	0.396154	-0.22911	0.568511	-0.22911	0.568511
TU(million)	0.010657	0.00257	4.14589	0.000144	0.005483	0.015831	0.005483	0.015831
D1	-0.00952	0.141028	-0.06747	0.946501	-0.29339	0.27436	-0.29339	0.27436
D2	0	0	65535	#NUM!	0	0	0	0
D3	0	0	65535	#NUM!	0	0	0	0
D4	0.193737	0.19085	1.015129	#NUM!	-0.19042	0.577898	-0.19042	0.577898
D1*D2	0.108623	0.1748	0.621415	0.537394	-0.24323	0.460478	-0.24323	0.460478
D1*D3	0	0	65535	#NUM!	0	0	0	0
D1*D4	0	0	65535	#NUM!	0	0	0	0

3.Operating Expenses

Regression Statistics	
Multiple R	0.855154
R Square	0.731289
Adjusted R Square	0.620966
Standard Error	0.170493
Observations	51

ANOVA					
	Df	*SS*	*MS*	*F*	*Significance F*
Regression	8	3.638919	0.454865	31.29689	2.62E-15
Residual	46	1.337116	0.029068		
Total	54	4.976035			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.338143	0.145147	2.329654	0.024269	0.045977	0.63031	0.045977	0.63031
TU(million)	0.007408	0.001883	3.934093	0.00028	0.003618	0.011199	0.003618	0.011199
D1	-0.03318	0.103316	-0.32117	0.749536	-0.24115	0.174783	-0.24115	0.174783
D2	0	0	65535	#NUM!	0	0	0	0
D3	0	0	65535	#NUM!	0	0	0	0
D4	-0.22874	0.139815	-1.63602	#NUM!	-0.51017	0.052693	-0.51017	0.052693
D1*D2	0.122411	0.128057	0.955904	0.344117	-0.13536	0.380177	-0.13536	0.380177
D1*D3	0	0	65535	#NUM!	0	0	0	0
D1*D4	0	0	65535	#NUM!	0	0	0	0

4.Investment Efficiency

Regression Statistics	
Multiple R	0.781706
R Square	0.611064
Adjusted R Square	0.490287
Standard Error	0.176381
Observations	51

ANOVA					
	Df	*SS*	*MS*	*F*	*Significance F*
Regression	8	2.248379	0.281047	18.06782	2.47E-11
Residual	46	1.431072	0.03111		
Total	54	3.679451			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.931845	0.15016	6.20566	1.42E-07	0.629588	1.234102	0.62959	1.2341
TU(million)	0.005979	0.001948	3.06909	0.0036	0.002058	0.0099	0.00206	0.0099
D1	0.010284	0.106885	0.09621	0.92377	-0.20486	0.225431	-0.20486	0.22543
D2	0	0	65535		0	0	0	0
D3	0	0	65535		0	0	0	0
D4	-0.7353	0.144644	-5.08349		-1.02645	-0.44414	-1.02645	-0.44414
D1*D2	-0.70539	0.13248	-5.32452	2.94E-06	-0.97206	-0.43872	-0.97206	-0.43872
D1*D3	0	0	65535		0	0	0	0
D1*D4	0	0	65535		0	0	0	0

5.Debt Management Efficiency

Regression Statistics	
Multiple R	0.47428
R Square	0.224942
Adjusted R Square	0.070589
Standard Error	0.269142
Observations	51

ANOVA					
	Df	*SS*	*MS*	*F*	*Significance F*
Regression	8	0.967068	0.120883	3.337595	0.004813
Residual	46	3.332124	0.072437		
Total	54	4.299192			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.158002	0.229132	0.689569	0.49393	-0.30322	0.61922	-0.30322	0.61922
TU(million)	0.005491	0.002973	1.847129	0.071166	-0.00049	0.011474	-0.00049	0.011474
D1	0.285517	0.163097	1.750603	0.086682	-0.04278	0.613813	-0.04278	0.613813
D2	0	0	65535	#NUM!	0	0	0	0
D3	0	0	65535	#NUM!	0	0	0	0
D4	0.011326	0.220714	0.051317	#NUM!	-0.43295	0.455601	-0.43295	0.455601
D1*D2	-0.62759	0.202153	-3.10452	0.003258	-1.0345	-0.22068	-1.0345	-0.22068
D1*D3	0	0	65535	#NUM!	0	0	0	0
D1*D4	0	0	65535	#NUM!	0	0	0	0

Annexure 5.2 Airports Financial Data

DIAL	**Rs. In Million**		
Components	**2011-12**	**2012-13**	**2013-14**
Aero Revenue	6000	25000	28000
Non Aero Revenue	8000	9000	12000
Cargo	1200	1200	1400
Gross Revenue	**14000**	**32000**	**30200**
AAI Revenue Share	7000	15300	18300
Net Revenue	7000	17000	20000
Expenses	6200	6600	8300
Depreciation	4000	4000	4000
Interest	6000	6000	5000
Profit after Tax	**10000**	**1000**	**5000**

MIAL	**2011-12**	**2012-13**	**2013-14**
Components			
Aero Revenue	4000	5000	11000
Non Aero Revenue	7000	7000	8000
Cargo	2000	2000	1000
Gross Revenue	**13000**	**14000**	**21000**
AAI Revenue Share	5000	5600	8300
Net Revenue	7000	8000	13000
Expenses	3000	4000	5000
Depreciation	1500	1600	2000
Interest	660	670	1900
Less Tax	880	700	1000
Profit after Tax	**1000**	**1400**	**2500**

Chennai			
Components	**2011-12**	**2012-13**	**2013-14**
Aero Revenue	2500	2800	3800
Non Aero Revenue	2400	2500	2300

Cargo	1700	1400	800
Total Revenue	6600	6000	7000
Expenses	2500	2900	3000
Depreciation	1400	1500	3200
Interest			
Less Tax			
Profit after Tax			

BIAL			
Components	**2011-12**	**2012-13**	**2013-14**
Aero Revenue	3700	3500	3700
Non Aero Revenue	2000	2350	2470
Cargo	200	200	200
Gross Revenue	**6000**	**6200**	**6500**
AAI Revenue Share	250	250	260
Net Revenue	5800	5800	6000
Expenses	1700	2000	2300
Depreciation	1200	1300	1400
Interest	1300	1100	1200
Less Tax		400	900
Profit after Tax	**1800**	**1300**	**1000**

