Strategy Tripod Perspective on the Determinants of Airline Efficiency in A Global Context: An Application of DEA and Tobit Analysis

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“A Strategy Tripod Perspective on the Determinants of Airline Efficiency in A Global Context: An Application of DEA and Tobit Analysis”

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Abstract

The airline industry is vital to contemporary civilisation since it is a key player in the globalisation process: linking regions, fostering global commerce, promoting tourism and aiding economic and social progress. However, there has been little study on the link between the operational environment and airline efficiency. Investigating the amalgamation of institutions, organisations and strategic decisions is critical to understanding how airlines operate efficiently.

This research aims to employ the strategy tripod perspective to investigate the efficiency of a global airline sample using a non-parametric linear programming method (data envelopment analysis [DEA]). Using a Tobit regression, the bootstrapped DEA efficiency change scores are further regressed to determine the drivers of efficiency. The strategy tripod is employed to assess the impact of institutions, industry and resources on airline efficiency. Institutions are measured by global indices of destination attractiveness; industry, including competition, jet fuel and business model; and finally, resources, such as the number of full-time employees, alliances, ownership and connectivity. The first part of the study uses panel data from 35 major airlines, collected from their annual reports for the period 2011 to 2018, and country attractiveness indices from global indicators. The second part of the research involves a qualitative data collection approach and semi-structured interviews with experts in the field to evaluate the impact of COVID-19 on the first part's significant findings.

The main findings reveal that airlines operate at a highly competitive level regardless of their competition intensity or origin. Furthermore, the unpredictability of the environment complicates airline operations. The efficiency drivers of an airline are partially determined by its type of business model, its degree of cooperation and how fuel cost is managed. Trade openness has a negative influence on airline efficiency. COVID-19 has toppled the airline industry, forcing airlines to reconsider their business model and continuously increase cooperation. Human resources, sustainability and alternative fuel sources are critical to airline survival. Finally, this study provides some evidence for the practicality of the strategy tripod and hints at the need for a broader approach in the study of international strategies.

Acknowledgements

It is thirty-five years since my first solo flight in a Jet Provost at Linton-On-Ouse, a Royal Air Force base in North Yorkshire. I am grateful to have had the chance and ability to accomplish this doctorate degree. Flying for me is a hobby, a passion, and, after all, a miracle. I hope that others feel the same and are as passionate as I am.

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Thank you all.

Dedication

To all the young cadets who join the forces directly from schools, this is for you

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Chapter 1 Introduction

1.1 Research Motivation

The first part of the research (Chapters 1–5) investigates the determinants of airline efficiency in a global setting. From a theoretical perspective, our study incorporates the widely acknowledged viewpoints of Peng et al. (2008), Peng et al. (2009) and Su et al. (2016). The strategy tripod mixes resource-, industry- and institution-based interpretations to explore factors affecting firms' performances. Following similar research in data envelopment analysis (DEA) (e.g. Assaf, 2011; Barros & Peypoch, 2009; Huang et al., 2021; Kweh et al., 2015; Lee & Worthington, 2014; Pointon & Mathews, 2016; Wanke et al., 2015; Yuen et al., 2013), we attempt to apply a two-stage bootstrap DEA efficiency method to examine variables that have a significant effect on airline performance (see IATA, 2018).

Since the mid-1980s, air transport has witnessed a significant structural and institutional transformation. Understanding the environment of operation is crucial to airline success. Creating a technique that can capture a broader perspective is problematic and often complex (Li et al., 2015). Additionally, in a volatile environment where technological fluctuations evolve quickly, firms are more likely to encounter challenges that may hinder their performance.

The second part (Chapter 6) explores the global aviation industry's response to the current COVID-19 outbreak. The pandemic marked a dismal period in recent history, with enormous economic consequences, particularly to the aviation industry (McKibbin & Fernando, 2021). COVID-19 has triggered a precipitous decline in demand, putting airlines to the test (Forsyth et al., 2020). The majority of airlines were forced to rely on government subsidies (Abate et al., 2020).

External shocks play a significant role in any industry; Brown and Kline (2020) classify exogenous shocks into three types: macroeconomic, security and health threats. While there is a wealth of research on efficiency, the airline industry remains limited in its understanding of how to react to external shocks. Our study adds another piece to the puzzle of previous airline efficiency studies. Theoretically, this study has three foci: the first is on airline efficiency determinants, the second is on the use of the tripod strategy in airline studies and the third is on how the industry responds to external shocks.

1.2 Background

Efficient air transportation can boost the regional economy by allowing access to the world market, facilitating integration and labour mobility and fostering local industries. In this regard, air transport can act as a means of transporting traded goods and providing complementary services of labour mobility. The European Commission acknowledged the strategic importance of the industry, as it creates more than five million jobs and produces 2.1% of European gross domestic product (GDP) (EC, 2020). Across the Atlantic, civil aviation contributes about 460 billion dollars (5.4%) of GDP to the US economy and provides 11.8 million jobs (FAA, 2015), supporting not only the travel and tourism sector but also serving as an essential input in the path of social and economic development of the country. Air transport is a vital hauler of low-bulk cargo and high-value products constituting about 40% of world trade (Button, 2008a).

Over time, significant evolutions have occurred, stemming from globalisation and the upgradation in technology, which are shaping the industry. At the same time, the airline industry has faced several challenges affecting efficiency, productivity and profitability, including weak economic recovery, high fuel prices and global health threats. Thus, the financial performance of airlines varies vastly in different regions across the world (Belobaba & Odoni, 2009). Despite the setbacks, air transport continues to have a central role, not only because of its enormous influence on economic growth but also due to its shared solid and synergistic relationship with other important industries (Vasigh et al., 2018). Operations in air transportation networks result from complex interactions between passengers, operators and policymakers in their unique local and global settings. Air transport is critical for areas that lack good roads or rail infrastructure. Health care aids are often delivered only by plane in many isolated villages and tiny islands. ATAG (2014) has predicted that there will be more than 6.5 billion passengers in 2030, with aviation supporting more than 103 million in employment and 5.8 trillion dollars in economic activity.

Air transport studies continue to be published in economics, econometrics, social sciences, business and management. Air transport is the subject of more than 4,000 scholarly publications as of 2016, and the number of papers that evaluate efficiency in air transportation reaches 2,900 if we limit our study to those published since 1990 (Bilotkach et al., 2016).

1.3 Aim and Objectives

Deregulation has impacted the airline sector; the air transport industry's assessment of productivity, performance and profitability has received a great deal of attention. Since the introduction of the single sky in Europe, airlines and airports have placed a strong emphasis on performance assessment and benchmarking (Doganis, 2005).

The airline segment is critical, mainly because it facilitates quick long-distance travel. Airlines are at the centre of enabling humans to travel and transport cargo within a few hours over distances that would otherwise take other transportation modes days or weeks. Therefore, the industry is central to the world's interconnectivity, allowing people and cargo to move between cities thousands of miles apart and ultimately increasing the world's oneness (Kasarda & Sullivan, 2006). As the world becomes increasingly globalised, it is becoming impossible for countries to exist independently. Instead, they must depend on fast delivery of essential items, especially labour, food products, equipment, machinery and medicines. Hence, it is essential to have a highly effective airline industry.

Not only is it vital in realising the interconnectivity and quick movement that globalisation demands, it is also instrumental in employing many people worldwide (Boonekamp et al., 2018). A fully functional and complete global village makes the sector highly sensitive. Apart from being highly sensitive, the industry is also characterised by huge investments (Camilleri, 2018) with uncertainties on returns, unlike most sectors, where start-up and working capital are minimal. Undoubtedly, managers within the sector have the mammoth task of guaranteeing profitability, innovation, safety and competition. Therefore, they need relevant tools at their disposal to guarantee their survival.

The cause of airline failures can be attributed to external factors, internal factors or a combination of both (Ateş et al., 2018). In line with the research motivation, the aim of this research is to determine airline efficiency utilising the strategy tripod approach (Peng et al., 2008), as well as to explore how the recent COVID-19 pandemic transformed the airline industry. This research will provide a benchmark for future studies while adding comprehensive knowledge and a broader approach to efficiency research on the airline industry.

Objectives:

a. To examine the relative differences in airlines concerning optimal efficiency and productivity.
b. To examine the industrial factors that impact the efficiency of an airline.
c. To examine the resource factors that impact the efficiency of an airline.
d. To examine the institutional factors that impact the efficiency of an airline.
e. To examine the use of the strategy tripod theory in determining airline efficiency. Linking objectives, b, c and d is objective e, herein attaining the study input as it attempts to provide a comprehensive view that links the use of the strategy tripod with airlines' performances.
f. To explore airlines' responses to the recent outbreak of COVID-19.

In order to achieve the research objectives, we attempt to answer the following **research questions:**

1. What are the external and internal factors that impact the efficiency and productivity of an airline?
2. How can the use of the strategy tripod theory help us in understanding the complex operational efficiency determinants in the airline industry?
3. What has been the impact of COVID-19 on the airline industry and how the industry responded?

1.4 Problem Statement

The vast and global reach of the airline industry has contributed to the complexities and sensitivities of researching the industry (O'Connor & Fuellhart, 2012). Governments across the globe have fiercely safeguarded and controlled the aviation sector for decades due to its significance to the national economy, national security and its unpredictable performance. Many regulations and laws have been put in place to limit competition and preserve the business.

Since the deregulation in 1978, significant structural, institutional and regulatory changes have occurred in international air transport. These transformations have resulted in increased market competitiveness and razor-thin margins, resulting in the closure of many companies, bankruptcies, acquisition and merger activities. Thus, to take full advantage of automation processes and strive towards the development of sustainability, the industry needs to be well aware of their productivity and efficiency levels. With such drastic swings in the typical operating environment, there is an increasing requirement for strategic planning to address uncertainty and identify critical problems that will influence the entity's future behaviours. Additionally, in a dynamic sector such as aviation, external influences, such as developing markets, economic fluctuations, technical advances, regulatory trends, and political and security instability, serve as the foundation for this unpredictability.

Researchers have focused on examining the performance and operations of the airline industry during momentous events, such as the 1991 Gulf Crisis, the 2001 9/11 terror attacks and 2008-2009 global financial crisis. Further, the 21st century has been the era of technological advancements and the time wherein the focus has not just been on deriving competitive advantage and profits but also on sustainability. Thus, there is a need to explore these companies beyond the industry level, particularly their efficiency and productivity. Not surprisingly, many managers often struggle to sustain efficiency and high performance in their respective airlines. One of the primary reasons for this is the uncertainty over the key factors that affect the performance of airlines. Indeed, we still need to understand how airline performance interrelates with the broader context.

The current pandemic challenges are an excellent example: the pandemic has been an unparalleled organisational crisis that calls into question the existing status quo (Hall et al., 2020; Wong & Yang, 2020). This interaction between airline and its operating environment is at the heart of the problem we try to investigate. Unfortunately, the aviation industry was unprepared for a pandemic as devastating and disastrous as COVID-19, which brought the whole sector to a standstill.

1.5 Nature of the Study

This study uses primarily quantitative approaches to conduct the research. According to Castellan (2010), the quantitative technique is consistent with positivism, which has no prior beliefs about the phenomena and depends on the scientific method to analyse and comprehend complicated topics. As we develop the two stages of the research, we utilise DEA in the first part to derive the efficiency and productivity scores and then use these scores to regress on the external variables selected for this study. The quantitative technique is ideal for the study as it allows the use of panel data over a period of time and utilises statistical analysis to understand the relationship between efficiency and the context of operations (Cui &Yu, 2021). On the other hand, qualitative research helps in investigating the human aspect of phenomena and the complexity of a business problem or process while also taking into account dynamics such as people's or groups' life experiences (Hyett et al., 2014).

In the second part of the research, a qualitative approach is used to capture a more recent and ongoing pandemic that has devastated the aviation industry. Semi-structured interviews with experts in the area are conducted to examine how the industry reacted during the outbreak and how the industry will be transformed by the pandemic.

1.6 Significance of the Study

Efficiency can lead to better performance, the source of efficiency is critical, airline managers need to understand the context of operation and the regulations of the country they operate in.

Managers and policymakers can evaluate and amend the existing practices of a firm at the country and regional level to provide the best possible outcome for their airline's performance.

1.6.1 Theoretical Implication

Incorporating the strategy tripod theory is a theoretical opportunity to broaden the study scope to understand what contributes to airline performance. The strategy tripod integrates resource-, institutional- and industry-based views. What Peng (2002), Peng et al. (2008) and Peng et al. (2009) attempted to present was a solution to understanding the determinants that drive company strategy in a globalised industry. The tripod is the result of a synthesis of previously established theories, such as that of resources (Barney, 1991; Wernerfelt, 1984), institutions (North, 1990; Scott, 2008) and the industry (Porter, 1980; Porter, 1985a). According to Peng (2002), theoretical complementarity may be created by combining already established and available ideas. This combination would certainly define the strategic decisions made in the national or global market and, as a result, explain a company's competitive performance.

This work highlights a wide range of theoretical ramifications. It provides readers with an overview of airline efficiency determinants using the strategy tripod framework and identifies supporting tools and methods. The theoretical use of the strategy tripod in assessing airline performance can be further fine-tuned in future research to pave the way for more advanced interactive mixed-methods research. The pandemic gives an ideal opportunity to examine the impact of external shocks on the sector and to develop a theoretical lens that can be used to analyse future external risks and how to overcome them.

The study's results can be used by aviation policymakers, regulatory agencies, civil aviation directors and managers, airport authorities, members of national economic boards, aviation industry associations, educators and researchers in aviation management disciplines, consultants and other strategic planning specialists.

1.6.2 Contribution to Business Practice

The airline industry certainly has an enormous impact on other related industries within a country or region. Therefore, it is critical for managers and airline operators to have an in-depth knowledge of what drives airline efficiency. Efficient and productive industry can only boost the local economy and increase the flow of people, which in turn can help the local economy flourish. The results of this study can help the airline industry work on the identified aspects and have better efficiency derivation. Along with that, identifying the efficiency and productivity aspects helps airlines manage their functions to survive in a competitive environment and derive better profitability.

Raising employees' awareness to help them develop a new set of values may help stop widespread layoffs and improve workers' cooperation and communication with their unions to find common ground and stop more job losses. Communities may benefit from better living standards as a result of increasing employment (Garrow & Lurkin, 2021).

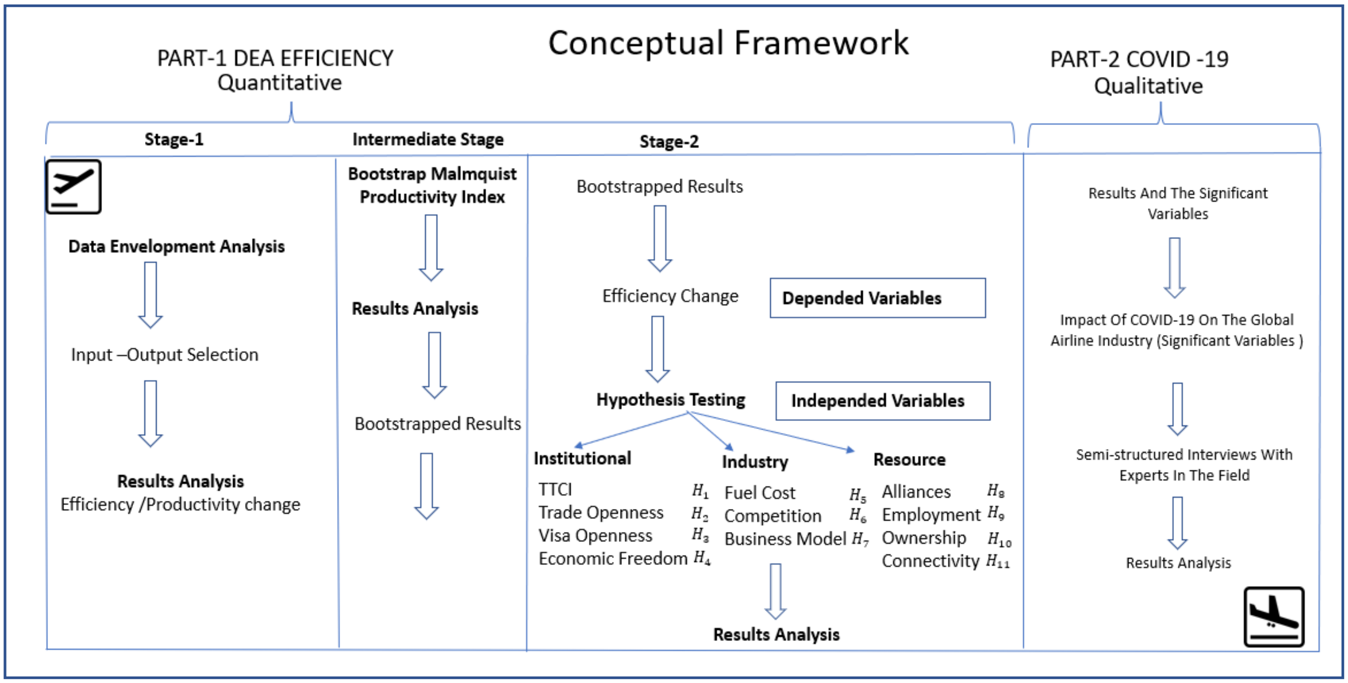
The development and loosening of certain institutional policies at the country and regional level may attract consumers and investors so local communities can benefit from the increasing flow of passengers (Allroggen et al., 2015).