Chennai			
Components	**2011-12**	**2012-13**	**2013-14**
Aero Revenue	1800	2700	3900
Non Aero Revenue	1500	1500	1500
Cargo	390	380	380
Total Revenue	3700	4600	5900
Expenses	1550	1730	2530
Depreciation	500	600	2700
Interest	400	500	100
Less Tax			
Profit after Tax			

GHIAL			
Components	**2011-12**	**2012-13**	**2013-14**
Aero Revenue	3600	4400	4400
Non Aero Revenue	2300	2600	2800
Cargo	100	100	100
Gross Revenue	**5900**	**7300**	**7300**
AAI Revenue Share	240	290	300
Net Revenue	5700	6700	6900
Expenses	2100	2100	2200
Depreciation	1200	1200	1300
Interest	2000	2000	2000
Less Tax	300	600	1000
Profit after Tax	**200**	**1000**	**600**

CIAL			
Components	**2011-12**	**2012-13**	**2013-14**
Aero Revenue	600	600	800
Non Aero Revenue	1700	2300	2700
Cargo	200	100	200
Gross Revenue	**2500**	**3000**	**3500**
AAI Revenue Share	0	0	0
Net Revenue	2500	3000	3470
Expenses	1500	1600	1700
Depreciation	100	200	300
Interest	20	0	50
Less Tax	300	300	500
Profit after Tax	**1000**	**1300**	**1400**

Other AAI Airports			
Components	**2011-12**	**2012-13**	**2013-14**
Aero Revenue	14400	16000	15400
Non Aero Revenue	7400	7500	9200
Cargo	2100	2000	1700
ANS Revenue	18000	18900	22300
Income for Leasing of Airport	1300	21500	25900
Other Income	4400	3400	5400
Gross Revenue	**58600**	**68200**	**77600**
Expense	33200	39800	47000
Depreciation	10100	13100	15100
Interest	500	1300	1000
Profit after Tax	**8700**	**7500**	**8000**

Annexure 5.3 Airports Input Output Data

		Output				**Input**			
Airports	**Year**	**Revenue in Cr**	**Aircraft Movements in No.**	**Passengers in No.**	**Cargo in MT**	**Manpower in No.**	**Depreciation (in Cr.)**	**Operating Expenses (in Cr.)**	**Interest in Cr.**
Airports	**Year**	**Y1**	**Y2**	**Y3**	**Y4**	**X4**	**X5**	**X6**	**X7**
Delhi	2011-12	14000	295491	35881965	568355	1491	4000	6200	6000
Delhi	2012-13	32000	280713	34368411	546311	1491	4000	6600	6000
Delhi	2013-14	30200	290772	36876986	605699	1491	4000	8300	5000
Mumbai	2011-12	13000	251492	30747841	657470	1500	1500	3000	660
Mumbai	2012-13	14000	244499	30207514	635163	1500	1600	4000	670
Mumbai	2013-14	21000	260666	32221395	648742	1500	2000	5000	1900
Bangalore	2011-12	6000	118431	12698343	224949	950	1200	1700	1300
Bangalore	2012-13	6200	104642	11993887	226548	950	1300	2000	1100
Bangalore	2013-14	6500	117728	12868830	242391	950	1400	2300	1200
Hyderabad	2011-12	5900	99013	8444431	78099	900	1200	2100	2000
Hyderabad	2012-13	7300	90151	8300433	80005	900	1200	2100	2000
Hyderabad	2013-14	7300	87741	8653784	86670	900	1300	2200	2000
Cochin	2011-12	2500	40181	4717650	42706	650	100	1500	20
Cochin	2012-13	3000	40150	4880773	46906	650	200	1600	0
Cochin	2013-14	3500	46029	5383114	52408	650	300	1700	50
Nagpur	2011-12	2556	15322	1415739	4976	600	582	1768	58
Nagpur	2012-13	3029	1262921	1263837	5206	600	582	1768	58
Nagpur	2013-14	3670	12990	1263837	5524	600	714	2223	47

Chennai	2011-12	6600	120127	12925218	357191	950	1400	2500	0
Chennai	2012-13	6000	117418	12776760	315879	950	1500	2900	0
Chennai	2013-14	7000	121817	12896055	292080	950	3200	3000	0
KOLKATA	2011-12	3700	99843	10303991	125593	1028	500	1550	400
KOLKATA	2012-13	4600	93330	10169386	122232	1028	600	1730	500
KOLKATA	2013-14	5900	92871	10100232	129782	1028	2700	2530	100
TRIVANDRUM	2011-12	8066	27239	2814799	48202	520	441	1448	22
TRIVANDRUM	2012-13	9605	24803	2839021	39453	520	1845	5605	183
TRIVANDRUM	2013-14	10435	23781	2934074	29077	520	2030	6320	134
AHMEDABAD	2011-12	13454	40506	4695115	31757	322	2319	7623	115
AHMEDABAD	2012-13	14084	38289	4162747	48175	322	2705	8219	268
AHMEDABAD	2013-14	16232	42229	4564225	51637	322	3159	9831	209
GOA	2011-12	10091	27430	3521551	6170	102	1739	5717	86
GOA	2012-13	11986	26810	3542797	4964	102	2302	6995	228
GOA	2013-14	13818	28904	3885452	4767	102	2689	8369	178
CALICUT	2011-12	6332	16150	2209716	25591	226	1091	3587	54
CALICUT	2012-13	7692	16733	2273703	27612	226	1478	4489	147
CALICUT	2013-14	8765	16220	2464647	22899	226	1706	5309	113
GUWAHATI	2011-12	6432	28088	2244684	7761	250	1109	3644	55
GUWAHATI	2012-13	7027	26938	2076938	6013	250	1350	4101	134
GUWAHATI	2013-14	7816	27098	2197633	7907	250	1521	4734	101
JAIPUR	2011-12	5239	18603	1828304	6710	294	903	2968	45
JAIPUR	2012-13	6098	18260	1802479	6677	294	1171	3559	116
JAIPUR	2013-14	7049	19808	1981951	6705	294	1372	4269	91
SRINAGAR	2011-12	4677	12187	1632098	2361	72	806	2650	40
SRINAGAR	2012-13	6299	14109	1861691	3027	72	1210	3676	120
SRINAGAR	2013-14	7124	15288	2003186	3722	72	1386	4315	92
AMRITSAR	2011-12	2556	9208	892104	7087	208	441	1448	22
AMRITSAR	2012-13	3029	9167	895425	1512	208	582	1768	58
AMRITSAR	2013-14	3670	10054	1031821	1615	208	714	2223	47
PORTBLAIR	2011-12	1751	7759	611184	2386	30	302	992	15
PORTBLAIR	2012-13	2380	8668	703483	2206	30	457	1389	45
PORTBLAIR	2013-14	2692	8453	757009	2687	30	524	1631	35

Annexure 6.1 Traffic Data for 17 Airports an India

1. CHENNAI AIRPORT

YEAR	A/C MOVEMENTS (IN NOS.)			PASSENGERS (IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	9194	20672	29866	1195849	1834264	3030113	54653	14160	68813
1996-97	9984	22135	32119	1543055	1826449	3369504	57402	10869	68271
1997-98	10862	20231	31093	1744083	1755854	3499937	61904	12926	74830
1998-99	11170	20653	31823	1736021	1788005	3524026	58708	15433	74141
1999-00	11080	23531	34611	1702534	1944844	3647378	75423	24155	99578
2000-01	12063	25293	37356	1833957	2231932	4065889	82028	23930	105958
2001-02	12398	25673	38071	1741458	2042784	3784242	94171	24941	119112
2002-03	14490	29863	44353	1947937	2213409	4161346	106836	29824	136660
2003-04	14502	36749	51251	2054043	2501778	4555821	119563	34560	154123
2004-05	18111	43122	61233	2400670	3233256	5633926	146443	39427	185870
2005-06	21155	47900	69055	2606638	4173345	6779983	167853	38118	205971
2006-07	23567	76208	99775	2895930	6078196	8974126	195195	43130	238325
2007-08	27690	88175	115865	3410253	7249501	10659754	227704	42904	270608
2008-09	30453	85458	115911	3663908	6179282	9843190	219562	52806	272368
2009-10	31674	78491	110165	3860410	6670875	10531285	249522	73153	322675
2010-11	32211	78567	110778	4245836	7803843	12049679	295497	93336	388833
2011-12	33535	86592	120127	4308038	8617180	12925218	272461	84730	357191
2012-13	34102	83316	117418	4462419	8314341	12776760	237105	78774	315879
2013-14	35268	86549	121817	4537677	8358378	12896055	220401	71679	292080
2014-15	34616	87761	122377	4707145	9592055	14299200	222472	81432	303904

2. KOLKATA AIRPORT

YEAR	A/C MOVEMENTS (IN NOS.)			PASSENGERS (IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	7018	20028	27046	530127	2034919	2565046	19143	22738	41881
1996-97	7837	20436	28273	611072	1965499	2576571	19845	23209	43054
1997-98	7322	17714	25036	620380	1892379	2512759	22362	25021	47383
1998-99	6735	17646	24381	610913	1910584	2521497	22501	26562	49063
1999-00	6560	19635	26195	594314	2004567	2598881	23482	30180	53662
2000-01	6658	19537	26195	631558	2054842	2686400	25070	28780	53850
2001-02	6336	22213	28549	590445	1970857	2561302	26200	29949	56149
2002-03	6268	26091	32359	585236	2241558	2826794	27026	31234	58260
2003-04	6625	32195	38820	591038	2499815	3090853	26252	36020	62272
2004-05	7568	34806	42374	637355	2857209	3494564	30529	39099	69628
2005-06	9250	42303	51553	742247	3664548	4406795	32164	42335	74499
2006-07	9414	56273	65687	805191	5197072	6002263	36379	47144	83523
2007-08	10586	70117	80703	1007502	6451730	7459232	41004	49905	90909
2008-09	11070	70761	81831	1002169	5987750	6989919	40743	49127	89870
2009-10	13506	72190	85696	1187160	6858564	8045724	40088	70168	110256
2010-11	13942	80433	94375	1428086	8203586	9631672	45098	84861	129959
2011-12	15527	84316	99843	1566102	8737889	10303991	43890	81703	125593
2012-13	13733	79597	93330	1653162	8516224	10169386	42436	79796	122232
2013-14	15962	76909	92871	1765013	8335219	10100232	45482	84300	129782
2014-15	16269	80859	97128	1926562	8990107	10916669	47803	88896	136699

3. AHMEDABAD AIRPORT

YEAR	A/C MOVEMENTS(IN NOS.)			PASSENGERS(IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	684	9884	10568	88852	800988	889840	410	5222	5632
1996-97	789	9327	10116	100802	673302	774104	891	5646	6537
1997-98	874	9910	10784	133556	659282	792838	1237	6244	7481
1998-99	874	9956	10830	141383	630273	771656	1481	6415	7896
1999-00	844	10048	10892	175554	642818	818372	1880	6614	8494
2000-01	958	9324	10282	185849	660756	846605	1734	7764	9498
2001-02	1036	9178	10214	172050	596085	768135	1159	6887	8046
2002-03	1108	10554	11662	181954	636064	818018	1125	9571	10696
2003-04	2170	10956	13126	252451	724236	976687	1246	11907	13153
2004-05	3767	11126	14893	373199	916548	1289747	2535	14157	16692
2005-06	4657	16535	21192	453642	1438969	1892611	3614	13264	16878
2006-07	4092	21662	25754	426439	2092026	2518465	4240	16149	20389
2007-08	6502	28095	34597	701738	2461909	3163647	6708	16868	23576
2008-09	5635	26043	31678	684330	2141609	2825939	10294	12739	23033
2009-10	7036	26717	33753	847241	2678756	3525997	11657	11018	22675
2010-11	6241	28445	34686	826931	3216542	4043473	12980	15060	28040
2011-12	5595	34911	40506	744946	3950169	4695115	11793	19964	31757
2012-13	5884	32405	38289	818209	3344538	4162747	12830	35345	48175
2013-14	7542	34687	42229	997771	3566454	4564225	15705	35932	51637
2014-15	8176	30621	38797	1216236	3834197	5050433	17527	41786	59313