Managers may also benefit from researching external shocks and how to overcome barriers related to global crises or pandemics in the future. Further, the study's findings will help to provide recommendations for future related research, allowing other scholars to design better research methodologies. Ultimately, managers within the airline sector will be able to use the study's findings to improve the performance of their respective airlines. A critical thing to note is that the list of variables that can influence an airline's overall performance is not exhaustive. Generally, the degree of influence varies between variables.

1.7 Overall view of the research

The **Figure 1**. below summarises the essential stages of the research along with the identified hypothesis to be tested, the methodology used and the analysis that could be considered further

Figure 1 Overall view of the research



1.8 Scope of Study

The scope of this study is limited to specific airlines only. Herein, the work is focused on the efficiency examination, contribution in performance comparison and identification of the factors that contribute academically in knowledge and suggest strategies for better performance. The research considers not only the economic elements but also the industry's long-term viability during and after COVID-19. As a result, the study focuses not only on a quantitative evaluation of the efficiency determinants of the chosen global airlines but also on a qualitative means of examining the present pandemic and how the airlines responded to such a life-changing event as COVID-19.

1.9 Operational Definitions

DEA: Non-parametric method in operations research for the estimation of production frontiers.

Strategy Tripod: Combines industry-based, resource-based and institution-based factors.

Deregulation: Airline deregulation is the process of removing government-imposed entry and price restrictions on airlines.

Global Indices: Measure the economic, social and political dimensions of globalisation.

Open Skies Agreement: An international policy concept, which liberalises rules and regulations.

Business Model (BM): Describes how an organisation creates, delivers and captures value.

Low-Cost Carrier (LCC): No-frills budget or discount carrier or airline.

Full-Service Carrier (FSC): Offers various passenger services, such as in-flight entertainment, meals, beverages and comforts in the ticket price.

Fuel Hedging: Establishing a fixed or capped cost via a commodity swap or option.

COVID-19: Coronavirus disease is an infectious disease caused by the SARS-CoV-2 virus.

1.10 Thesis Structure

- **Chapter 1 - Introduction:** This chapter provides basic information about the global airline industry and establishes the background of the study by discussing the status of the global airline industry, significant reforms undertaken in the industry and the aspects influencing the productivity and efficiency of the industry. Further, it presents the study's problem statement and the research aims and objectives, followed by research questions, significance and the scope of the study.
- **Chapter 2 - Literature Review:** This section is based on a review of previously available research and academic studies to shed light on the aspects already explored and identified

by researchers. It presents a description of developments in the airline industry, efficiency in airlines and an empirical review of the research. The importance of institutions and country attractiveness are explored as well as the theoretical lens of the strategy tripod and the identification of variables influencing the efficiency and productivity of the global airline industry.

- **Chapter 3 - Hypothesis Development:** This part of the research examines the utilisation of the strategy tripod to help us identify the variables influencing the efficiency and productivity of the global airline industry.
- **Chapter 4 - Research Methodology:** The methodology provides a plan of the study by discussing the research approach, data collection procedure, data analysis procedure and the reliability and validity of the study with detailed description of the source of data collection, selection criteria and the tools and methods of analysing data.
- **Chapter 5 - Data Analysis and Discussion:** Two levels of analysis are presented in this chapter. The first assesses the airlines productivity and efficiency. The second stage uses regression analysis to compute the source of efficiency differentials. The findings and outcomes of the research are presented and discussed in the discussion section.
- **Chapter 6 - COVID-19:** This section of the study is a self-contained chapter, including a related literature evaluation, research methods and an analysis of the findings. It focuses mostly on the aviation industry's response to COVID-19.
- **Chapter 7 - Conclusion and Recommendations:** Herein, the cohesive conclusion is drawn from examining the global airline industry, and the relevant key findings are provided to answer the study's objectives. The recommendations, the limitations of this study and the scope for future study are also presented.

Chapter 2 Literature Review

2.1 Overview of the Chapter

The importance of air transportation to a country's economic and social growth has been recognised in the literature. According to Daley (2009), aviation offers companies the opportunity to expand and penetrate into new markets. It promotes corporate specialisation by generating scale economies and stimulating direct foreign investment and social benefits, such as workforce mobility, leisure travel and cultural exchange. This chapter will commence with a brief history of aviation up to the deregulation of the industry in 1978. Following that, we will go through the factors that influence efficiency, as well as a thorough analysis of the literature on efficiency studies. When working on a global scale, the importance of institutions cannot be overstated. The significance of a country's attractiveness is examined in terms of generating a beneficial environment for businesses to prosper. The theoretical application of the strategy tripod, as well as the identification of many fundamental factors that have been identified as major drivers of airline efficiency. This chapter will close with a few concluding observations.

2.2 Early Development in the Airline Industry

The world suddenly changed on the historic day when the Wright brothers managed to take a controllable flying machine into the air in 1903 in North Carolina. A few years after the Wright brothers' flight, in 1906, humanity witnessed another step towards the advancement of aviation when the French aviator Louis Bleriot crossed the English Channel (Fox, 2017). This crossing was again a significant challenge, as it marked the first international flight that brought many uncertainties, fears and questions. Who is authorised to control the airspace above us (Fox, 2017)? As a result, air freedom regulations were born.

At the time, only a few states supported the idea of freeing the air universally like the high oceans. The French and German governments opposed this idea at the international aviation conference held in Paris in 1910 (see Mackenzie, 2010, pp. 12–23). The idea of a state's sway over its airspace was affirmed during the Paris aviation conference towards the end of the First World War, which resulted in the formation of the Paris Accord (Jeon, 2011, p. 239).

Paris was then the world's capital (MacMillan, 2007). Cooper (1952) wrote that the initial political discussion to study flight constraint and regulation was organised in Paris in 1910 only to be suspended one month later, lacking any conclusion. Indeed, the First World War would confirm the importance of aviation in military operations. Most of the convention provisions stressed that the military had an apparent stimulus on the Paris Convention outcome and contributed mainly to its restricted geographical reach.

The primary outcome of the Paris Convention was the granting of what is known as 'cabotage rights', subject to multilateral agreements between contracting parties (Cooper, 1952). According to De Leon (1992), cabotage is derived from the French verb *caboter* (from the Spanish *cabo*, or cape, meaning navigating near the shoreline without losing sight of it). Cabotage is usually not given under most Open Skies agreements. The ability to operate under cabotage freedom is uncommon in civil air transport and still exists today (De Leon, 1992).

In 1919, the French government organised the Paris Convention. It was initially labelled the Convention Relating to the Regulation of Aerial Navigation. The uniqueness and importance of this convention were that it was the first-ever universal gathering to address the political complications and complexity of operating at the international aerial navigation level. The convention was established with the support of the International Commission for Air Navigation, which is identified today as the International Civil Aviation Organization (ICAO) (see Fox, 2014). The convention aimed to minimise the mystification of earlier viewpoints and strategies deployed by each state by laying down some fundamental values and requirements agreed upon and signed in Paris. One of the most important outcomes of the Paris Convention was that every country had absolute sovereignty over the airspace overlying its territories and waters. Later, the Paris Convention was replaced by the Convention on International Civil Aviation (also known as the Chicago Convention).

2.3 The Chicago Convention

The Chicago Convention was chartered with the performance of many tasks. One of the purposes of the assembly was to develop a secure and safe traffic system; this was only made possible by the members' belief that there was a need for an international agreement that governed air movement internationally. Some of the preliminary complications with the convention were that some members sought complete freedom of operation, while others wanted a more controlled airspace overriding international authority (Fox, 2014).

The plan offered by the US at the Chicago Convention consisted of a United Nations type of organisation, with considerable power in technical matters and as little regulation as possible. The US proposals presumed that market forces would set frequencies and fares without international interference (Fox & Ismail, 2017). As a result of the convention, the only uncertainty was the question of capacity and the frequency of control of the services offered by global airlines. The stalemate over this issue resulted in Article 6 of the Chicago Convention, which states that no scheduled international air service may be operated over or into the territory of a contracting state, except with the special permission or other authorisation of that state, and under the terms of such permission or authorisation.

The characteristics of the provocative fifth freedom, which gives the right to travel between two foreign nations on a flight that originates or terminates in one's own country, were at the root of this Article 6 debate. The grant of the fifth freedom was not the issue because a degree of fifth freedom rights is indispensable to an international air route network operation. Rather, the crucial disagreement was over the regulation of capacity concerning the fifth freedom. Even though the Chicago Convention failed to achieve a multilateral exchange of commercial traffic rights, it has had a bigger effect on bilateral agreements than is usually thought (Barry, 2017).

2.4 The Global Airline Industry

Globalisation has led to a more miniature world, full of opportunity and openness to new markets. Deploying human capital on a global scale remains a significant factor in developing the economy worldwide (Fox, 2017). Due to the complexity of its operational process and its impact on associated industries, such as trade, tourism and aircraft manufacturing, it has gained considerable attention from governments, policymakers, consumers and the media (Belobaba et al*.,* 2016; Muthusamy & Kalpana, 2018).

The extraordinary growth of the air transport industry started in 1950 with major technological innovations, such as the inception of jet airplanes. During this time, airlines were under strict regulations, which created an environment wherein government policy and technological advancement favoured competition. By 1978, this scenario changed as economic deregulation for US airlines took place. Instead of relying on government policies and innovation, the focus shifted towards better operational performance and profitability, competitive behaviour and cost efficiency. This liberalisation spread worldwide, mostly in industrialised countries, with increased focus on the industry's constant evolution to make the airline industry internationally more competitive (Belobaba & Odoni, 2009).

Air travel has grown 5% over the past 30 years, with slight variation due to the difference in the economics of regions and the ever-changing economic state. For example, world air traffic declined in 1991 due to the Gulf Crisis, in 2001 owing to the 9/11 terror attacks in the US and in 2009 during the global financial crisis (IATA, 2016). North America continued to be the region with the highest air traffic, followed by Europe and Asia-Pacific. Africa has the least amount of revenue generated from air traffic. The rise of the airline industry in different parts of the world with growth-orientated marketing approaches generates pressure and surely edges the international market to an even more competitive environment (O'Connell, 2011).

2.5 The Effect of Airline Deregulation

Substantial operational, institutional and governmental deviations have occurred in the air transport industry since its deregulation in 1978. Known for his contributions to the airline deregulation movement, Alfred Kahn has been described as the '*father of the airline deregulation drive*' (Rose, 2012. p. 376). In the early seventies, unemployment and rising inflation rates were very high, with economies such as the US' experiencing a period of stagnation (see Greenspan, 2008). This unstable and risky atmosphere paved the way for sweeping regulatory changes. At the beginning of the regulatory changes, both consumers and businesses hesitated over whether deregulation would benefit either group.

There were still powerful institutions opposed to changes, mainly from large and well-established organisations and their unionised workers. The immediate effect of deregulation was the control of prices, as price restrictions were eliminated, leading to a more competitive environment and a drop in average prices. With the new settings, the airline sector underwent a radical transformation. The early years of deregulation witnessed many changes to the market, forcing well-established airlines to expand and venture into new areas. New carriers were forming, and new LCCs were introduced to the market. By 1984, several companies had failed, with an increasing number of liquidations and acquisitions having occurred. During the following years, industry concentration increased, especially on hub routes, raising concerns about the exercise of market power and the durability of early deregulation price reductions.

The deregulation in the airline industry led to a reduction in the average prices and more frequent and direct flights to destinations. We detected a radical transformation in the network structure with better and improved productivity, especially in the US (e.g., Borenstein & Rose, 2007). One of the effects of lowering prices raised concerns about packed flights and poor service quality, especially among business commuters; the competitive market has proven that most customers are ready to trade comfort for lower prices (Khan, 2003, p. 3).

The massive changes in the operation of the airline industry, even after 40 years of deregulation, continue to be a source of worry. Razor-thin margins and fluctuating aggregate earnings, as well as a high rate of firm turnover and bankruptcies, have been at the heart of such controversy, particularly among those advocating a return to regulation. Moreover, although average prices have dropped, fare differences have continued to fluctuate (Borenstein & Rose, 2007). Morrison and Winston (2010) developed a counterfactual model using the regulatory standard industry fare level. It is assumed that prices in the deregulated marketplace would have been equal to or lower than those established by the regulatory body if they had not been abolished. Rates in 2005 were approximately 30% cheaper than the predicted standard industry formula fares that year. In contrast to the above analysis, the lower estimate still indicates that the net impact on consumer welfare would rise by about 28 billion dollars in that year.

Furthermore, load factors also improved much more than anticipated; by early 1980, load factors had climbed to 60%. By 1990, they had reached 70% and figures are even higher nowadays, especially for LCCs. It is also worth mentioning that the effects of airline deregulation were much more extensive since they altered the network from a linear point-to-point structure to a hub-and-spoke one. Developing a more extensive network capability, with improvement in the scheduling and frequency of flights, allows customers to fly in the morning, attend to their business during the day and return home at night (Morrison & Winston, 2010).

The change in market structure has encouraged many old and well-established trunk carriers to acquire smaller local service providers that operate within their hub cities. Lastly, deregulation stimulated people to travel more due to the spillover impact of reduced costs. Efficiency also improved with more privatisation plans, especially those that had previously been controlled by the government. Even though there is still considerable scepticism about changing regulations, such as ownership and access to airport control on a global scale. This could be less evident at the domestic level in large countries, such as the US or China.

From a globalisation point of view, it is clear that the days of stringent control of the airline industry are disappearing. Severin and Nancy (2008) claim that the deregulation of the airline sector has failed to develop a new equilibrium and a healthier environment for the airline industry to operate in. In reality, deregulation has opened the door for more innovative ideas and more competition. We have seen a shift and an advanced industry emerge over time. Today, airlines operate differently; the advancement in aircraft manufacturing, better navigational operations and more regional integration have contributed to the change in the way airlines operate. Indeed, what deregulation allowed for was a more dynamic rather than static industry. Perhaps, we conclude with Baily's (2010) remarks, stressing that the '*aviation deregulation act may be the most important microeconomic policy achievement of the last century*' (p. 200).

2.6 Radical Reforms in the Global Airline Industry

Air transport has always been held to an inherently strategic value. Many airlines are still flag carriers for their respective countries, representing their countries' international commercial presence. Airlines used to be considered potential transporters of high-speed mail services and long-term or medium-term passenger transport. However, technology developments have made them a more reliable source of intercontinental services, with a rise in their international significance since the 1930s. Airlines were always a highly regulated transportation medium, with associated economic and political objectives.

Technological advancements after the Second World War led to the introduction of planes with higher speeds, extended flying range, increased ability to cope with adverse weather, enhanced efficiency of navigation, better air traffic control and improved airport facilities and communications (Button, 2008b). The Chicago Convention of 1944 laid the foundation for the new international potential of civil aviation and the institutional structure for having more than 10,000 bilateral air service agreements between nations. Focusing on the grant of rights, capacity clause, tariff approval, withholding, designation, statistics and cooperative arrangements, this effort resulted in better protectionism maintenance between nations, sharing of revenue and variation in fares (Oum et al., 2010).