4. GOA AIRPORT

YEAR	A/C MOVEMENTS(IN NOS.)			PASSENGERS(IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	1402	7422	8824	262858	665066	927924	207	2830	3037
1996-97	1088	5776	6864	163428	557292	720720	359	2563	2922
1997-98	1101	5787	6888	187448	509646	697094	283	2564	2847
1998-99	1083	5689	6772	193923	514636	708559	525	2826	3351
1999-00	1178	6408	7586	212170	547045	759215	665	3019	3684
2000-01	1463	6474	7937	249894	626829	876723	600	3137	3737
2001-02	1654	6458	8112	200541	590085	790626	733	2653	3386
2002-03	1834	7608	9442	210594	629324	839918	1183	2291	3474
2003-04	2252	8822	11074	278065	709616	987681	1043	2443	3486
2004-05	2674	10355	13029	359866	905544	1265410	1233	3623	4856
2005-06	2728	12927	15655	404802	1267864	1672666	1356	3812	5168
2006-07	2842	16840	19682	403357	1808474	2211831	964	3934	4898
2007-08	2880	20193	23073	434402	2143846	2578248	775	4194	4969
2008-09	2738	19198	21936	389703	1831355	2221058	688	3289	3977
2009-10	3028	21298	24326	430903	2198151	2629054	917	3460	4377
2010-11	4030	19988	24018	575887	2504150	3080037	2535	4247	6782
2011-12	3870	23560	27430	578256	2943295	3521551	2154	4016	6170
2012-13	4085	22725	26810	656325	2886472	3542797	2379	2573	4952
2013-14	4426	24478	28904	736340	3149112	3885452	2015	2752	4767
2014-15	4305	29117	33422	613110	3900091	4513201	1210	3288	4498

5. TRIVANDRUM AIRPORT

YEAR	A/C MOVEMENTS (IN NOS.)			PASSENGERS (IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	5969	2639	8608	785759	245931	1031690	20752	1922	22674
1996-97	6172	2321	8493	847200	256348	1103548	21130	2295	23425
1997-98	6773	2837	9610	842218	302936	1145154	22461	4354	26815
1998-99	6438	2628	9066	828179	310006	1138185	24870	5802	30672
1999-00	5752	3062	8814	757604	275602	1033206	24336	3816	28152
2000-01	5547	3664	9211	759805	250721	1010526	23583	2012	25595
2001-02	5486	3682	9168	735421	223155	958576	24621	1320	25941
2002-03	6552	3951	10503	774381	239906	1014287	24009	1353	25362
2003-04	7310	3166	10476	825091	248491	1073582	24878	1382	26260
2004-05	7100	3322	10422	872516	287635	1160151	22287	1368	23655
2005-06	7763	3719	11482	1003136	322597	1325733	23280	1300	24580
2006-07	10176	8517	18693	1186160	595042	1781202	30465	1442	31907
2007-08	13022	11061	24083	1398759	703145	2101904	30693	1412	32105
2008-09	13004	8880	21884	1473827	481055	1954882	30169	1415	31584
2009-10	15185	10166	25351	1695912	637808	2333720	31708	1442	33150
2010-11	16656	8213	24869	1842824	684061	2526885	37795	1540	39335
2011-12	15531	11708	27239	1835952	978847	2814799	46753	1449	48202
2012-13	14161	10642	24803	1850469	988552	2839021	37963	1490	39453
2013-14	14150	9631	23781	1948549	985525	2934074	27283	1794	29077
2014-15	14803	8916	23719	2093025	1080993	3174018	28731	1166	29897

6. CALICUT AIRPORT

YEAR	A/C MOVEMENTS (IN NOS.)			PASSENGERS (IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	1856	4006	5862	178548	226438	404986	192	1550	1742
1996-97	2320	3830	6150	259059	241995	501054	296	2087	2383
1997-98	2537	3585	6122	282609	217509	500118	329	1955	2284
1998-99	3066	3404	6470	281871	224396	506267	1048	2049	3097
1999-00	3069	3211	6280	300531	229862	530393	2107	3329	5436
2000-01	3058	3219	6277	283897	201931	485828	3619	2921	6540
2001-02	3254	3390	6644	329488	192547	522035	4134	3016	7150
2002-03	3725	4520	8245	441989	187572	629561	5564	2223	7787
2003-04	7357	1464	8821	509849	145748	655597	6408	1192	7600
2004-05	7983	1464	9447	639920	187941	827861	9411	1178	10589
2005-06	9562	1572	11134	768856	191506	960362	9193	1437	10630
2006-07	11255	1850	13105	900345	233277	1133622	10691	770	11461
2007-08	12902	2361	15263	1097281	235466	1332747	8792	602	9394
2008-09	16888	2544	19432	1516107	162988	1679095	12556	363	12919
2009-10	14708	2907	17615	1657929	205940	1863869	17132	368	17500
2010-11	13812	2884	16696	1829752	230227	2059979	21964	282	22246
2011-12	13450	2700	16150	1982955	226761	2209716	25400	191	25591
2012-13	13094	3639	16733	1962316	311387	2273703	27256	356	27612
2013-14	13526	2694	16220	2179200	285447	2464647	22735	164	22899
2014-15	14382	3099	17481	2286829	296911	2583740	22509	340	22849

7. GUWAHATI AIRPORT

YEAR	A/C MOVEMENTS (IN NOS.)			PASSENGERS (IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96		7602	7602	0	449874	449874		4168	4168
1996-97		7992	7992	0	379891	379891		4983	4983
1997-98	0	6138	6138	0	386687	386687	0	6140	6140
1998-99	0	6188	6188	0	370571	370571	0	4981	4981
1999-00	0	7653	7653	0	408808	408808	0	5791	5791
2000-01	0	8399	8399	0	450567	450567	0	6560	6560
2001-02	0	8308	8308	0	433564	433564	0	5980	5980
2002-03	102	9679	9781	8560	500159	508719	8	4741	4749
2003-04	40	13363	13403	4370	536863	541233	113	4263	4376
2004-05	50	13629	13679	1256	597676	598932	2	4308	4310
2005-06	288	14584	14872	9865	724001	733866	140	4460	4600
2006-07	88	18983	19071	4234	1073869	1078103	50	3648	3698
2007-08	98	24347	24445	3437	1344048	1347485	6	2056	2062
2008-09	100	25062	25162	7282	1366258	1373540	2	1642	1644
2009-10	46	26205	26251	5421	1584836	1590257	0	2918	2918
2010-11	226	26715	26941	14523	1920227	1934750	0	8520	8520
2011-12	452	27636	28088	26864	2217820	2244684	0	7761	7761
2012-13	416	26522	26938	21810	2055128	2076938	94	5919	6013
2013-14	494	26604	27098	25721	2171912	2197633	36	7871	7907
2014-15	474	26397	26871	27564	2206037	2233601	15	10445	10460