In 1950, the computerised reservation system (CRS) was developed in the US and implemented in 1962 to support reservation agents in managing the distribution process (Belobaba et al., 2016). After that, in late 1978, the US broke their regulatory structure by initiating deregulation of airlines across the world to reduce government involvement in airlines' economic regulations. In 1979, the US enacted the International Air Transportation Competition Act to promote liberalised bilateral agreements between nations, leading to the first successful Open Skies agreement between the Netherlands and the US in 1992. By 2008, the country had signed Open Skies agreements in six continents and with a total of 94 countries (Oum et al., 2010). From 1988 to 1997, the European Union (EU) implemented three air transport liberalisation packages, and by 2007, recognising the EU as a common market, 66 countries allowed air carriers for flight operations between Europe and these countries (Oum et al., 2010). These deregulations resulted in a higher growth rate, and even the fares decreased. US airline fares in 2013 were 40% below the prices of airlines in 1978. Due to market competition and the need to cut costs, many airlines saw a rise in profit volatility, bankruptcies of airlines, job losses and mergers (Belobaba et al., 2016).

In 1990, international air transport liberalisation took place to support airlines' growth in an unconstrained environment. This led to growth in annual passengers by 46%, i.e. from 1.457 billion to 2.1 billion passengers per year in 2007 (Oum et al., 2010). These reforms, though, predict a rise in the performance of airlines by increasing the number of passengers from 2.7 billion in 2010 to 5.9 billion in 2030, with the number of jobs increasing from 8.36 million to 12.1 million. However, the constraints of infrastructure, lack of runways, lack of trained workers and increased emissions have degraded the efficiency of airlines. Thus, reforms were undertaken to create a sustainable civil aviation industry by improving air navigation systems and training, increasing airports' capacities and improving fuel efficiency (ATAG, 2018; ILO, 2013).

Technology has also improved by enabling frictionless travel with biometrics and humanising the experience through artificial intelligence, robotic revolution and automation. Seamless data sharing via blockchain, travelling in augmented or virtual reality and passenger experience and the internet of things (WNS, 2018).

2.7 Aspects Influencing the Efficiency and Productivity of Airlines

The airline industry contributes to economic development in many ways. It helps increase economic cooperation and globalisation, international movements of goods or services and job opportunities. As a result, there is a requirement to oversee the operation of this industry. Thus, the efficiency of the aviation sector is critical to the growth of the economy (Ahmad & Khan, 2011). In the airline industry, productivity is encouraged through privatisation and deregulation, wherein private ownership and high-standard operations are promoted. Deregulation has resulted in regulation and proper management accountability for protecting the lives and interests of passengers (Ejem et al., 2017).

The airline industry is recognised as a resource-intensive industry despite having a long capital-investment gestation period. There is a need for continuous upgradation of facilities and equipment with technological advancements. Because the resources used in the airline industry's production process are expensive, there is a need to use them effectively. The resource-based model tends to identify all the internal resources of airlines, i.e. physical, intangible or human resources (HR), such as type of employment, size, aircraft fleet composition or establishment reputation, which tend to affect the functioning of the airline industry (Low & Lee, 2014). Although the highly regulated environment enhanced profitability by effectively utilising strategic resources and pursuing an efficiency-orientated strategy, a sustainable competitive advantage could not be derived (Mattos & Fregnani, 2016). With deregulation, efficient management practices were promoted, productivity improved and higher-quality services were provided to customers. The emphasis shifted towards flight frequency, in-flight services and geographical coverage. Even aspects such as on-time performance, fuel prices, employee salaries, passenger load factor and maintenance cost per flight hour tend to directly affect the productivity and efficiency of industries and influence their profitability (Parast & Fini, 2010).

The aviation industry has become very resource- and infrastructure-efficient as a result of its reliance on technology and pursuit of sustainability. The fuel costs, labour costs, the expansion of the market and the production aspects tend to affect airlines' efficiency. Lately, airlines are shifting towards becoming more fuel-efficient and thereby reinforcing improvements in productivity by reducing associated costs and expanding the market (ATAG, 2008).

BMs, liberalisation policies, ownership and control, airline cooperation and airline size could all be used to boost productivity and efficiency. Variables such as ground crew, flight attendants, employees, number of passengers, revenue passenger miles (RPM), revenue tonne-mile, available seat mile, average flight length and average load factor tend to measure the productivity of airlines (Muthusamy & Kalpana, 2018). An increase in prices and the introduction of legislative restrictions on managing greenhouse gases (GHGs) has led to the need for a source that would improve environmental and operational efficiency and harness the benefits of these efficiencies (Beck et al., 2011).

Organisations are influenced not only by internal factors but also by external factors that have a broader and interorganisational impact. For example, the airline industry, with its international connectivity, is influenced by air passenger demand, income per capita, production index, inflation rate, exchange rate, environmental awareness, terrorism threat, foreign competition, global pandemics or fluctuating oil prices. Another aspect that can influence airline performance and directly affect its efficiency is the environment in which it operates. The institutional and regulatory constraints implemented in different countries differ depending on the region or continent. Therefore, institutions that oversee the context of operation and the type of regulation are essential aspects of airline performance; incorporating the institutional theory within our study can provide us with a much wider lens on how firms manage the consequences of external and internal pressures (North, 1991; Peng et al*.,* 2008; Secilmis & Koc, 2016; Wan & Hoskisson, 2003; Zhu et al*.,* 2019). To that extent, to understand the role of airlines in economic prosperity, the industry focus on superior maintenance of their productivity and efficiency by working on the perspectives of industry, resource-based and institutional factors in order to build a better connection between firms' performance and the environments they operate in.

2.8 Aviation and Economic Activity

The aviation industry has surely transformed, with a significant improvement in the industry's operational, technical and management capabilities. In 2019 alone, airlines around the globe transported more than 4.54 billion passengers through their global network (ICAO, 2020). This increase is more than double the number of passengers carried in the year 2005. With the increased activities in the global arena, we witness an interactive and closely knotted relationship between both air transport and economic activity.

Looking at previous annals and today's statistics, we see a huge transformation in the number of passengers carried and the amount of freight transported worldwide. At the same time, we witness the global GDP triple from 12 to 36 trillion US dollars (World Bank, 2008). As the use of air transportation keeps rising, we detect a more cemented role in the global economy. In 2004, 40% of international tourists travelled by air, and 40% of interregional commodities were airlifted (ATAG, 2005). For perishable products and time-sensitive individuals, air transportation is the only feasible long-distance mode of transport. It is often the only channel of access to many physically isolated areas.

Air transportation facilitates access to markets, people, money, knowledge, opportunity and resources. As a result, the availability of air transportation broadens the geographic scope and duration of economic activity. Several mechanisms exist to control the relationship depending on the combination of various economic and air transportation structures. The nature of air transportation flows differs in each economy as a result of these distinct features. In certain countries, international visitors account for the bulk of passengers, while in others, domestic traffic predominates. Domestic traffic patterns inside the US, for example, account for 90% of all US passengers, while almost 90% of Ireland's passengers travel internationally (Williams, 2002). The examination of the broader effect on economies and the additional direct connection between them is probably still in its infancy within academic research (Duval, 2013). Furthermore, the connections between the external environment and other principles influencing aviation performance, such as international law, new industrial economies and international commerce, are often missing in studies trying to understand the relationship between economic activities and air transport performance.

Governments may put regulatory limits on access, climate policies, immigration restrictions or economic changes to provide air transport with a greater chance of reducing uncertainty and future crises. Contextual differences become more obvious when one attempts to adapt concepts and findings from one country to another. Collaboration and diversity have also sparked the interest of academics (e.g. Hitt et al., 1997; Tallman & Li, 1996). Despite its significance, this area of research has focused its theoretical and empirical attention on a few industrialised regions, notably the US, Japan and Europe. It has seldom examined businesses in other less developed regions (Tallman & Shenkar, 1990). Additional research is required to establish whether different regulatory setups may benefit businesses operating in different national contexts.

What is lacking here is studies on what relationships exist between companies' diversification strategies and their financial success from an institutional economics philosophy as a starting point (e.g. Clague, 1997; North, 1990; Wan & Hoskisson, 2003). Previous theories of cooperative diversification have explicitly recognised the importance of the home country's environment and that their levels of environmental stewardship vary (Bennett et al., 2018; Castrogiovanni, 1991; Dess & Beard, 1984; Tang & Buckley, 2020)). Perhaps the emphasis is to highlight the significance of the home country environment by expanding our knowledge of cooperative diversification by clarifying the performance implications of product and international diversification strategies via the lens of institutional economies (North, 1990). Also, focusing our study on a global sample makes it credible to achieve better results in a more universal and diverse model. This will surely enhance our results and provide a better understanding of how to research in a diverse global environment.

2.9 Efficiency Measurement Concepts

The capacity of an entity to maximise output production while reducing input utilised for that specific production is described by the term's efficiency or productivity, which are often used interchangeably. Meanwhile, total factor productivity (TFP) assesses an entity's productive efficiency by calculating the aggregate output generated by the unit of aggregate input (Saini, 2018). Within the parametric approach, estimation of production frontiers has taken two general paths: (1) deterministic frontiers, which force all observations to be on or below the frontier, and any deviation from the frontier is attributed to inefficiency; and (2) stochastic frontiers, which decompose a deviation from the frontier into a random component reflecting measurement error and statistical noise, including a component reflecting inefficiency. Hence, productivity and efficiency are concerned with the number of input units required to generate a certain number of outputs.

Furthermore, these measures of efficiency are not the same as profitability (or other financial performance indicators). Profitability is defined as a company's capacity to earn profits in proportion to its costs. Therefore, it is impacted by the prices of its goods and the prices of the inputs used in production. The air transport industry has always been regarded as a transportation medium whose functioning is influenced by political, economic and cultural aspects (Kazemi & Bagherieh-mashhadi, 2014). Thus, in air transport, efficiency is described as the relative ability of the individual airline to maximise their performance and minimise resource consumption (Saini, 2018). Indeed, the growth in air transport, technological advancement, aviation deregulation and substantial investments have led to rapid growth and a very complex industry (Coli et al., 2011). With a global operation, differences exist in production factors, costs, sensitivities to political and economic developments and multilateral cooperation between countries and companies from different parts of the world. Thus, all these variations pile up to intensify the competition among airlines, leading to a more complex and efficient operation. Moreover, maximising the efficiencies improves competition and derives acceptable returns for their investments. Airlines worldwide have consolidated their activities, reduced costs and modernised their fleet to have more efficient fuel consumption and an extended range (Ahmad & Khan, 2011).

In the past, the methodology to determine airline efficiency used the single output and input method. These partial measures could not adequately compute the overall productivity of airlines. This limitation led to a shift in measuring efficiency, where multiple inputs and outputs could be used. Caves et al. (1982) initiated this method to measure the efficiency of US airlines during the 1970s, with many researchers applying the same approach. For example, researchers have used total revenue, revenue per kilometre, average stage length, the number of destinations served, total operational cost, load factor, fuel price, average wage and employee number. A few examples are discussed in the following paragraphs:

Gillen et al. (1987) assessed the efficiency of Canadian airlines using the TFP method, and Oum et al. (2005) focused on 10 key airlines' efficiency in North America in terms of cost competitiveness. They looked at the TFP by inserting multiple inputs, such as fuel cost, labour, aircraft numbers and materials, into a single input index and multiple outputs, such as freight, passenger revenue per kilometre and incidental services, into a single output index.

Nyshadham and Rao (2000), like Caves et al. (1984), examined the major and regional US carriers from 1970 to 1981 by considering different cost components concerning airline network operations. Although the primary TFP measure was a significant breakthrough in measuring efficiency, especially when considering multiple inputs and outputs, more innovative and practical models were still developing that could capture the efficiency frontier more precisely. The result was the introduction of a non-parametric approach methodology such as DEA, which enabled the assessment of decision-making units (DMUs) using multiple inputs and outputs. Hence, DEA become a modern approach for computing the productivity and efficiency of many industries (Duygun et al*.,* 2013). This methodology compares the efficiency of DMUs by contributing to the establishment of best practices and benchmarks for defining the operational efficiency frontier. Earlier studies in airline efficiency analysis using DEA methodology focused on the examination of traditional business operations, wherein the focus was on the conversion of inputs, such as materials, labour or capital, into revenue-generating capabilities of the industry.

For airlines, popular methods include input-orientated models (minimisation of input to achieve a similar level of output), output-orientated models (maximisation of output at a given level of input) and base-orientated models (equal optimisation of output production and input consumption) analysis (Scheraga, 2004a). Since the inception of DEA, a number of different approaches have been created and refined. Over the years, the method has gained popularity and application because it is simple to use, can assess multifactor production efficiencies by integrating a large number of diverse inputs and outputs into a single efficiency score and does not necessitate the use of any statistical processes.

DEA is the only feasible paradigm that connects all of the aspects of efficiency by examining the connection between each input and output to obtain a scalar measure of performance that is comparable across industries (Schefczyk, 1993). An in-depth discussion of the DEA technique is provided in the methodology part of this document. Existing efficiency models are always being improved, and new extensions are constantly being added to the stream of research. See **Appendix 14** for more information on the various types of DEA that have been introduced in the field of efficiency research. According to Simar and Wilson (1998), the DEA methodology has a key flaw in that it does not account for noise or random errors while computing efficiency scores. The bootstrap method, which is used to check the statistical biases of calculations, was their solution to this problem.

2.10 Efficiency Studies in the Airline Industry

DEA research has developed into a powerful quantitative diagnostic tool for measuring and evaluating performance. In **Table 1** we provide an up-to-date survey of the previous DEA research that has been summarised and indexed by different authors in the DEA literature.

Table 1 Data envelopment analysis (DEA) research citation-based literature review

Authors	Research Title	Research Summary	Journal
Seiford (1997)	A bibliography for DEA 1978–1996	A bibliography of DEA-related literature that serves as a one-stop source, allowing for more advancement in the area.	Annals of Operations Research
Gattoufi et al. (2004)	Epistemology of DEA and comparison with other fields of OR/MS for relevance to applications	The article discusses statistical trends within DEA.	Socio-Economic Planning sciences
Emrouznejada et al. (2008)	Evaluation of research in efficiency and productivity: A survey and analysis of the first 30 years of scholarly literature in DEA	From its beginning until the year 2007, this study presents a comprehensive account of DEA research that includes theoretical breakthroughs and 'real-world' implementations.	Socio-economic planning sciences
Liu et al. (2013)	DEA 1978–2010: A citation-based literature survey	Looks at the latest in DEA research and subareas.	Omega, 2013
Farantos (2015)	The DEA method and the influence of a phenomenon in organisational efficiency: A literature review and data envelopment contrast analysis new application	Gives a survey of the non-parametric linear programming DEA literature.	Journal of Data Envelopment Analysis and Decision Science
Yu (2016)	Airline productivity and efficiency: Concept, measurement and applications	An overview of several approaches for evaluating and comparing airline productivity and efficiency is provided.	Airline Efficiency
Qiang Cui and Ye Li (2017)	Will airline efficiency be affected by carbon-neutral growth from the 2020 strategy? Evidence from 29 international airlines	An excellent and informative literature review.	Journal of Cleaner Production
Kottas and Madas (2018)	Comparative efficiency analysis of major international airlines using DEA: Exploring effects of alliance members and other operational efficiency determinants	Lists very comprehensive details on previous DEA airline research.	Journal of Air Transport Management
Ali et al. (2021)	Four decades of airline productivity and efficiency	The paper provides a bibliometric analysis of airline productivity and	Journal of Air Transport Management

	studies: A review and bibliometric analysis	efficiency studies during the period from 1979 to 2020.	
Emrouznejad et al. (2022)	Data envelopment analysis: Recent developments and challenges.	Provides details of the recent theoretical developments in DEA	The Palgrave Handbook of Operations Research
Moradi-Motlagh and Emrouznejad (2022)	The origins and development of statistical approaches in non-parametric frontier models: A survey of the first two decades of scholarly literature (1998–2020)	The paper surveys the increasing use of statistical approaches in non-parametric efficiency studies	Annals of Operations Research

Here, we focus on a selection of the studies included in **Appendix-14**, Schefczyk (1993) was the first to use DEA to measure airline efficiency; he evaluated 15 large international airlines in 1990. Banker and Johnston (1994) used the DEA input-orientated variable returns to scale to measure and evaluate the effects of operating strategies on efficiency; their sample included 12 US carriers between 1981 and 1985. Utilising the DEA and stochastic frontier model, Good et al. (1995) examined European and US air carriers' post-deregulation, wherein DEA allowed the honest evaluation of efficiencies in these airlines compared with the traditional model-based assessment using the stochastic frontier approach.