8. JAIPUR AIRPORT

YEAR	A/C MOVEMENTS(IN NOS.)			PASSENGERS(IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	0	5887	5887	0	355896	355896	0	735	735
1996-97	0	6382	6382	0	221650	221650	0	460	460
1997-98	0	6222	6222	0	229792	229792	0	587	587
1998-99	0	5878	5878	0	232322	232322	0	803	803
1999-00	0	6448	6448	0	267027	267027	0	801	801
2000-01	0	6942	6942	0	273315	273315	0	972	972
2001-02	99	6501	6600	3086	225786	228872	1	948	949
2002-03	744	6107	6851	35850	254084	289934	23	1303	1326
2003-04	1127	6669	7796	36077	263747	299824	117	1312	1429
2004-05	1118	6124	7242	48252	331999	380251	240	1531	1771
2005-06	1241	7277	8518	52389	394452	446841	509	1853	2362
2006-07	2317	8231	10548	195711	595386	791097	728	1940	2668
2007-08	2331	16013	18344	204282	1135109	1339391	395	2539	2934
2008-09	2953	14057	17010	221706	982634	1204340	340	2142	2482
2009-10	2730	15728	18458	255704	1267563	1523267	446	5763	6209
2010-11	2273	12716	14989	247374	1407838	1655212	398	8177	8575
2011-12	1870	16733	18603	232649	1595655	1828304	235	6475	6710
2012-13	1800	16460	18260	227678	1574801	1802479	189	6488	6677
2013-14	2037	17771	19808	258876	1723075	1981951	245	6460	6705
2014-15	2742	17110	19852	334503	1863456	2197959	715	2544	3259

9. SRINAGAR AIRPORT

YEAR	A/C MOVEMENTS(IN NOS.)			PASSENGERS(IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	0	0	0	0	0	0	0	0	0
1996-97	0	2235	2235	0	194211	194211	0	864	864
1997-98	0	2242	2242	0	209896	209896	0	1847	1847
1998-99	0	2362	2362	0	195427	195427	0	745	745
1999-00	0	1217	1217	0	243650	243650	0	908	908
2000-01	0	1293	1293	0	253356	253356	0	1040	1040
2001-02	0	1268	1268	0	243647	243647	0	1302	1302
2002-03	44	1658	1702	4286	225629	229915	0	1413	1413
2003-04	168	2910	3078	17723	246612	264335	0	1679	1679
2004-05	130	3858	3988	12743	376750	389493	0	2172	2172
2005-06	174	4264	4438	17921	457000	474921	0	2665	2665
2006-07	144	6748	6892	17519	690384	707903	0	2145	2145
2007-08	154	7834	7988	16327	763382	779709	0	1918	1918
2008-09	174	6885	7059	16252	716837	733089	0	1501	1501
2009-10	264	8386	8650	19696	906824	926520	0	1815	1815
2010-11	0	9016	9016	0	1039505	1039505	0	2016	2016
2011-12	0	12187	12187	0	1632098	1632098	0	2361	2361
2012-13	124	13985	14109	17469	1844222	1861691	0	3027	3027
2013-14	130	15158	15288	17380	1985806	2003186	0	3722	3722
2014-15	130	14698	14828	15052	2025756	2040808	0	5636	5636

10. AMRITSAR AIRPORT

YEAR	A/C MOVEMENTS(IN NOS.)			PASSENGERS(IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	460	617	1077	4466	25330	29796	1826	57	1883
1996-97	272	923	1195	4630	22259	26889	2217	53	2270
1997-98	376	781	1157	5762	16428	22190	3078	46	3124
1998-99	465	801	1266	19979	14845	34824	2897	31	2928
1999-00	366	838	1204	31050	13986	45036	948	46	994
2000-01	921	780	1701	100445	12128	112573	45	32	77
2001-02	1158	688	1846	117130	12238	129368	100	25	125
2002-03	1446	418	1864	163784	14253	178037	352	40	392
2003-04	2051	124	2175	219043	6249	225292	1095	31	1126
2004-05	2668	362	3030	316613	31298	347911	1278	34	1312
2005-06	3372	1226	4598	409166	77974	487140	1331	68	1399
2006-07	4294	1460	5754	488310	108018	596328	1744	98	1842
2007-08	4775	2108	6883	552687	125081	677768	1252	111	1363
2008-09	3517	2976	6493	438825	133773	572598	1798	376	2174
2009-10	3846	3985	7831	499271	203133	702404	2784	329	3113
2010-11	4314	4757	9071	468726	296468	765194	5834	161	5995
2011-12	3548	5660	9208	398207	493897	892104	6998	89	7087
2012-13	2874	6293	9167	342906	552519	895425	1424	88	1512
2013-14	2515	7539	10054	307481	724340	1031821	1486	129	1615
2014-15	2585	6825	9410	334252	749432	1083684	537	322	859

11. PORT BLAIR AIRPORT

YEAR	A/C MOVEMENTS(IN NOS.)			PASSENGERS(IN NOS.)			FREIGHT(IN MT)		
	INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
1995-96	270	888	1158	0	71919	71919	0	690	690
1996-97	0	662	662	0	56779	56779	0	392	392
1997-98	2	700	702	80	64061	64141	0	412	412
1998-99	0	938	938	0	73085	73085	0	497	497
1999-00	10	1650	1660	316	107874	108190	0	896	896
2000-01	2	1528	1530	0	121492	121492	0	1016	1016
2001-02	14	1628	1642	399	133646	134045	0	947	947
2002-03	18	1692	1710	242	160202	160444	0	1099	1099
2003-04	25	2735	2760	359	193974	194333	0	1363	1363
2004-05	4	3717	3721	0	193785	193785	0	1736	1736
2005-06	6	2818	2824	4	204375	204379	0	1442	1442
2006-07	8	6166	6174	16	504064	504080	0	1658	1658
2007-08	0	7888	7888	0	775464	775464	0	1962	1962
2008-09	0	7126	7126	0	479526	479526	0	2139	2139
2009-10	9	5975	5984	29	521054	521083	0	2290	2290
2010-11	10	7068	7078	45	580942	580987	0	2299	2299
2011-12	8	7751	7759	151	611033	611184	0	2386	2386
2012-13	0	8668	8668	0	703483	703483	0	2206	2206
2013-14	0	8453	8453	0	757009	757009	0	2687	2687
2014-15	0	9642	9642	0	815873	815873	0	3046	3046

Annexure 6.2 GDP and IIP Data

YEAR	GDP(in billion $ at 2005-6 prices)	IIP (1993-94=100)
1995-96	448.72	123.3
1996-97	482.60	130.8
1997-98	502.14	139.5
1998-99	533.20	145.2
1999-00	580.36	154.9
2000-01	602.65	162.6
2001-02	631.73	167.0
2002-03	655.76	176.6
2003-04	707.30	189.0
2004-05	763.34	211.1
2005-06	834.22	227.9
2006-07	911.50	255.0
2007-08	1000.84	277.1
2008-09	1039.78	286.1
2009-10	1127.95	316.2
2010-11	1246.91	341.0
2011-12	1325.84	359.5
2012-13	1368.76	363.5
2013-14	1472.78	363.1
2014-15	1584.72	373.2

Annexure 6.3 Traffic Forecast- All India Airport Traffic

Plan Period	YEAR	AIRCRAFT MOVEMENTS (IN '000)			PASSENGERS (IN MILLION)			FREIGHT (IN '000 MT)		
		INTL	DOM	TOTAL	INTL	DOM	TOTAL	INTL	DOM	TOTAL
	2014-15	**345.5**	**1257.6**	**1603**	**50.8**	**139.3**	**190.1**	**1542.5**	**986.4**	**2528.9**
	Growth Rate	**7%**	**8%**	**8%**	**8%**	**9%**	**9%**	**7%**	**8%**	**7%**
XII Plan	2015-16	369.6	1358.2	1727.8	54.9	151.8	206.7	1650.5	1065.3	2715.7
XII Plan	2016-17	395.5	1466.8	1862.3	59.3	165.5	224.8	1766	1150.5	2916.5
XIII Plan	2017-18	423.2	1584.2	2007.4	64	180.4	244.4	1889.6	1242.5	3132.2
XIII Plan	2018-19	452.8	1710.9	2163.7	69.1	196.6	265.7	2021.9	1341.9	3363.8
XIII Plan	2019-20	484.5	1847.8	2332.3	74.6	214.3	289	2163.4	1449.3	3612.7
XIII Plan	2020-21	518.4	1995.6	2514	80.6	233.6	314.2	2314.9	1565.2	3880.1
XIII Plan	2021-22	554.7	2155.2	2710	87.1	254.6	341.7	2476.9	1690.5	4167.4
XIV Plan	2022-23	593.6	2327.7	2921.2	94	277.6	371.6	2650.3	1825.7	4476
XIV Plan	2023-24	635.1	2513.9	3149	101.5	302.5	404.1	2835.8	1971.8	4807.6
XIV Plan	2024-25	679.6	2715	3394.5	109.7	329.8	439.4	3034.3	2129.5	5163.8
	Growth Rate	**6%**	**7%**	**7%**	**7%**	**8%**	**8%**	**7%**	**8%**	**7%**
XIV Plan	2025-26	720.3	2905	3625.4	117.4	356.2	473.5	3246.7	2299.9	5546.6
XIV Plan	2026-27	763.6	3108.4	3871.9	125.6	384.6	510.2	3474	2483.8	5957.8
XV Plan	2027-28	809.4	3326	4135.3	134.4	415.4	549.8	3717.2	2682.6	6399.7
XV Plan	2028-29	857.9	3558.8	4416.7	143.8	448.7	592.4	3977.4	2897.2	6874.5
XV Plan	2029-30	909.4	3807.9	4717.3	153.8	484.5	638.4	4255.8	3128.9	7384.7
XV Plan	2030-31	964	4074.4	5038.4	164.6	523.3	687.9	4553.7	3379.2	7932.9
XV Plan	2031-32	1021.8	4359.7	5381.5	176.1	565.2	741.3	4872.4	3649.6	8522

Annexure 7.1 List of Proposed Airports under PPP

In Task Force has recommended the following 32 airports to be developed under PPP model at the cost of Rs.6000 Crores.

1. Jharsuguda (Odisha)
2. Warangal (AP)
3. Chakulia (Jharkhand)
4. Raxaul (Bihar)
5. Rupsi (Assam)
6. Kishtwar
7. Lahual Spiti (Jammu & Kashmir)
8. Hissar
9. Karnal
10. Ludhiana
11. Adampur (Punjab)
12. Radhanpur (Gujarat)
13. Parsoli (Gujarat)
14. Chandrapur
15. Karwar
16. Donakonda (AP)
17. Durgapur
18. Malda
19. Bhagalpur
20. Muzaffarpur
21. Jogbani
22. Madhubani
23. Jagdalpur
24. Ambikapur
25. Daltonganj (Jharkhand)
26. Jaypore (Odisha)
27. Utkela (odisha)
28. Gopalpur (Odisha)
29. Lenglec (Mizoram)
30. Agartala
31. Kamalpur (Tripura)
32. Juhu (Mumbai)

Annexure 7.2 Brownfield Airports

The following Tier-III Brownfield Airports proposed to be developed in any region.

i) Tezu
ii) Daparazo, Arunchal Pradesh
iii) Along, Arunchal Pradesh
iv) Ziro, Arunachal Pradesh
v) Pasighat, Arunchal Pradesh
vi) Rupsi, Asam
vii) Lengpui, Mizoram
viii) Kamalpur
ix) Tura (Meghalaya)

Annexure 7.3 Greenfield Airports

The following are the Greenfield Airports for which in-principle approval has been granted.