Sengupta (1999) also used the DEA method to examine various airlines' performances by assessing the efficiency of their total operating costs, total non-flight assets and aircraft capacity consumption. Greer (2006) examined 14 US passenger airline efficiencies using the DEA method in 2004 by considering labour, fleet seating capacity and aircraft fuel consumption as inputs and available seat per kilometre (ASK) as an output. The analysis revealed that discount carriers are technically more efficient than legacy carriers. Thus, the production cost advantage borne by discount carriers is due to this superior technical efficiency.

Lin (2008) used personnel cost, aircraft cost and fuel cost as input variables; seat mile and flight number as production variables; and embarkation passengers and passenger mile as service variables and assessed the efficiency of airlines using DEA. Barros and Peypoch (2009) used two-stage DEA to get a better look at operational performance. They used revenue per passenger and

EBIT as outputs; employees, planes and operational costs as inputs; and trend, population, alliance and low cost as the second stage variables.

Barros et al. (2013) assessed the efficiency of US airlines using total cost, the number of gallons and the number of employees as input variables and RPM, passenger load factor and total revenue as output variables. Herein, by removing the complexities associated with the aggregation of inputs and outputs, DEA enhances the effectiveness of measuring the productivity and efficiency of airlines.

Parast and Fini (2010) further examined US airline industry performance for the period 1989 to 2008, wherein labour productivity, on-time performance, fuel price, employee salary, passenger load factor and maintenance cost per flight hour affected the profitability of airlines. Employee salary and labour productivity had a positive impact on profitability, whereas average annual maintenance cost and fuel price had a negative impact on airline performance. Merkert and Hensher (2011) focused on examining the efficiency of 58 passenger airlines using a two-stage DEA for the fiscal years of 2007/2008 and 2008/2009. Herein, first- and second-stage DEA consisted of labour, available tonne-kilometres (ATK), full-time equivalent prices and ATK prices as inputs, while RTK and revenue per passenger kilometre (RPK) were the outputs for the model. Further, partially bootstrapped random-effects Tobit regression analysis was performed by considering airline size, stage length, aircraft size, fleet age, aircraft manufacturers and aircraft families as the explanatory variables. The analysis revealed that airline size, aircraft size, stage length and fleet size tended to have a positive and significant influence on the technical efficiency of airlines.

Rai (2013), for the period 1985 to 1995, measured the efficiency of US airlines using DEA. The number of employees, gallons of fuel and planes were considered inputs. In contrast, the number of departures, RPM, available tonne-miles and the number of passengers were regarded as outputs. When an efficient portfolio was compared to an inefficient one, efficient airlines outperformed inefficient ones by 23% annually.

Lee and Worthington (2014) assessed the efficiency of the US and European airline industries from 2001 to 2005 by considering total assets, the number of employees and kilometres flown as inputs, while considering ATK as an output. Further, regression analysis was performed by using variables, i.e. ownership, departures, LCCs and weight load factor as independent variables. The analysis revealed significance with 2,000 iterations, ownership, LCCs and load factor positively influencing airline efficiency.

Jain and Natarajan (2015) focused on assessing Indian airlines' technical and scale efficiency from 2006 to 2010 with total ATK and operating cost as inputs and non-passenger revenue and RPK as outputs against the airline type, size and ownership structures. The analysis revealed that most budget airlines and small private-sector airlines were efficient, and the variables of size, ownership and service type had a significant influence on airline efficiency. Pinho (2017) determined the efficiency of 137 passenger airlines using the two-stage DEA method by considering the number of aircraft, scheduled ATK and total employees as inputs and scheduled RTK as an output in the first stage. For the second-stage analysis using bootstrapping, the input- and output-based efficiency scores were considered dependent variables. At the same time, the duration of each flight, load factor, scheduled freight and mail tonne-kilometres, ICAO type classification, alliance membership, number of aircraft manufacturers and regional market share were regarded as independent variables. The analysis revealed that load factor and scheduled freight and mail tonne-kilometres positively and significantly influenced input-based efficiency scores. On the other hand, variables such as the load factor and the ICAO type classification made output-based efficiency scores better.

Carlucci et al. (2018) examined the efficiency of 34 Italian airports via DEA for the period 2006 to 2016 by considering labour costs, other expenses and invested capital as inputs and cargo, passenger movements, aeronautical activities, aircraft movements, commercial activities and handling activities as outputs. With the derivation of the efficiency, the impact of LCCs, the number of workload units or size and the percentage of cargo carriers on the overall technical efficiency, pure technical efficiency and scale efficiency were taken into account. The analysis revealed that all the variables were positive and significant; thus, with the rise in size, LCCs and cargo percentage in workload units, the technical efficiency of airlines improved. Kottas and Madas (2018) examined 30 international airlines' efficiency for the period 2012 to 2016 by using the DEA method. Herein, employees, aircraft and operating costs were inputs while RTK and RPK were outputs. The analysis revealed that revenue-based airlines with higher freight traffic were more efficient than airlines with a lower freight traffic share. There was a difference in efficiency based on geographical location, i.e. European and Asian air carriers were more efficient than American air carriers.

Abdullah and Satar (2019) assessed technical efficiency for FSCs and LCCs between 2002 and 2011, taking into account variables such as operating costs, operating revenues (ORs), operating fleets and RPKs. The assessment of the airlines based on efficiency score revealed that FSCs were more technically efficient than LCCs, with generation of high potential output. Further, Xu et al. (2021), in their analysis of 12 US airlines' environmental efficiencies from 2013 to 2016 via DEA, considered employment, fuel consumption and operating expense as inputs, while revenue tonne-mile, flight delay and GHG emissions were outputs. This was followed by a Tobit regression analysis on freight traffic, fleet age, ownership, carrier type and market share as independent variables and environmental efficiency scores as dependent variables. The analysis revealed that all these factors significantly influenced the airlines' performances. More data on DEA studies is summarised in **Appendix 14**.

2.11 Summary of the overall trend of prior airline efficiency Studies.

There is a significant amount of research that focuses on the performance of airlines. In the early days of efficiency research, the primary focus was on efficiency and benchmarking, with DEA scores being the primary measurement tool and performance being evaluated in comparison to peers and slacks. This was gradually improved to include the Malmquist productivity index as a means of measuring the improvement in airline efficiency over time and deriving a number of different components, including technological change, pure efficiency change, and the contribution of each to productivity. In recent years, we witnessed the development of more complex models of the DEA, such as the network DEA, and the analysis of two- or three-stage DEA models. The assumption that the derivation of the efficiency source should include the insertion of an external or environmental variable has also become a highly popular field of research. The most common types of regression analysis used in the second stage are truncated and Tobit regressions.

2.12 National Institutions and Firms Competitive Advantage

The importance of national institutions to a country's competitiveness is increasingly recognised in the literature. Institutional perspectives are assessed at the national and company levels. Aguilera and Grøgaard (2019) say that one of the most important challenges in International Business [IB] is shedding light on the different strands of institutional theory, since each strand defines institutions in a different way and has different degrees of applicability in IB literature. Munir (2019) claims that the institution-based paradigm oversimplifies an extremely complex topic. Another argument is that the rapid expansion of institutional literature has fragmented it. As a result, the term "institution" has become excessively vague (Alvesson & Spicer, 2019).

The formal and informal rules that provide society with order and structure are known as institutions (North, 1990; Scott, 1995). Scott (1995) says that institutions are 'cognitive, normative, and regulatory structures and activities that give social action stability and direction' (p. 33). As a result, they impact individual and organisational performance (DiMaggio & Powell, 1983). North (1990), on the other hand, says that institutions are important because they establish 'the rules of the game in society'. To put it another way, institutions control how people interact with each other and give people and groups reasons to do things.

The role of institutional context is widely scrutinised via the 'three pillars of institutional framework': regulatory, cognitive and normative components in institutional-based theory (Scott, 1995). The firm has power to integrate, build and reconfigure internal and external skills to address dynamically changing surroundings (Teece et al., 1997, p. 516) and to offer a competitive edge in a fast-changing environment (Madhok, 1997; Teece et al., 1997). Evolutionary behaviour in economic has its origins in the evolutionary theory of firms and is based on managers' deficient rationality (e.g. Cyert & March, 1963; Nelson & Winter, 1982). The ability of a firm to acquire, analyse, disseminate, deploy and utilise information is considered a dynamic process (Madhok, 1997).

The industry-based perspective asserts that industry-specific characteristics drive business strategy and performance, whereas the resource-based perception stresses how firm-specific traits influence strategy and competitive advantage. Both theories fall short of the critical influence of institutions on firms' strategic stance (Peng et al*.,* 2008). The underpinning of the perspective that 'institutions matter' has allowed the institution-based approach to grow into a significant theoretical paradigm (Meyer & Peng, 2016).

At various levels of analysis, the institution-based viewpoint draws together numerous distinct lines of research with a shared interest in the interplay of economic players and institutional settings (Ahuja & Yayavaram, 2011; Peng et al*.,* 2008). Both institutional economics (North, 1990) and sociology (Scott, 2013) theories have their disciplinary foundations. Institutions and businesses are lively and tend to change with time. While practically all countries' institutions are evolving, some emerging economies (such as China, Russia and South Africa) are undergoing particularly significant transitions. Peng (2003) define institutional transition as 'fundamental and comprehensive changes made to the official and informal rules of the game that affect organizations as participants' (Peng, 2003, p. 275).

Globally, the rate of institutional reform varies. In certain countries, institutional shifts occur quickly – consider the 'shock therapy' in post-1989 central and eastern Europe. Other countries' institutional changes are more gradual, as seen by China's consistent reforms. The danger of a fast-changing institution is certainly a disrupted system. Large corporate companies that value regularity and relationship-building may find it challenging to manage such uncertainty (Lee et al*.,* 2008; Siegel, 2007). On the other hand, small changes can help maintain long-term relationships and trust, which can help businesses do well (Banalieva et al., 2015; Luo & Chung, 2005).

2.13 Theoretical Perspective on Country Attractiveness

A country's environment has been demonstrated to be a critical contextual component in explaining the relationship between firm-specific resources and performance, particularly in emerging economies and, more broadly, in the international arena (e.g. Hoskisson et al*.,* 2013; Kafouros & Aliyev, 2016; Kim et al*.,* 2015; Meyer et al*.,* 2009). Intellectual capital studies may pay insufficient attention to the country's environment (Barney, 1991; Penrose, 1995; Priem & Butler, 2001; Kim & Hoskisson, 2015).

A country's environment has been conceptualised as having two primary dimensions – available resources and institutions (Miller, 1996; Wan, 2005; Wan & Hoskisson, 2003) – and can be defined in two ways. The signalling theory explains how economic factors influencing a country's attractiveness can inspire international investment (Spence, 1978). The second is soft power, which influences intangible (i.e. social and environmental) components of a country's attractiveness to international tourism and migration (Nye, 2003).

Lee et al*.* (2008) identified and classified a wide range of destination attributes used in previous research on destination attractiveness as follows: tourist attractions (e.g. natural endowments, cultural and historical assets and artificial resources), support for tourism infrastructure (e.g., accommodation and food), accessibility (travel distance and cost) and ancillary services and facilities (e.g. safety, security and information). As a result, it is plausible to suppose that the determinants of destination appeal are a conglomeration of tourist attractions, infrastructure and services provided by both commercial and governmental entities (Buhalis, 2000; Cracolici & Nijkamp, 2009).

Furthermore, destination authorities and managers must integrate various tourist attractions, infrastructures and services in order to develop and promote specific types of tourist products and experiences (for example, wellness tourism and business tourism), which are the primary reasons for visiting the destination (Buhalis, 2000). The location must attract and gratify tourists from other regions as a prerequisite for being an appealing and competitive destination in the defined tourism goods and markets (Enright & Newton, 2004). The variations in the availability and quality of elements, together with different institutional structures, provide opportunities or constrain firm activities. At the same time, the institutional framework around resources and resource strategies can either stimulate or inhibit their successful utilisation (Oliver, 1997).

The institutional environment includes legal and political structures as well as ideology and culture (Kaufmann et al*.,* 2018). Furthermore, institutions influence a firm's capacity to fully exploit a resource and capture the income generated by it (Kafouros & Aliyev, 2016; Peng et al., 2009). Companies, for example, feel more confident conducting economic activities in countries where the rule of law is well-established since the legal norms are evident to management;

businesses may use legal channels to pursue justice (Elango & Lahiri, 2014). Firms may avoid making new investments in countries where the rule of law is not the norm because they are concerned about the safety of their assets.

2.14 Theoretical Background of the Strategy Tripod Perspective

Explaining performance differences between organisations and determining the source of competitive advantage has always been an important theoretical and empirical topic in strategic management studies (Hawawini et al., 2003; Martin et al., 2014). To explain firm performance, scholars frequently use both the industry- and resource-based approaches. Nonetheless, it is always difficult to express the overall advantage without taking into account the operating environment.

Peng (2002), trying to find an answer to the question 'Why do strategies of enterprises from different countries differ?', analysed various uses of the industry-based view in conjunction with the resource-based view in corporate strategies. His answer was to include the effect of the environment as a third leg of the tripod. This principle led to the formulation of the 'strategy tripod' (Peng, 2002), with the concept's roots in institutional theory and institutional economics (Peng et al*.,* 2009; Peng et al*.,* 2018). Research in the country-specific context may also help to advance the theory. As a result, Peng et al. (2008) assert that institution-based research conducted in developing economies takes an important theoretical path because institutions in developing economies can have a direct impact on firm strategy and performance (Gao et al., 2010). Eventually, the institution-based view and the strategy tripod perspective (STP) originated in the strategic management literature to bridge this divide.

While attempting to introduce the concept, Peng (2002, p. 253) was well aware of the link between the industry-based view and the societies that organisations operate in. An institution-based corporate strategy approach focuses on the dynamic commerce between institutions and associations by considering that institutions examine strategic decisions as a result of such relations. Strategic decisions are impacted not only by the explicit industry-based variables but also by the establishment of resources that classic strategy discourse highlights (Barney, 1991; Barney & Mackey,2016; Porter, 1980).

Meyer and Peng (2005) combined the sedulity-based approach (organisational economics) with the resource-based view to develop the strategy tripod concept. Peng et al. (2008) provided insight on how the strategic tripod perspective may explain corporate strategy and performance in the context of IB. On the other hand, the strategy tripod literature is not entirely cohesive and encompasses a wide range of theoretical and empirical findings. Analysing the institutional environment is crucial in IB because it may help recognise benefits and pitfalls (Hitt et al., 2015). Peng (2002) reveals that when looking at the institutional environment of developing markets, institutions have a different effect on firms than they do on established markets. This is because the efficient institutions that frequently manage developed markets are often weak or non-existent in developing markets. In such an environment, firms operating in developing markets feel driven to change their strategy and take on a variety of jobs and obligations in order to do business and fill these institutional gaps (Khanna & Palepu, 2004). It is critical in developing markets to address instances in which local institutions are simply different or function according to a different logic than in developed markets.

Despite the widespread application of the strategy tripod concept (Calixto et al*.,* 2013), it is still necessary to empirically establish the method of notion and metric operationalisation. This is because, as previously indicated, multiple dimensions are used to measure the same concept, resulting in faults in applying this theoretical underpinning. When we look through the strategy tripod papers, we observe how many measures are utilised to study the same element. This diverse set of metrics emphasises the importance of further examining construct validity in implementing such a strategy in IB studies.

One possible reason might be that the strategy tripod is a relatively new concept. On the other hand, its underpinnings are the resource, industry and institutional views as a theoretical lens, which have been developed over time and solidified by scholars. To this extent, the strategy tripod may be considered immature as a theoretical prospect because the advancements made by the theories that back it does not appear to be utilised in unfolding the tripod in its practical application. This is consistent with Brewer and Hunter's (2006) conclusion that research examining the validity of metrics is rare. This is owing to the complexity of validating the research methodology that can back it up. Most social scientists would rather come up with new ideas and use those than test how precise and accurate their measuring tools are.