i) Kannur, Kerala
ii) MOPA, Goa
iii) Pekyong, Sikkim
iv) Sindhudurg, Maharashtra
v) Gulbarga, Karnataka
vi) Bijapur, Karnataka
vii) Hassan, Karnataka
viii) Shimoga, Karnataka
ix) Andal-Faridpur, West Bengal
x) Navi Mumbai, Maharashtra
xi) Kushinagar, Uttar Pradesh
xii) Dabra, Madhya Pradesh
xiii) Shirdi, Maharashtra
xiv) Karaikal, Pudducherry
xv) Aranmula, Kerala

Annexure 7.4 Greenfield Airports to be granted

The following are the Greenfield Airports for which site clearance has been granted

i) Itanagar, Arunachal Pradesh
ii) Machiwara, Ludhiana, Punjab
iii) Dholera (Ahemadabad), Gujarat
iv) Ongale (Prakasham Distt.), Andhra Pradesh

Annexure 7.5 Greenfield airports under site clearance

The following are the Greenfield Airports for which site clearance is under process

i) Sholapur, Maharashtra
ii) Bhaini Bhairon (Meham Div. Rohtak Distt.), Haryana
iii) Chakan (Pune), Maharashtra
iv) Belora, Amravati, Maharashtra
v) Shirur (Pune), Maharashtra
vi) Kotkasim (Alwar Distt.), Rajashthan
vii) Bellari, Karnataka
viii) Ankkara (Idukki Distt.), Kerala
ix) Dwarka, Gujarat
x) Jamshedpur, Jharkhand
xi) Velankarani, Nagapattinam, Tamilnadu
xii) Rumari, Assam

Annexure 8.1 Macroeconomic Factors and Air Traffic

Year	Air transport, registered carrier departures worldwide	Air transport, freight (million ton-km)	Air transport, passengers carried	Cargo traffic per aircraft movement	Passenger traffic per aircraft movement	Imports of goods and services (constant 2005 US$)	Exports of goods and services (constant 2005 US$)	GDP per capita (constant 2005 US$)	GDP	Trade Openness
	ACM	CT	PT	CTM	PTM	M	X	PGDP	GDP	TOPN
1971	64700	108.4	2554000	0.0017	39.5	8.54E+09	6.52E+09	272.2	1.54E+11	0.0976
1972	96600	131.1000	3285800	0.0014	34.0	8.38E+09	7.05E+09	264.5	1.53E+11	0.1006
1973	94300	176.5	3391600	0.0019	36.0	9.06E+09	7.40E+09	266.9	1.58E+11	0.1039
1974	69000	144.7	3037300	0.0021	44.0	7.90E+09	8.01E+09	263.9	1.60E+11	0.0993
1975	90600	211.3	3839900	0.0023	42.4	8.00E+09	9.33E+09	281.4	1.75E+11	0.0990
1976	94700	250.7	4534000	0.0026	47.9	8.15E+09	1.12E+10	279.6	1.78E+11	0.1087
1977	99000	275.8999	5147500	0.0028	52.0	1.04E+10	1.08E+10	293.1	1.91E+11	0.1109
1978	105300	297.7000	6099600	0.0028	57.9	1.04E+10	1.16E+10	302.8	2.02E+11	0.1091
1979	100100	297.6000	6546800	0.0030	65.4	1.24E+10	1.29E+10	280.5	1.91E+11	0.1325
1980	100000	366	6603100	0.0037	66.0	1.42E+10	1.36E+10	292.5	2.04E+11	0.1361
1981	104600	411.3999	7574500	0.0039	72.4	1.56E+10	1.35E+10	303.0	2.16E+11	0.1345
1982	106500	409.8999	8391700	0.0038	78.8	1.61E+10	1.43E+10	306.4	2.24E+11	0.1360
1983	113500	461.6000	9164800	0.0041	80.7	1.97E+10	1.42E+10	321.2	2.40E+11	0.1410
1984	120400	545.5	10125700	0.0045	84.1	1.69E+10	1.52E+10	325.9	2.49E+11	0.1286
1985	139900	489.7000	10993800	0.0035	78.6	1.92E+10	1.42E+10	335.4	2.62E+11	0.1275
1986	151000	539.7000	11785200	0.0036	78.0	2.25E+10	1.50E+10	343.7	2.75E+11	0.1364
1987	159500	645.2000	12668600	0.0040	79.4	2.21E+10	1.69E+10	349.6	2.86E+11	0.1366
1988	157600	646.2999	12863100	0.0041	81.6	2.41E+10	1.82E+10	375.2	3.13E+11	0.1351
1989	156300	680.5999	12740100	0.0044	81.5	2.47E+10	2.04E+10	389.2	3.32E+11	0.1356
1990	125800	662.9000	10862200	0.0053	86.3	2.55E+10	2.26E+10	402.3	3.50E+11	0.1373
1991	117500	493.1000	10717400	0.0042	91.2	2.55E+10	2.48E+10	398.4	3.54E+11	0.1421
1992	120300	429.3999	11127100	0.0036	92.5	3.09E+10	2.60E+10	411.9	3.73E+11	0.1524