2.15 The Strategy Tripod Perspective in the Airline Industry

Historically, the economic growth of cities has been linked to the development of transportation infrastructure that connects them to the rest of the world (for an overview, see Derudder & Witlox, 2016). Investigating airlines' performance on a global level needs to be viewed from a broader perspective. Peng et al.'s (2008) strategy tripod provides an excellent basis for understanding complicated issues in a diverse environment (Su et al., 2016). In addition, the majority of international strategy and operational research is primarily concerned with the context in a developed market (Maclennan & Oliva 2016). People often miss the opportunity to look at internationalisation from a broader perspective.

Scanning the literature, we can note that the strategy tripod is used to investigate the internationalisation of services (Krull et al., 2012), knowledge production capacities (Su et al., 2016), export conduct (Gao et al*.,* 2010) and strategic positioning (Ju et al., 2014). Using the strategy tripod to investigate such complicated concepts can bring a wealth of knowledge to incredibly challenging industries, particularly in performance assessment and, more specifically, in complicated disciplines, such as the aviation sector.

The literature will help us formulate a clear goal as to which variables most affect airline performance, whether these variables are related to a specific area of investigation that relates to an industry, resource or institution, or a combination of the three. Unfortunately, the literature is inconsistent with airline performance assessment and is often limited. One of the principal reasons for this is that most of the IB studies originate in the US, where resource- and industry-based views are measured with little or no consideration for the institutional consequences, as they operate in a similar environment (see Mahoney, 2005: P. 223). With this in mind, Peng et al.'s (2008) theory provides an attractive solution to the problem at hand. Utilising their strategy tripod perception to determine the possible sources of efficiency and productivity will surely enhance our understanding of the possible link between the two.

According to Maclennan and Oliva (2016), the strategy tripod is considered a relatively young proposition, lacking unified measurements, and uses disparate measures to analyse comparable variables. However, we believe that such a theory will shed light on a highly complex industry and aid in evaluating performance in a diverse and unique environment. The strategy tripod perception allows us to expand on our research issues via the three lenses of industry-, resource- and institutional-based views to comprehend a strategic mindset that can freely investigate the phenomenon. Multiple approaches are required to properly grasp these sensitive settings (Kellert et al., 2006). It is critical to include both external and internal perspectives to measure performance (Bailey & Richardson, 2010). Careful integration of the three perspectives into our airline performance evaluation will provide extensive and immense knowledge of how each perception relates to performance (He et al., 2022).

2.16 Chapter Conclusion

The primary goal of this chapter is to provide some background on the early history of the aviation industry, a summary of notable historical events that have had a significant influence on the development of this industry. While working in a global setting, we examined numerous efficiency strategies as well as the importance of institutions. The strategy tripod was introduced, as was the benefit of employing such a strategy in developing our airline's efficiency determinants. The development of the hypothesis will be examined in more depth in the next chapter.

Chapter 3 Hypothesis Development

Operational research has always considered the context of the operation an important element when investigating a global phenomenon. The way institutions and regulations are established may have a significant impact on a country's economy. When public policy is changed or modified, the ramifications for institutions and rules are often obvious. This is also true in the aviation industry, where it exerts a large influence.

3.1 Institutional Quality and Airline Performance

The institutional perspective on strategy views strategic decisions as the outcome of interactions between organisations and their formal and informal institutional environments (Peng, 2002). The term 'institution' has many meanings, each with distinct features (see, for example, DiMaggio & Powell, 1983; Dunning & Lundan, 2008; North, 1990; Oliver, 1991; Peng et al., 2009), within the justification and expectations of the institution (Garcés -Ayerbe et al., 2012). It has been suggested that performance management is critical to companies operating in unpredictable environments since it provides them with clear goal formulation, operationalisation and plan execution, as well as possible corrective measures (De Waal, 2013).

Nevertheless, in an environment where institutional settings vary from nation to nation, it is crucial to evaluate the impact of these institutional settings on firm performance. The absence of clear evidence on how institutions affect the performance of airlines gives us a clear motive to chase in understanding the possible stimuli of these settings on airline performance. Typically, governments want to control and guard specific institutional settings to protect their home nation's airlines, national sovereignty and security. In particular, airlines are influenced by such institutional forces, as they operate in an international setting, exposing them to any changes in the institutional forces imposed upon them.

Nye (2021) has presented a similar philosophy of economic power in which political and economic stimulus are on top with an additional domain that he terms 'soft power', which is the capability of a country to influence without the use of power or economic motivations. The challenge is recognising what makes your country more attractive to the general public or foreign investors.

The overall country's image and attractiveness must be on the priority list for policymakers and authorities. Easing and facilitating various institutional constraints will help to encourage customers, vacationers and corporations to visit and do business in your country (Kotler & Gertner, 2002). Destination attractiveness is vital in order to succeed. Making your country more attractive and more pleasing can make a difference in how the world perceives it. There is a strong need for specific standards among countries to better judge each other in a globalised world.

To that extent, pursuing a better society has resulted in various complex indicators of progress, ranging from total GDP to indices such as the happiness index. These indices often include social, cultural, psychological and political foundations. They are seen as critical for measuring a country's degree of development and the effect of policy, particularly in the public sector (see the book by Anheier et al., 2018). Overall, they are composed of numerical measures that characterise the well-being of both individuals and society as a whole. In times of global uncertainty and continually rising dependence, there is a need for third-party indices to better assess a country's operational, social and risk performance. In this respect, using indicators as a method for assessing a country's reaction to a set of risks affecting its development is essential. Institutions worldwide develop and evolve with time. Maintaining an up-to-date indicator that can reflect and measure institutional reforms in countries is essential for IB and researchers.

Many multinational corporations use global indices to make strategic decisions, such as boosting investment inflows or decreasing involvement in a specific industry. The use of indices is, however, not without criticism. Razavi et al. (2020) claim that the ranking method is problematic because ranking nations based on weighted scores across variables evaluated differently and not directly compared with one another is questionable. Classifying nations based on their stage of development and weighting the variables allows for a more dynamic examination of the data since it is possible to see how, as an economy grows, the requirements of its businesses change as it pursues a competitive advantage. However, it may be claimed that bias is created by applying different weights to various nations, which affects the comparability of the final scores and rankings (Gregior & Laurel, 2003, as cited in Sabadie & Johansen, 2010). People have always said that politicians who make decisions based on data from different types of indices are 'ruling by numbers' (Grek, 2009, p. 23).

3.1.1 Destination Attractiveness

Destination attractiveness is an important contributor to the leisure travel industry. Tourism and aviation seem to be interconnected (Forsyth, 2006). Furthermore, this connection has become sturdier since the deregulation of the air transport industry. The Travel and Tourism Competitiveness Index [TTCI] is a global assessment of a country's performance. In this context, competitiveness is measured by creating an index that tracks travel and tourism across many countries. This index is composed of 90 distinct indicators organised into 14 pillars, from which an average index is produced (TTCI, 2019), this average index is used in this research.

Tourism and aviation have undeniably strong reciprocal and synergistic connections (Beiger & Wittmer, 2006; Debbage, 1991; Forsyth, 2006; Forsyth, 2016). While air travel is a significant factor in global and regional passenger flows, it is still a relatively unexplored area of study within tourism geography. Peeters and Landré, (2012) even refer to a significant gap in this area. While the business- and economics-based research on the global aviation segment is abundant, most of it is likely not well-represented in the tourism literature (see, for example, Papatheodorou, 2002; Warnock-Smith & O'Connell 2011). Tourism and air transport scholarship is based on interdisciplinary concepts informed by geography, economics, marketing and management. Therefore, there are many possibilities for academic cross-fertilisation. Commercial aviation works under a complex and opaque regulatory framework that constrains and liberates contemporary international commercial aviation.

Whereas Debbage and AlKabbi (2016) rightly claim that the economics of airline operations have influenced tourist demand in many ways, an airline's entry into the market is controlled by economic regulation rooted in international laws and institutions. The majority of governments see the cross-border movement of people as a double-edged sword. On the one hand, they applaud the economic advantages associated with movements such as tourism, commerce and foreign capital investment, even though in a globalised setting, not all of these economic movements benefit all nations equally (Kemeny, 2011). On the other hand, they are anxious about individual cross-border movements for security concerns and the possibility that tourists may become illegal immigrants. Globalisation may have diminished nation-states' capacities to enforce their right to mobility control, but it has not abolished their authority to do so. In contemporary social life, globalisation is defined as the 'widening, deepening, and accelerating of international connectivity' (Held et al., 2000 p. 2).

Numerous analysts believe tourism to be one of the world's primary economic drivers. It provides job opportunities, attracts foreign currency and strengthens infrastructure (see, for example, Algieri et al., 2018; Jarvis et al., 2016; Nazmfar, 2012). Consequently, tourism is one of the most lucrative businesses, generating the highest revenue with the lowest investment and creating the least pollution (Nazmfar, 2017). According to Othman & Rosli (2011), tourism produces more revenue than oil. In addition to creating 266 million jobs each year, tourism contributes 9.5% of the world's GDP (WTTC, 2020). Data from the United Nations World Tourism Organization (UNWTO) shows that over 1.1 billion tourists travelled in 2014, an increase of 5% over 2013.

Tourism is considered the primary source of a country's economic development since it helps facilitate the use of resources, attracts foreign currency, creates employment opportunities, develops infrastructure and improves technology (Gorcia et al., 2015; Hingtgen et al., 2015; Ignative, 2015; Ridderstaat et al., 2014). Aviation and tourism have been properly identified as the catalysts for tourism's meteoric rise to the world's biggest industry (Abeyratne, 1999). Constraints such as cultural differences, perceptions of safety, visa and passport processes, and limitations on the movement of people are only some of the obstacles that influence international tourism (Prideaux, 2005; Timothy, 2002). Travel and tourism are hindered by borders, which denote the boundaries of sovereignty that restrict movement (Timothy, 2001). It is inevitable that borders will be politicised and that tourism will be bound up in extremely sensitive regulations that will limit access and hinder tourist flows (Sofeild, 2006). Although physical barriers may be lowered or eliminated, the presence of political borders creates a perception of distance to specific locations that is usually far greater than the actual distance (Timothy & Teye, 2004).

Certain tourist destinations face several difficulties. The most apparent is the need to stay current with changes in airline operations, including alterations in external operating environments that may affect profitable airlines. Without a good knowledge of air transport, accurate planning is impossible. Second, tourist destinations must choose how they influence the current commercial aviation operating environment. Third, tourist destinations should examine quantitative measures of much of commercial aviation's economic value. This would naturally extend beyond tourism to include a broader mobility strategy, which should be helpful given the strong connection between the performance of the tourist industry and the route of wider economic growth. Therefore, we hypothesise that:

H1: Measured by the TTCI, the more attractive a country is, the more efficient the airline operating in that country is.

3.1.2 Trade Openness

Trade openness is measured as the sum of a country's exports and imports as a share of that country's GDP (in %). The World Bank's Trade Openness Index indicates economic regulations that either limit or encourage trade between nations. For example, if a nation imposes high trade tariffs, it restricts the flow of goods between it and other countries. Trade openness is the total of imports and exports normalised by GDP.

Over the past four decades, international commerce has been a significant engine of global development and wealth. When a country's exports grow, national profits grow, and its national revenue increases. However, purposeful commerce cannot be achieved without the nations involved being economically open to the rest of the world. Trade openness fosters trade's ability to increase competitiveness and productivity, thus improving living standards and the sustainability of economic development (Gbosi, 2003). 'Around 250 years ago, the Scottish philosopher David Hume' (see the book by Weeks et al., 2021, p. 47) established the idea that international commerce helps economic development by facilitating the movement of technology, intermediate products and knowledge across countries. Trade liberalisation has long been a substantial cause of productivity in developed nations (Cuadros et al., 2004).

Hoffmann and Kumar (2013) emphasise the importance of international trade in boosting the competitiveness and development of a country. Both authors credit air transport for laying the groundwork for international commerce in the escalating era of globalisation. In many sectors, the efficiency of the just-in-time supply chain is seen as a significant competitive advantage (see Porter, 1990).

Thompson and Thompson (1994) discussed the critical problems connecting economic growth and transportation, which they assert are inextricably linked. Irwin and Kasarda (1991) studied the relationship between the structure of an airline network and employment growth in 104 metropolitan economies in the United States. They concluded that airline networks were critical in transforming and integrating the spatial economy of the United States.

Kulendran and Wilson (2000) examined Australia's connections with four nations using the co-integration and Granger causality methods. They recommended that more studies be conducted after concluding that such a connection did exist. Chang and Chang (2009) investigated a causal connection between the development of air freight transportation and Taiwan's economic growth. Their findings indicated bidirectional causation between these factors, suggesting that increased air freight transportation contributed significantly to Taiwan's economic development.

Brindis et al. (2015) scrutinised the long-run relationship between airport passenger movement and economic growth in Chile. They concluded that there is a long-term relationship between airport passenger movement and economic growth, in addition to their positive bidirectional Granger causality in Chile. In general, the new data in the literature suggests that open economies may sustain more significant levels of production and wealth. However, one must keep in mind that not all trade liberalisations result in growth.

According to some studies, the advantages of trade liberalisation are conditional. Others argue that low-income nations have reaped minimal benefits from trade liberalisation. As suggested by Winters and Masters (2013), liberalisation cannot be seen as a theory to be investigated but rather as a policy to be implemented by the appropriate authorities. Earlier research by Wacziarg and Welch (2008) suggest that these studies fail to demonstrate a clear connection between trade and economic growth. Additionally, Cuadros et al. (2004) examined the period from 1990 to 2003 and revealed that growth had no meaningful connection with any trade openness indicator during this period. On the other hand, research undertaken in India, Côte d'Ivoire, and BRICS countries indicate long- and short-term economic growth due to greater trade openness (See, for example, Prabhakar et al., 2015; Keho, 2017; Latif et al., 2018).

In the past two decades, classical ideas related to the importance of trade openness to long-term economic development have received wider recognition. According to David Ricardo's long-standing comparative advantage theory, if specialisation promotes productivity development, the advantages of international trade may be more dynamic than static (as cited in Lucas, 1988). Given that globalisation involves the effective integration of global markets, which requires the movement of huge amounts of goods, services and people across international borders, air transport is becoming one of the world's most important international businesses (Gudmundsson & Oum, 2002). Therefore, we hypothesise that:

H2: The higher a country's Trade Openness Index is, the more efficient the airline operating in that country is.

3.1.3 Visa Regulation and Restrictions

Visa openness ratings are generated from Arton Capital's mobility scores [MS], a global ranking of the world's passports, and are updated on a regular basis when new visa exemptions are enacted. The MS number used in this study is the accumulated points for each destination a passport holder can visit without a visa. The higher the number, the greater the degree of international mobility (MS, 2022).

Travel restrictions are not new; in the 17th century, the Danish government implemented a restrictive travel law (Hayton, 2014). During the late 1800s and into early 1900, people did not need a passport or other kind of identification document in order to travel (Keynes, 1920, p. 11). At the same time, the role of migration in economic growth has a long history (Lewis, 1954). It is succinctly summarised in a single observation by Banarjee and Duflo (2011) in their seminal work *Poor Economics*, *A Radical Rethinking of the Way to Fight Global Poverty*: 'Moving can be the first step toward changing a family's trajectory' (p. 419). Limitations on a nation's ability to issue visas impose costs on both the country applying the restrictions and the citizens prevented from obtaining them.

Hu (2013) estimates that establishing the Visa Waiver Program in the US to provide visa waivers to nationals of some countries has saved the government somewhere between 1.9 billion and 3.2 billion dollars in costs. In addition to 6.9 billion to 10 billion dollars in direct spending by foreign tourists each year. Neumayer (2010) and Neumayer (2011) carried out extensive worldwide cross-sectional research showing that visa requirements reduce travel motivation by between 52% and 63%, reducing bilateral trade by approximately 21% and foreign direct investment (FDI) by 32%. According to Lawson and Roychoudhury's (2016) study, an even higher impact of visa restrictions on tourist travel was found, resulting in a 70% drop in tourists' travel.

Globalised business necessitates the need for business travellers to conduct business face-to-face or to have a presence in foreign markets (Hovhannisyan & Keller, 2015; Storper & Venables, 2004) and to understand local knowledge (Gertler, 2003). Restrictions on visas often result in constrained passenger flow. Furthermore, visa restrictions can harm bilateral trade and FDI (Neumayer, 2011). According to Neumayer (2006), visa limitations are used as a blunt weapon to minimise or manage security issues by stopping undesirable individuals from entering the nation. In their study, Aral-Tu et al. (2016) found that visa restrictions have a remarkable impact on the flow of international travellers. Their coefficient estimate suggests that visa requirements reduce the bilateral flow of tourists by 55%, close to the impact that Neumayer (2010) found.

The macroeconomic and non-economic factors of incoming tourism have been the subject of much research in the literature. Conflicts, political instability, security and terrorism, for example, are all cited as possible causes of uncertainty influencing tourism growth (Ghaderi et al., 2017; Saha & Yap, 2014; Saha et al., 2017). Visa facilitation is intended to boost exports and FDI by reducing the costs, inconveniences and uncertainties associated with incoming travel. Yasar et al. (2012) and Karaman (2016) demonstrate that visa waiver programmes in the US promote foreign travel into the implementing country. Whereas Kulendran and Wilson (2000), Tsui and Fung (2016) and Van De Vijver et al. (2014) reveal a causal connection between business travel and bilateral commerce, Song (2012) has identified visa limitations as a significant impediment to tourism.

When South Korea, for example, instituted a ‘Gold Visa’ in 2001, the number of foreign IT researchers allowed to work in the nation increased. This effort has been one of the core elements in South Korea’s leapfrogging of many industrialised countries. An excellent illustration of the economic advantages that labour mobility may provide is the EU’s cross-border immigration policies. Research carried out in Africa by Kennan (2017) estimates that the enormous benefits from open borders for people and unrestricted labour mobility are noteworthy, particularly in less developed countries. According to this study, nations such as Ghana, Nigeria, South Africa and Uganda may all see their GDP rise by a weighted average of 160% due to open borders and the free movement of people.

Research was conducted by Enright and Newton (2005) on destination-competitive visa policies, among other government policies. It is believed that the United Arab Emirates (UAE) and other nations that have opened their countries to visa-free travel will rapidly increase their position in the Henley index (Kirisci, 2005; Satish, 2006). Friendliness between nations is often reciprocated. However, visa-free rights may be withdrawn because of political events. Getting rid of any visa restrictions is simpler if, for example, there are significant levels of tourist, commercial or cultural linkages with nations located nearby (Crotts, 2004). Diplomatic initiatives, such as a country’s participation in and collaboration with multilateral organisations, can advance cross-border integration. According to Rose (2005), visa policies include a variety of aspects, including the criteria for obtaining an entrance visa, the time required to obtain permission for a visa and the length of permitted stay. Davis and Gift’s (2014) analysis of the trade impacts of the Schengen Agreement’s elimination of border controls between Schengen members, using a gravity model (proposed by Tinbergen, 1962), he concluded that labour mobility promotes commerce and generates hundreds of millions of euros for the economy. Czaika and Neumayer’s (2017) research examines the impact of the roles of a visa on cross-border mobility. Due to the dyadic character of many of these variables, the studies confront protentional endogeneity issues in which travel limitations are affected by the degree of bilateral integration. With the above discussion in mind, we hypothesise that:

H3: The higher the Visa Openness Index, the more efficient the airline operating in that country is.

3.1.4 Economic Freedom of a Country

The Fraser Institute, in conjunction with the Cato Institute, releases the Economic Freedom Index (EFI) and the Economic Freedom of the World (EFW) to examine the effect of immigration on institutions (Gwartney et al., 2010). The EFW index has been widely utilised in the scholarly literature to conduct rigorous research on various topics (Hall & Lawson, 2014) and has been found to have a strong correlation with economic growth (De Hann et al., 2006). The EFW index comprises several components: government size, sound money, international trade freedom and regulation. Each area combines several measures into scores, with 10 indicating the greatest possible degree of economic freedom (Beach & Miles, 2006).

Our capacity to utilise air travel as a competitive advantage in a global economy should be a key criterion for determining the viability of our air transportation system. The world's capacity to move goods, services and people to markets wherever they exist should be a primary objective for every country when developing its policies. International air transportation is critical in developing tourism in large nations and in small and remote islands. Air travel is critical to the survival of many of these remote areas that are difficult to reach. Such remote countries and businesses depend on air freight services to provide high-quality services to consumers and efficiently manage production. Nations often want to safeguard their commercial air fleets for national security concerns, but the motive is usually economic protectionism. Bourguignon and Darpeix (2016) found that air travel has a beneficial impact on economic development, either directly or indirectly. Air transport is considered a major source of foreign currency (Van De Vijver, 2014) and contributes to new infrastructure investment. Additionally, air transport stimulates other economic sectors via direct, indirect, induced and catalytic impacts. Air transport contributes to creating job possibilities and income growth (Özcan, 2013) and promotes economies of scale. Thus, enhancing a country's competitiveness is critical in disseminating technical information. On the other hand, a country's economic development may significantly affect air transport improvement. The construction of modern infrastructures, such as airports, increases the potential to promote exports, tourism, business operations and productivity, all of which affect businesses' location and investment choices (Halpem & Bråthen, 2011).

These empirical economic liberty measures integrate many factors into a single index number that can monitor changes in economic freedom over time and compare the economic rights of various nations. EFI and EFW are often mentioned in economics textbooks, with researchers examining the appropriate role of markets and governments in the contemporary economy via the lens of these indices (Boyes & Melvin, 2014; Gwartney & Fike, 2015; Krueger & Anderson 2014; Rittenberg & Tregarthen, 2009). Other textbooks extensively use the indices to evaluate the causes of economic development (Cowen & Tabarrok, 2015; Freigenbaum & Hafer, 2011; Heyne et al., 2006; Miller, 2004). Rating nations on a scale from most to least free, or from least dominating to most dominating, does not indicate that one position (rating) is better than another. Many would claim that involvement beyond the minimum state would result in increased economic efficiency, less inequality, faster development or other desirable characteristics of a decent society. Whether these impressions are accurate is an empirical matter, and the EFW measure should aid those researching these issues. The EFW index may also be a proxy for a nation's institutional and policy environment.

Bauer (1957), De Soto (1989), North (1990), Scully (1988) and Scully (1992) have emphasised the significance of institutions and associated policy factors for many years. Similarly, the new growth theory proposes that good institutions and policies are necessary for economic development (see, for example, Barro, 1996; Barro & Sala-i-Martin, 1995; Knack & Keefer, 1995; Torstensson, 1994). Economic freedom is a distinct realm of human interaction from political and public freedoms. Political rights refer to electing government leaders and resolving political disputes. Fair and competitive political liberty exists when all adult individuals are free to engage in the political process through democratic elections. It is conceivable for a nation to have significant political freedom while still pursuing policies that significantly restrict economic freedom. Economic liberty, without a doubt, is complicated and multifaceted, which complicates quantification. From the start, it was decided that the EFW measure should be based on objective, measurable facts and transparent processes to the maximum extent feasible (Beach & Miles, 2006). Economic independence also improves competitiveness, shock resistance, adaptability (Ali & Crain, 2001; Easton & Walker, 1997) and employment prospects (Goldsmith, 1997).

Economic freedom has a positive short-run effect (Hanson, 2000; Wu & Davis, 1999) in addition to increasing GDP in the long run (Berggren, 2003; Weede & Kämpf, 2002) and improving capital and labour markets (Hackelman, 2000; Pal et al., 2011), the banking sector (Williamson & Mathers, 2011), product markets (Gwartney et al., 1996), investment potential and FDI, as well as business and entrepreneurship (Gwartney et al., 1996; Kutner et al., 2004). Hussain and Haque (2016) looked at the effect of economic freedom on five-year and yearly GDP growth rates and found compelling evidence for a positive correlation between growth rate and the EFI. Hence, we hypothesise that:

H4: The greater the economic freedom of a country, the more efficient the airline operating in that country is.

3.2 The industry-Based View on Specific Airline Variables

Accurate risk and performance assessments are critical to airline management. The cause of performance differences across firms is a critical theoretical and empirical problem in operational research (Hawawini et al., 2003). Several empirical studies have been conducted to investigate the relative importance of various business and industry variables. According to the industrial organisation approach, industry variables are the primary drivers of company performance (Rumelt, 1991) and are significant drivers of company strategy (Peng et al., 2008). Internal and external forces within the organisation all contribute to strategic organisational success. The pressure is often anticipated to originate mainly from the organisation's external environment, which is repeatedly defined as social, legal and cultural factors outside the business environment that impact how managers view the outside world (Menguc et al., 2010). These forces, among others, have a direct impact on how companies manage, control or resist the external burdens that face their organisation (Oliver, 1991).

The way companies respond to external pressure or difficulties differs depending on their individual capacity and competencies. In addition, the reactions to external pressure are determined by other types of induced variables, such as competitive advantage expectations, environmental uncertainty and institutional expectations (Grace-Ayerbe et al., 2012). In our study, we have selected three critical industry-specific variables that directly influence airline performance: cost of jet fuel, competition within the industry and the type of operation (BM). The literature highlights how important these variables are (please see the methodology chapter for a more in-depth look at each variable).

3.2.1 *Effect of Jet Fuel Cost and Hedging Policies*

The variable "Jet fuel cost" represents the average jet fuel cost in US dollars per gallon for each year of the research, as obtained from jet fuel monitor (IATA, 2019). Crude oil is a valuable resource, and its price fluctuation is strongly connected to the stock market, which represents the economic growth environment (see Basher & Sadorsky, 2006; Ding et al., 2017; Huang et al., 2005; Jones & Kaul, 1996; Miller & Ratti, 2009). The impact of crude oil prices on the industry is determined by the degree of reliance on crude oil of that particular industry, as measured by the percentage of oil costs in the overall cost (Phan et al., 2015).

According to Bams et al. (2017), the unpredictability of oil prices is a sector-specific issue critical for oil-related businesses. Peng et al. (2017) echo Bam et al.'s (2017) view and state that oil shocks substantially influence energy-related stock indices and oil-related businesses. Because crude oil is the primary energy source for contemporary modes of transportation, oil consumption is still high. According to Narayan and Sharma (2014), who estimated the crude oil usage intensity of 14 industries using US input–output statistics, the US transportation industry consumes the most. On the other hand, the proportion of crude oil consumed by China's transportation industry in overall crude oil consumption grew from 30.5% in 2000 to 49.6% in 2006 (Ji & Chen, 2006; Zhang et al., 2011).

Many studies examine the relationship between oil prices and the stock market index of firms. The goal of the airline industry is to learn how oil prices vary in relation to airline efficiency and productivity over time and determine if these changes or shocks affect airline performance and profitability. As airlines are heavily reliant on crude oil, volatility in crude oil prices will significantly impact airline performance and development. Hsu (2017) investigates the impact of the West Texas International (WTI) crude oil prices on the stock returns of six US airlines. The findings show that the change in crude oil prices and airline stock returns negatively correlate when the oil price rises and that crude oil price shocks tend to increase airline stock return volatility. According to Loundon (2004), the oil price has a significant adverse impact on the stock price returns of Qantas Airways and Air New Zealand. Rendering to Narandaran et al. (2016), jet fuel prices are adversely associated with the stock prices of Cathay Pacific Airways and China Airlines.

After analysing the impact of WTI crude oil prices on the stock prices of 56 airlines, Kristjanpoller and Concha (2016) noticed that changes in crude oil prices had a favourable effect on the stock prices of the majority of airlines. Their findings provide relevance to the concept of market rigidity, providing more evidence for the assumption that rising oil prices reflect better economic conditions. Airlines, like other transportation firms, consume a large amount of aviation fuel for air transport; thus, fuel cost expenditure plays a significant role in airline cost expenditure. The fuel consumed by various airlines accounts for more than 30% of the overall cost and is higher than all other costs linked to airline expenses (Yun & Yoon, 2019). Bahadra (2009) utilised DEA to look at intertemporal and peer group airline efficiency in the US market. His findings show that airline performance is convergent across time, and fuel cost has a more substantial impact on intertemporal inefficiency than peer group efficiency. As a result, the relevance of oil costs for airlines is confirmed.

Management and operators are continuously looking for ways to reduce fuel costs and occasionally load an aircraft with more fuel than is required for a particular route since fuel may be more expensive at the destination (IATA, 2008). Other essential operational and planning strategies for fuel-saving include steady descent, more extended high-altitude operation and single-engine taxing procedures on the ground. Another option for reducing fuel price variations is to employ fuel hedging. This hazardous strategy can save or increase expenditures depending on the hedge contract and the market price of fuel. The fundamental idea is to buy a contract that locks in a future fuel price, after which the airline will pay that striking price if the price of fuel rises over the spot (current) price. When assessing hedges, airlines usually use one of Four possibilities: forward contracts, options, collars or swaps (Morrell & Swan, 2006). Fuel prices directly impact airline performance and account for a substantial portion of operating costs. Therefore, we hypothesise that:

H5: The higher the cost of jet fuel, the more efficient the airline is.

3.2.2 Competition and Airline Performance

Competition in the airline industry is very challenging to quantify since what really constitutes competition is difficult to describe. Do you define competition on a route level, network, or type of operation? All of this complicates indexing this variable, so, for this research, this variable is kept as simple as feasible and defined as the number of airlines operating in the same country with comparable business models.

The airline industry is categorised as highly competitive, cyclic and as quickly developing innovation. Competition in this industry plays a vital role in shaping the performance of individual airlines. Competition is also known to increase consumers' welfare and lower profit, with an unclear overall effect on other strategic and quality variables (Banker et al., 1998). Mergers, for example, tend to decrease competition in the markets, mainly because the number of players is reduced and market control increases (Kim & Singhal, 1993; Prince & Simon, 2017).

A large stream of literature has scrutinised the effect of competition on airline operations, especially on non-price competition effects. Some studies have found that higher concentrations of airports and routes are associated with lower on-time performance levels (Bendinelli et al., 2016; Rupp et al., 2006). While others have found a contradiction – more routes and airports are associated with higher on-time performance levels (Ater, 2012; Brueckner, 2005). Rupp & Liu (2018) studied the influence of competition on the supply of first- and business-class tickets and the frequency of flights as a proxy of flexibility due to alliances.

Airlines cooperate with other competitors and share facilities and airport operations to reduce overall cost (Richard, 2003). Furthermore, they tend to create their own 'friendly circle' to boost regional markets and increase their network exposure (Gudmundsson & Rhoades, 2001). Mak and Go (1995) found that global competition significantly increased pressure and led to regional market changes; they then examined the function of collaboration as one of the drivers of change that impacted airline performance. Brueckner and Flores-Fillol (2005) proposed an airline schedule competition model that avoided the complexity of the spatial method and found that equilibrium flight frequencies were inefficiently low. Fageda et al. (2019) created a unified methodology to study a continuum of hybrid cooperation agreements in the airline sector, including revenue and cost sharing; they discovered that socially optimum cooperation agreements progressed from the entire alliance in inter hub marketplaces to merger. Ghare-Agahti et al. (2019) investigated airline collaboration using game theory and sustainable development techniques and discovered that airline cooperation might increase performance. The airline business is known to have a powerful rivalry that pushes carriers to continually modernise and innovate.

While innovation has various effects, such as new aircraft technologies and BMs or the implementation of novel yield management practices, one of the most notable outcomes has been the proliferation of sophisticated and complex hybrid agreements among airlines. This tendency has been strengthened by legislative limits on foreign ownership of airlines, which have hampered the creation of comprehensive mergers on an international scale. In reality, airlines affiliated with one of the three major global alliances typically operate on international flights (Oneworld, SkyTeam and Star Alliance). Members of alliances typically cooperate in various ways to maximise revenue synergies, such as code-sharing agreements, mutual recognition of frequent-flyer programmes and a variety of other services to provide a seamless experience for interline passengers (e.g. flight schedule coordination, shared lunge access and gate proximity). A typical code-sharing agreement, for example, permits one carrier to advertise a set number of seats on other carriers under its two-letter designator code.