Year	Air transport, registered carrier departures worldwide	Air transport, freight (million ton-km)	Air transport, passengers carried	Cargo traffic per aircraft movement	Passenger traffic per aircraft movement	Imports of goods and services (constant 2005 US$)	Exports of goods and services (constant 2005 US$)	GDP per capita (constant 2005 US$)	GDP	Trade Openness
	ACM	**CT**	**PT**	**CTM**	**PTM**	**M**	**X**	**PGDP**	**GDP**	**TOPN**
1993	105300	372.3999	9441600	0.0035	89.7	3.68E+10	2.96E+10	423.0	3.91E+11	0.1698
1994	130100	563.5999	11518400	0.0043	88.5	4.51E+10	3.35E+10	442.5	4.17E+11	0.1884
1995	168400	653.9000	14260600	0.0039	84.7	5.78E+10	4.40E+10	467.0	4.49E+11	0.2269
1996	151300	565	13394600	0.0037	88.5	5.64E+10	4.67E+10	492.8	4.83E+11	0.2138
1997	182500	528	16039800	0.0029	87.9	6.39E+10	4.56E+10	503.2	5.02E+11	0.2181
1998	196100	531.2999	16521000	0.0027	84.2	7.72E+10	5.20E+10	524.6	5.33E+11	0.2423
1999	180500	531.2000	16005400	0.0029	88.7	8.26E+10	6.13E+10	560.7	5.80E+11	0.2480
2000	198426	547.652	17299483	0.0028	87.2	8.64E+10	7.25E+10	572.1	6.03E+11	0.2636
2001	206690	515.37	16862737	0.0025	81.6	8.89E+10	7.56E+10	589.4	6.32E+11	0.2604
2002	231413	546.34	17633019	0.0024	76.2	9.96E+10	9.15E+10	601.5	6.56E+11	0.2915
2003	263870	579.85	19455085	0.0022	73.7	1.13E+11	1.00E+11	638.1	7.07E+11	0.3022
2004	302790	708.475	23934074	0.0023	79.0	1.39E+11	1.28E+11	677.7	7.63E+11	0.3487
2005	330484	774.04	27879461	0.0023	84.4	1.84E+11	1.61E+11	729.0	8.34E+11	0.4131
2006	453921	842.55	40288794	0.0019	88.8	2.23E+11	1.94E+11	784.4	9.11E+11	0.4572
2007	569033	967.684	51897450	0.0017	91.2	2.46E+11	2.05E+11	848.4	1.00E+12	0.4506
2008	592292	1233.937	49877935	0.0021	84.2	3.02E+11	2.35E+11	868.6	1.04E+12	0.5163
2009	601977	1235.158	54446373	0.0021	90.4	2.95E+11	2.24E+11	929.0	1.13E+12	0.4604
2010	623196.77	1630.964	64374253.8	0.0026	103.3	3.41E+11	2.68E+11	1010.3	1.24E+12	0.4900
2011	695626	1702.702	73996912	0.0024	106.4	4.13E+11	3.10E+11	1063.2	1.33E+12	0.5452
2012	678125.93	1579.229	72151828.9	0.0023	106.4	4.38E+11	3.30E+11	1102.9	1.39E+12	0.5513
2013	683646.80	1617.458	75589079	0.0024	110.6	4.01E+11	3.54E+11	1164.3	1.49E+12	0.5072
2014	720050.21	1738.982	82751554.9	0.0024	114.9	3.99E+11	3.58E+11	1235.5	1.60E+12	0.4730

Annexure 8.2 Environmental Indicators

Year	CO2 emissions (metric tons per capita)	CO2 emissions (kt)	CO2 intensity (kg per kg of oil equivalent energy use)	No ER, No pvt=1, 0	PVT=1,0	ER, PVT=1,0
	CO2P	CO2K	CO2I	RD1	RD2	RD3
1971	0.363338	205869	1.315756	1	0	0
1972	0.375731	217849.1	1.360464	1	0	0
1973	0.378031	224343.4	1.364011	1	0	0
1974	0.381915	231992.8	1.353707	1	0	0
1975	0.405662	252201.6	1.419022	1	0	0
1976	0.414638	263785.6	1.425408	1	0	0
1977	0.484986	315681	1.659595	1	0	0
1978	0.477576	318035.2	1.665459	1	0	0
1979	0.487174	331940.5	1.660347	1	0	0
1980	0.499952	348581.4	1.699119	1	0	0
1981	0.525284	374822.4	1.73511	1	0	0
1982	0.545553	398419.6	1.773595	1	0	0
1983	0.578453	432321	1.862639	1	0	0
1984	0.584714	447110	1.845988	1	0	0
1985	0.627125	490464.9	1.924997	1	0	0
1986	0.657651	525862.5	1.989586	1	0	0
1987	0.687149	561560.7	2.044938	1	0	0
1988	0.726154	606298.1	2.094179	1	0	0
1989	0.777434	662945.9	2.184691	1	0	0
1990	0.793218	690576.8	2.182612	1	0	0
1991	0.830434	737851.7	2.24342	1	0	0
1992	0.864498	783634.2	2.290019	1	0	0
1993	0.880821	814297.7	2.325837	1	0	0
1994	0.917598	864931.6	2.378169	1	0	0
Year	CO2	CO2	CO2	No ER,	PVT=1,0	ER,

	emissions (metric tons per capita)	emissions (kt)	intensity (kg per kg of oil equivalent energy use)	No pvt=1, 0		PVT=1,0
	CO2P	**CO2K**	**CO2I**	**RD1**	**RD2**	**RD3**
1995	0.957509	920046.6	2.396877	1	0	0
1996	1.023419	1002224	2.529476	1	0	0
1997	1.046224	1043940	2.535706	1	0	0
1998	1.054613	1071912	2.541798	1	0	0
1999	1.105716	1144390	2.566787	1	0	0
2000	1.126421	1186663	2.599885	0	1	0
2001	1.123105	1203843	2.593979	0	1	0
2002	1.125301	1226791	2.566471	0	1	0
2003	1.156576	1281914	2.61772	0	1	0
2004	1.197178	1348525	2.603655	0	1	0
2005	1.233151	1411128	2.614468	0	1	0
2006	1.294536	1504365	2.640474	0	1	0
2007	1.365787	1611199	2.668233	0	1	0
2008	1.497886	1793075	2.835964	0	1	0
2009	1.619049	1965820	2.822455	0	1	1
2010	1.58487	1950950	2.700147	0	1	1
2011	1.662873	2074345	2.759101	0	1	1

Paper Publication

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II. D P Singh, Narendra N. Dalei, & T. B. Raju (May, 2015). Airport Privatization and Economic Regulation: An Indian Experience. **International Journal of Multidisciplinary Research and Development,** Volume: 2, Issue: 5, 414-418, p-ISSN:2349-5979, e-ISSN: 2349-4182, Impact Factor: 3.762, www.allresearchjournal.com

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i) Narendra N. Dalei, D P Singh and Rahul Mazumder, IMPACT OF DEVELOPMENT OF GREENFIELD AIRPORTS ON ENVIRONMENT AND URBANIZATION, 8th Biennial Conference of Indian Society of Ecological Economics organized by Indian Institute of Science, Bangalore, 3-4th January, 2016.

ii) Narendra N. Dalei, and D P Singh, Development of Greenfield Airports in India: An Empirical and Case Study Analysis for Sustainable Environment, Fourth Annual Conference of the New Zealand India Research Institute, to be held in Palmerston North on April 1st - 2nd 2016 on the theme 'Sustainable Environments in 21st Century India' (accepted for presentation).

iii) D.P. Singh, N N Dalei, T B Raju, Development of Greenfield Airports and Air connectivity in India. ICMI, 2016.