Finally, hybrid airline cooperation agreements might take the form of joint ventures, which enable partners to share costs on specific routes to some extent (Thomas & Catling, 2014). The airline industry's profit margin has remained narrow despite a substantial rise in air travel demand over the years. Airlines' financial situations are under enormous strain due to high operational leverage and frequent demand interruptions. Pearce (2012) says that even in good years, the return on invested capital stays lower than the cost of capital. This means that the value to shareholders has gone down over time. Hence, we hypothesise that:

H6: In the airline industry, the higher the number of competitors in a country, the more efficient the airlines are.

3.2.3 *Airline Business Model*

The operational model and the type of aircrafts used by an airline characterise its BM. Typically, the distinction between the two is clear. In this research, the variable BM is treated as a "dummy" and 1 represents FSCs.

The term ‘BM’ has been used in the business arena for a long time. However, there is no widely accepted definition, and up to the year 2000, neither practitioners nor researchers were interested in studying the differences across BMs (Casadesus-Masanell & Ricart, 2010). When it comes to management-related literature, the expression BM has become one of the most commonly used phrases (Zott et al., 2011). Researchers have widely accepted the BM concept despite severe criticism of its usefulness and differentiation from the original strategy terms (Doganova & Eyquem-Renault, 2009; Porter, 2011). The BM notion is used to analytically describe and analyse a particular set of firm strategic and structural design parameters at a given point in time by assessing several fundamental components and subdimensions (Mason & Morrison, 2008; Morris et al., 2005; Shafer et al., 2005).

BMs were first used in the world of internet business and gradually spread thanks to other researchers from adjacent management fields; today, the BM is considered essential for the success of any organisation (Magretta, 2002; McGrath, 2010). Among several strategic management theoretical frameworks, Amit and Zott (2001) suggest that the BM idea provides the most acceptable framework for understanding the source of value generation. When a company wants to change its strategic position in the value network, a comprehensive understanding of the BM is helpful (Nenonen & Storbacka, 2010). Chesbrough (2007) points out that a more robust BM is frequently more critical than a superior idea or technology. Even though firms do not explicitly state their BMs, how they do business and offer their goods and services might provide some clues. In addition, how they present themselves strategically provides insight into the overall architecture of their business strategies. A company’s identity is based on strategic positioning statements, such as vision, purpose and values.

Airline BMs describe the logic behind how airlines deliver services to their consumers, as well as the airline network structure, which is a well-established part of airline BMs. FSCs tend to operate on a hub-and-spoke strategy, operating from primary airports and differentiating their service. On the other hand, LCCs operate point-to-point networks and usually use second-tier airports. LCCs also minimise aircraft ground time and costs while maintaining one aircraft type to reduce operational, spare part and training costs. As a result of using a single type of aircraft, they can use their market strength to negotiate better deals with suppliers (Button & Ison, 2008). The two BMs' (LCCs and FSCs) service offerings and cost positions differ and compete mainly within an area of short routes where the two networks intersect.

With the introduction of new BMs and changes to the current ones, the aviation industry is undergoing a revolution (Nair et al., 2011). When discussing airline BM in the literature, Alamdari and Fagan (2005), Francis et al. (2006), Mason and Morrison (2008) and Rhoades (2006) compare the features of LCCs with each other, as well as with the original Southwest model (the airline that pioneered the LCC model), highlighting the distinction between LCCs and network carriers (Franke, 2004). Gillen (2006) carried out extensive research using the product and organisational architecture method regarding airline BMs and network structure. Mason and Morrison (2008) classified and correlated essential aspects of airline BMs. Lohmann and Koo (2013) proposed an airline BM spectrum using a product and organisational architecture-based strategy. Daft and Albers (2015) established a framework for identifying key dimensions and components of airline BMs, which they called the Daft–Albers framework. The framework identifies three components, describing the value generation system of an airline. Meanwhile, the airline business is becoming increasingly competitive due to increased rivalry amongst carriers. Gillen and Gados (2008) and Daft and Albers (2015) found that the lines between airline BMs are becoming less clear and that BMs are changing quickly. Therefore, we hypothesise that:

H7: The LCCs' operational BMs are more efficient than FSCs' BMs.

3.3 Resources and Value Creation in the Airline Industry

The resource-based view differs from the industry-based, as it focuses mainly on explaining superior firm performance based on the available resources (Barney, 2014). This perception is sometimes criticised as focusing only on the competitive advantage obtained from the resources within the firm (Barney & Macky 2016). Industries with such strategic emphasis on excellent and unique resources can create a competitive advantage. Nevertheless, we still observe some organisations with a superior position and resources in desirable industries that are not profitable (Barney, 2014).

It is essential to identify the resources that can make a difference in performance, regardless of the industry. The challenge in the airline industry is the utilisation of the available resources, whether it is the individuals managing the airline or the type of aircraft being flown. Florida (2021) and Marrocu and Paci (2012) indicated that efficiency could be explained through the availability of highly educated and creative people. Moreover, employee education and knowledge are, without doubt, valuable resources from the perspective of performance evaluation. As the airline industry operates very similar aircraft types and conducts its business similarly, having an outstanding resource can make an enormous difference in attaining the competitive advantage a company may desire (Barney, 2014).

With a thorough literature investigation and evidence from several international aviation organisations, such as IATA and ICAO, a number of the most important resources available to airlines are identified. In our research, we considered four resource variables that have been identified as a source of value creation in the airline industry: alliances, HR, ownership and location (air connectivity). Further examination of each identified resource is in the methodology chapter.

3.3.1 Airline Alliances

An airline alliance is a strategic collaboration between two or more airlines. Alliances may provide codeshare agreements and facility sharing between airlines. The dummy variable "member" is set to 1 if the airline is a member of an alliance.

Airlines around the globe have been progressively embracing code-sharing agreements and global alliance partnerships. As a result, we witness an expanding number of airlines entrenched in multilateral 'cooperative' (i.e. cooperative yet competitive) networks that affect their product offerings, price tactics, operating efficiency, market dominance and overall performance. Global airline alliances allow airlines to synchronise their procedures to provide universal capability. Performance is often influenced by alliance network planning and development (Baum et al., 2014). Consumers will benefit from more destinations, lower ticket rates, more frequent departure times, access to more lounges, faster mileage rewards and the accessibility of ticketing packages around the globe (Brueckner & Whalen, 2000). All of this is only possible through airline alliances, as alliances provide several facilities, including sharing the same infrastructure, collaborating on sales and investing in various locations worldwide. Partners in an alliance have specific business intentions (Morrish & Hamilton, 2002), whether it is a resource orientation among other partner airlines (Das & Teng, 2000), novel product development (Deeds & Hill, 1996) or an improved network (Beamish, 1987). Hutt et al. (2000) propose that public relations principles, such as trust, commitment and compatibility, accelerate learning and increase the effectiveness of alliances. Button et al. (1998) noted that airline alliances existed long before the deregulation of the industry in 1978.

One of the main reasons behind the formation of these alliances was to mitigate the very tight and restrictive economic regulations. Alliance formation reduces expenses, increases market network, avoids institutional pressures and reduces economies of scale costs (Button et al., 1998). Oum et al. (2000) echoed Button et al.'s (1998) view, underlining that those alliances offer seamless traffic flow between allies' networks. Dresner et al. (1995) have claimed that earlier studies on alliances revealed very little or no benefits. However, as time elapsed, they witnessed a change in studies, indicating some benefits from joining alliances. According to Seo (2020), each airline alliance has a distinct set of organisational philosophies associated with the alliance's relative competitive advantage. On the other hand, Goh and Uncles (2003) discovered no significant variations in the advantages given by joining global alliances. Min and Joo (2016) looked at the comparative efficiency of global alliances and built DEA measures to evaluate operating efficiency. They observed no increase in airlines' comparative performance, and being part of a smaller alliance had a better impact than being part of a larger one. Seo (2020) conducted a study to determine what values are stressed in the mission statements of global airline alliance associates and if there are any significant dissimilarities between them. His theoretical conclusion revealed the presence of distinct ethics among international airline alliance members that provide a competitive advantage.

With the airline business catering to a worldwide audience, international airlines need to maximise their presence on a global scale. Unfortunately, no single airline, regardless of size or scope, can provide adequate service to locations all over the world. Airlines create and join alliances to compensate for this flaw, strengthening their market presence and network. An airline alliance is a code-sharing arrangement between two or more airlines to offer clients a more extensive range of facilities than they could get by themselves (Brueckner & Whalen, 2000). These agreements are the polar opposite of pre-regulatory periods since airlines now collaborate to access more routes, allowing them to issue tickets for flights operated by others as if they were their own (Park, 1997). While more prominent airlines have deals with regional carriers, the notion of alliances has now extended internationally, with US airlines collaborating with other airlines to create a vast network that spans the world. Star Alliance, SkyTeam and Oneworld are the three largest alliances (Brueckner & Whalen, 2000). Airlines competing on transatlantic routes have benefitted enormously from joining an alliance. Furthermore, airlines have a potential gain once two alliances have at least one airport in common. The number of achievable networks rises exponentially (Gaggero & Bartolini, 2012). Hence, we hypothesise that:

H8: Airlines that are members of global alliances are more efficient than non-member airlines.

3.3.2 *Employment and HR*

When evaluating an airline's efficiency, the workforce size is often taken into account. The straightforward number of the permanent staff is used to represent this variable and obtained directly from the airline annual reports. The deregulation of air transportation in the early 1980s led to intense competition in the airline industry. The poor economic conditions and the difficulties management faced had an unanticipated effect on the labour market for the crew, flight attendants and other airline workers. Incumbents' airlines were forced to negotiate a wage cut with their unionised workers (Capelli, 1984) to reduce operational expenses. In addition to reducing wages, airlines negotiated flexible work plans by recruiting non-union flying staff. No matter what happened, it was hard for legacy carriers to get their labour unions to agree to lower wages. Only after major setbacks such as 9/11 were some carriers able to lower wages to stay in business. In general, wages have slightly decreased due to significant setbacks or financial crises rather than the deregulation effect (Card, 1998; Hirsch & Macpherson, 2000).

The advantage that the LCCs and the new entrants enjoyed over the legacy and large carriers in terms of better employment contracts were compromised by other stipulations by the incumbents, such as the frequent-flyer programme and the overextended network operation (Costa & Almeida, 2018; Levine, 1987; Yu et al., 2016). In the airline business, labour costs account for over 25% of overall airline operating expenses (Tolkin, 2010). The majority of airlines globally, including those in the United States, have historically been subject to high levels of regulation.

ICAO created laws that encompass nearly every element of airline operations, including HR. ICAO regulations, for example, have previously addressed the minimum number of cabin crew in each flight, their training and licencing procedures, their responsibilities and functions on board, and their workloads and schedules (Doganis, 2005). For instance, every state in Europe had a slightly different deregulation effect, as it was gradual, and each had its own government regulatory preferences and shareholder welfare. Asia has much more diverse and weaker labour unions, which are more fragmented and not established enough to have any force on the airline industry (Gittell et al., 2009). Surprisingly, Hunter (2006) claims that unionisation is more significant than expected in the LCC industry, and permanent contracts account for a higher share of employment than contingent contracts.

However, as competition increases, there is some convergence between LCCs and the traditional carriers regarding human expenses. According to Greer's (2009) research, unionisation's influence on airline efficiency is statistically negligible after accounting for the impacts of other anticipated drivers. A general market with a much slower deregulation effect tends to be more profitable than others with a higher impact of deregulation, such as in the US (Herdman, 2007).

While airlines are categorised by a robust old-fashioned relationship because of their high levels of unionisation, progressively, we see a change in the relationship between the airline and the workforce – a more innovative and more liberal kind of approach (Gittell et al., 2009). The size of an airline represents a higher employee count, resulting in an economy of scale and more market power (Assaf, 2011), which leads to improved efficiency. Other researchers, such as Huang et al. (2021), found that workforce size hinders airlines efficiency from a cost perspective. It is vital to recognise the value of employees and HR in the airline industry, as they form a significant part of competitive advantage. It is imperative that governments and industry-specific administration reach a common ground to support the employees and safeguard the overall industry's survival. Sustaining improvements in service quality and gaining better financial performance in airlines will require additional dynamic and continuous restructurings in the labour–airline relationship (Gittell et al., 2004). Therefore, we hypothesise that:

H9: The higher the number of an airline's employees, the more efficient the airline is.

3.3.3 Effect of Ownership

Since the liberalisation of the airline industry, there has been a movement toward airline privatisation. Governments across the world are increasingly eager to convert their legacy carriers into private or public-share enterprises (Carney & Dostaler, 2006). The dummy variable ownership is set to 1 for state owned airlines with shares more than 50%.

Ownership arrangements and government policies may either help form organisational value or barricade its progress (Lawton et al., 2013). Ownership rearrangement through privatisation has various incentives, but the most common is to improve carrier financial performance and operational efficiency (Backx et al., 2002). With this in mind, there must be a complicated connection between ownership configuration and airline performance.

We face many methodological challenges when assessing international airlines' performance, such as data availability and comparability (Oum & Yu, 1995; Schefczyk, 1993). Because of this, it is hard to establish a global popularisation. In certain countries, the privatisation of certain airlines results in a mixed ownership arrangement with public and private shares. This arrangement lacks an explicit policy objective. Whether mixed ownership is meant to be a permanent arrangement or a transitory one, aspects of ownership are discussed in agency and strategic management theories (Beckx et al., 2002). Private airlines are more performance- and efficiency-focused than pure public- or mixed-model airlines, demonstrating that ownership is critical. However, the evidence in this respect is not even.

Chow (2010) and Chen et al. (2017) studied the Chinese aviation sector and found significant differences. Chow (2010) discovered that private and mixed organisations were superior to state-owned firms. At the same time, Chen et al. (2017) found that state ownership and company performance had a U-shaped connection. Duppati et al. (2016) found the opposite, observing that government ownership negatively impacted four out of five situations. Research by Ariff et al. (2009) examined a global sample of telecommunications firms four years before and four years after privatisation and found substantial improvements in economic and production performance.

Although ownership rules and regulations were implemented during the Chicago Convention in 1944, these regulations have proven to be highly resilient throughout the years and continue to be a critical factor in airline operations today. Currently, we observe that most of the change is being driven by airlines' efforts to develop new ways to evade ownership and control regulations to remain competitive. Once these limitations are eased or removed, many cross-border mergers and acquisitions worldwide are possible, which enhances the aviation industry's economic performance.

Ownership may appear to be a straightforward issue, but managing it is difficult; the right to nominate and give an investor control over management is just one of the complications encountered. Flag carriers are identified as having specific ownership and management threshold requirements (Gertler, 1982; Patel, 2008) in order to have international air service agreements (see Duval & Koo, 2012). Many publicly owned and operated national flag carriers have been fully or partially privatised. The motive for ownership restructuring through privatisation is diverse but typically includes enhancing carrier financial performance and operating efficiency (Backx et al., 2002). According to Wang et al. (2018), LCCs and privately held airlines dominate the Indian market, whereas state-owned airlines control the Chinese industry. Whether a firm is privately held or state-owned, the influence of such ownership on airline performance must be investigated. Understanding the link between airline ownership and efficiency is critical for executives and policymakers. to that end, we hypothesis that:

H10: Private airlines are more performance-and efficiency-focused than pure public-or mixed-model airlines are.

3.3.4 Air Connectivity Index

Air connectivity is a metric that reflects a country's level of access to the global air transport network (IATA, 2019), and is based on each country's average global rank. The index provides a measure for air connectivity at the global, regional and country level. Despite the fact that air connectivity generates significant economic benefits and knowledge about how cities are connected, it is not well-documented in the literature. This knowledge-based connectivity report helps the local and national economy by improving competition and enhancing employment and economic growth opportunities.

There are several effective techniques published in the literature to assess air connectivity. The first is the work of Pearce (2007) and the UNCTAD (2007) index, followed by an index produced by the World Bank (see Arvis & Shepherd, 2011). More recently, Cheung et al. (2020) provided a scale for their Global Airport Connectivity Index; by understanding variations in the Global Airport Connectivity Index, it is possible to classify the appropriate forces driving international travellers' movements. The work of Redondi et al. (2021) scanned the literature and provided a detailed examination of different connectivity concepts, from their inceptions through their most recent additions.

According to IATA (2018), a country's ability to reap economic gains from aviation is determined by its degree of connectivity, building competent and well-functioning institutions and implementing policies to foster growth in air connectivity. Governments have a significant contribution to make to improve air connectivity in their respective countries. Asia is the most connected region globally, with a solidly growing domestic and regional market, notably in China, India and Indonesia. The second most connected region is North America, with the US being the most connected country globally. In terms of connectivity growth, both Asia and the Middle East have had the highest growth rates over the five years from 2014 to 2019, followed closely by Europe with a growth rate of 38% (IATA, 2020).

In 2019, the world's most connected nation was the United States. With a strong connection increase of 62% over the previous five years, China comes in second, followed by India and Indonesia. Europe has some of the world's busiest air transportation hubs. However, the region's general development is driven by the rising eastern and central European economies. The European aviation sector faces new difficulties, such as climate change alarms, an uncertain economic future and capacity restrictions (ICAO, 2019). The European aviation sector remains one of the most tightly regulated globally.

The Latin American and Caribbean region's air travel sector has the potential to expand. Regional demand for domestic aviation is strong due to an expanding middle class. Several liberalised cross-border ownership agreements continue to benefit and expand the industry, allowing pan-regional brands to flourish with price reductions throughout the area.

Africa remains the least connected continent. Initiatives to boost connectivity and infrastructure development are happening. Africa has created the Single African Air Transport Market to encourage connectivity. With Single African Air Transport Market, Africa will be able to increase its air connectivity massively (InterVistas/IATA, 2019).

The Middle East's geographic location enables the region to reach the world's population within eight hours of flight time. Airlines in the region have developed a robust long-haul travel market. During the five years from 2014 to 2019, the area's air connectivity grew by 40%, making it the fastest growing region in the world (The Economist Intelligence Unit, 2019).

A country's level of connectedness is affected by its economy, size and population. As a result, larger economies with larger populations will naturally be connected to more destinations and provide more available seats than smaller nations. It appears that Asia's growth rate in air connectivity is similar to Asia's increase in GDP. While connectivity increased beyond the GDP growth in the Middle East and Europe. Hence, we hypothesise that:

H11: The higher the connectivity index of a country, the more efficient the airline operating in that country is.

Chapter 4 RESEARCH METHODOLOGY

4.1 Introduction

Quantitative research designs are generally associated with positivism, especially when used with predetermined and highly structured data collection techniques. Utilising Saunders et al.'s (2015) research philosophy and understanding the nature of our research topic, the geographic scope it covers, deductive method will be utilised. The deductive method often begins with a hypothesis and attempts to assess pre-established generalisations against current notions or practices.

Certainly, the review of the literature demonstrates a wide range of research approaches and procedures. One of the most commonly utilised methods in efficiency research is the DEA, which can be combined with bootstrap procedures (Simar & Wilson, 1998) to avoid any statistical noise and eliminate any errors. In the second stage, we incorporate the STP (Peng et al*.,* 2008) to help us determine the efficiency drivers. Research studies are designed to find answers to a specific question or topic under investigation.

In this chapter, different parameters are considered to conduct the research, including the research approach, research type, research design, data collection, sampling and data analysis to reach evidence-based solutions. The study's overarching goal is to uncover opportunities for improving airlines' efficiency. The methodology of the research began with the selection of 35 different airlines over the period of FY2011–FY2018. Important considerations, such as ethics, reliability and validity, were taken into account while deciding on the method of data collection for the research.

4.2 Research Approach

The research methodology is an essential part of research that includes a systematic plan for gathering, evaluating and analysing the study data (Creswell, 2021). There are three sorts of research approaches: qualitative, quantitative and combined. The appropriate strategy for this study is determined by the nature of the data gathering and research challenges. Data for this study were gathered from airline annual reports as well as global indices, such as the World Bank, Visa Openness, Economic Freedom and the TTCI.

The research design is the process of gathering, analysing, interpreting and reporting data in a research project (Creswell, 2021). Explanatory research is done for two reasons: to test hypotheses and to learn as much as possible about the topic at hand. A consistent research philosophy incorporates methodological selection, plan, data gathering methodology and data analysis approach (Saunders et al., 2007).

4.3 Methods of Efficiency Measure in Airlines

The efficiency and productivity of airlines have remained a subject of great interest for scholars and professionals. Following the deregulation of the aviation industry in 1978, aviation research has expanded to include various methodologies and geographical locations. Researchers from many disciplines continue to be fascinated by this area of research, with many adopting even more sophisticated methods.

A vast array of traditional airline efficiency measures exists. However, an emerging trend in recent years involves assessing airline efficiency by integrating undesirable outputs, including carbon emissions, flight delays, accident reports and poor supply chain management, into evaluating and examining airline performance.

Scanning the literature, the initial investigations into the efficiency of the airline industry, including those conducted by Caves et al. (1982), Barla and Perelman (1989), Mechling (1991), Forsyth (2001) and Oum et al. (2005), primarily examined the impacts of deregulation on airline efficiency. These scholars employed conventional cost-production function estimation or index number methodologies to achieve their objectives.

In the 1990s, there was a growing interest in the implications of liberalisation in the international arena. Prominent works in this area include studies conducted by Bruning (1991), Encaoua (1991), Good et al. (1993), Distexhe and Perelman (1994), Oum and Yu (1995) and Fu et al. (2015).

Other researchers, such as Douglas and Tan (2017), employed the difference-in-difference (DiD) analytical approach to investigate whether the foundation of global airline alliances and the subsequent growth of network coverage led to greater profitability for the founding members. Their analysis demonstrated that developing global alliances did not enhance profitability for founding member airlines or provide any economic advantage over non-founding members. This discovery is consistent across geographical regions, specific international partnerships and diverse event dates.

Bernardo and Fageda (2017) analysed the influence of the EU-Morocco open skies agreements on the volume of air traffic in Morocco. The researchers examined the influence of the agreement on the availability of seats on existing routes and the effect of deregulation on the probability of establishing new routes between the countries involved. Applying the DiD method to assess if the pretreatment trends were comparable between the two groups, with any divergence in post-treatment trends, might suggest the effectiveness of the change (Angrist & Pischke, 2015). The researchers found that the open skies agreement established between Morocco and the EU substantially impacted air traffic services between the countries involved. It was found that the supply of seats on current routes grew by around 20–35%, while the number of new routes saw substantial growth.

Jiménez et al. (2023) used the DiD estimator to ascertain the causal effect of interest: Does augmenting the subsidy affect the daily spending and duration of overnight stays for non-resident travellers? The resulting estimates indicate that non-resident visitors' daily expenditures decreased while daily spending at the destination increased significantly.

Ye and Cui (2018) used an Input-shared Network Range Adjusted Measure model to assess the efficiency of 29 airlines from 2008 to 2015. They evaluated shared-worker contributions and responsibilities in operations, services and sales, as well as the relevance of the airline reaching the optimal distribution proportions throughout all three stages. To attain high airline efficiency, airlines must optimise the allocation proportions of their resources. The primary findings indicate that using shared input significantly improves airline efficiency compared to its absence. The operational and service efficiency of most airlines surpasses their revenue earning. The ratio of staff ideal allocation varies significantly across different airlines, and most carriers should allocate the highest proportion of their employees to sales.

Other researchers directed their attention to financial indicators, namely the Return on Assets (ROA), which quantifies the effectiveness of a corporation in using its assets to produce a profit. The ROA is determined by dividing the net income by the total assets, which, in turn, gives a more equitable assessment of profitability. Metrics such as Return on Equity fail to consider the risk associated with financial debt. At the same time, ROA provides investors with a more transparent assessment of management's capacity to generate returns from its assets.

It is essential to understand that airlines function within a competitive industry characterised by substantial fixed expenses, restricted profitability and many operational intricacies. Comparing strategic management accounting to that of rivals is critical, as is closely monitoring competing airlines' strategies and operations (Tirado & Mavlutova, 2023). Strategic management accounting provides critical information that may help firms make decisions and reduce uncertainty in the business environment, possibly leading to improved financial performance (Susilawati & Faisal, 2021).

However, the aviation industry is notorious for producing inconsistent results using traditional financial performance metrics like ROA or strategic accounting (Schefczyk, 1993). This is mainly because obtaining the necessary data can be challenging, especially when evaluating state-owned airlines. Another valid justification for refraining from using such criteria to assess airline efficiency is the capital-intensive characteristic of the airline industry, which requires extensive and strategic long-term planning. Actions such as acquiring or leasing aircraft, establishing airport hubs, developing airport infrastructure and extending route networks require substantial long-term financial investment and constant expenditures. Hence, accounting data in the aviation industry is improbable to serve as the only predictor of future development potential (Gu et al., 2023).

According to evidence presented by Borochin (2020), inconsistently negative returns are demonstrated to be associated with the disclosure of poor on-time performance. This serves as irrefutable evidence in support of the claim that obligatory disclosures of non-financial indicators yield genuine economic benefits, helping not only the organisation itself but also its executives (Christensen et al., 2017; Borochin, 2020; Grewal et al., 2019).

The field of aviation productivity and efficiency research has changed over time. In addition to the few methods stated above, two more widely used approaches have emerged: Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Several scholars, including Oum et al. (2004), Merkert and Morrell (2012) and Yan et al. (2019), have conducted research on the impact of business models and management strategies (such as mergers and alliances) on the performance of airlines. In addition, an increasing number of studies have combined measures of airline productivity and efficiency with environmental factors, such as those examined by Lee and Worthington (2014), Scotti and Volta (2015), Lee et al. (2017) and Cui and Li (2019), flight delays, as explored by Fleurquin et al. (2014), Chen et al. (2017) and Tsionas et al. (2017), and safety concerns, as investigated by Khoshkhoo et al. (2018), Rosenow and Fricke (2019) and Rosenow et al. (2019).

In particular, DEA has been subjected to several modifications and extensions regarding how academics have used it, beginning with the conventional application (Schefczyk, 1993) and progressing up to the fuzzy technique (Shirazi & Mohammadi, 2019), the Bayesian network DEA technique (Zervopoulos et al., 2023), conditional and meta-frontier analysis (Wanke et al., 2016; Daraio & Simar, 2007) and two-stage least squares (McDonald, 2009). Each of the various methods that have been outlined above is, in one way or another, a strategy used to significantly improve the validity of the DEA approach, as well as to lessen the possibility of endogeneity and correlation between variables and contextual factors (Simar et al., 2016).

The DEA's strengths are indisputable in assessing airline performance since it can simultaneously analyse several financial and non-financial factors. Moreover, the DiD and ROA methods are exceptionally efficient when evaluating the consequences of alterations in operational practices, including but not limited to the formation of alliances, open skies agreements or ownership transitions. Although the ROA metric is a robust assessor of organisational performance, it fails to accurately evaluate firm efficiency. Considering the methods mentioned above as examples of alternative approaches to measuring airline performance, the current study utilises the DEA-MPI efficiency change scores to analyse the factors that influence the efficiency change of the airline sample.

4.4 Motivation for Using Data Envelopment Analysis

There has been a growing interest in analysing productivity in the airline business. According to an extensive literature analysis by Cui and Yu (2021) and Emrouznejad and Yang (2018), DEA and MPI are the most often utilised approaches for examining productivity in the aviation industry. The parametric SFA and the non-parametric DEA are often seen in many studies addressing airline efficiency.

SFA necessitates predetermining the production function and data assumption forms, leading to greater operational complexity. Conversely, DEA does not need a predetermined functional form (Tan et al., 2021). It determines the optimal combination of inputs and outputs from several decision-making units (DMUs) to establish a production frontier. Each DMU's relative efficiency is measured by its divergence from the frontier.

DEA has been extensively used to examine the performance of other sectors like hotels, agriculture, oil and gas, software, manufacturing and transportation. Over time, many researchers analysing finance and economics have begun to apply DEA in the financial industry to anticipate future business models, evaluate different efficiency indicators and provide managers with stand-alone business solutions.

The DEA's widespread usage reflects its superior benefits, which include requiring no previous assumptions and simultaneously handling several inputs and outputs. DEA does not need the specification of function form and may break down efficiency into several elements, including pure, technical, scale, allocative and technological efficiencies. Additionally, DEA is unit invariant, meaning it can work on variables of various units without requiring them to be unitised. Furthermore, DEA can be used to benchmark, establish targets and effectively identify peers.

The DEA's primary objective was to evaluate the performance of DMUs. However, there has been a surge of interest in the next logical step: analysing DMU productivity differentials in recent years. Indeed, understanding the impact of external environmental factors on efficiency is critical for explaining efficiency, recognising economic surroundings that create inefficiency and indirectly enhancing managerial performance.

Although these external variables are neither inputs nor outputs within the producer's control, they may impact the performance of the production process. In the literature, two primary approaches have been employed. The ‘one-stage’ technique incorporates environmental factors, inputs and outputs directly into the linear programming formulation, which is referred to as the SFA. On the other hand, the ‘two-stage’ approach employs either the DEA or the MPI scores and uses them as dependent variables in a second-stage regression. As an extension of the two-stage technique, several researchers offer three- and four-stage studies as potential alternatives.

The primary disadvantage of the one-stage approach is that environmental variables must be identified as inputs or outputs before analysis. As Simar and Wilson (2007) point out, the two-stage approach has a fundamental fault in that the efficiency estimates are serially correlated in a complicated way and the first-stage efficiency scores are biased. Consequently, they proposed a bootstrap-based technique for second-stage inference, allowing for more precise results. It should be emphasised that these two-stage techniques have one more drawback: they depend on a separability constraint between the input-output space and the space of environmental variables.

Furthermore, all previous investigations utilised a constrained parametric model for second-stage regression. Daraio and Simar (2005) provided an entirely non-parametric technique that eliminates most of the issues above. They introduced conditional boundaries based on external environmental components and conditional order-m boundaries. Order-m frontier estimators (Cazals et al., 2002) are recognised to be more robust against outliers and extreme values than complete frontier estimates. These new conditional measures assist analysts in better comprehending the impact of external factors without worrying about separability issues.

The literature on DEA and MPI is complicated, including the many expansions that have emerged to both the DEA and MPI. In this study, we use the conventional DEA-MPI and bootstrap efficiency change scores to regress on external variables while addressing the main restrictions noted by previous studies.

4.5 Data Envelopment Analysis

In 1957, Farrell stated a non-parametric approach for the measuring and evaluation of technical efficiency in the presence of multiple inputs and a unique output (Farantos, 2015). This non-parametric approach seemed to be effective in measuring the efficiency of various fields. However, the limited range of output prevented the formulation of an effective production frontier. Charnes, Cooper, and Rhodes (CCR) (1978) modified this model and presented a new non-parametric approach that enabled the assessment of Decision-Making Units [DMUs'] efficiency and productivity by considering multiple outputs and inputs. Although the CCR model enabled the assessment of efficiencies, as it could be applied only to technologies having constant returns to scale, Banker, Charnes, and Cooper (BCC) (1984) extended the CCR model to accommodate variable returns to scale in technologies. Methodological contributions from different researchers accumulated into the formation of significant literature around CCR and BCC models, thus giving way to DEA analysis (Ray, 2004).

The definition of DEA is flexible and generic, but recent years have witnessed various changes in the application of this method, like airlines, hospitals, cities, courts, universities, business firms, courts, or the performance of different regions or countries. DEA is a type of linear programming used to evaluate the efficiency of homogenous operating units (Goksen, Dogan & Ozkarabacak, 2015). As the process enables dataset examination even in the presence of multiple criteria and helps in formulating strategies for improving the performance by providing an overview of the existing productivity of the company, it is an essential approach for efficiency examination (Ebrahimi et al., 2014; Malik et al., 2018).

4.5.1 Single stage DEA analysis

Single stage DEA analysis is the one wherein the simple inclusion of inputs and outputs. Efficiency is measured relative to the best performing DMUs (Saini, 2018). Initially Charnes, Cooper and Rhodes (1978) formulated DEA input oriented model wherein measurement of efficiency is based on the ratio of weighted outputs to weighted inputs for a DMU. The original CCR input model of efficiency is:

$$Max\ h_0 = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}$$

subject to:

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1\ j = 1,2, \dots n$$

$$u_r\ , v_i\ \geq 0\ i = 1,2, \dots . m$$

Equation 1: Original efficiency model - input oriented (Charnes, Cooper and Rhodes, 1978)

wherein, x_{ij} defines input of j^{th} DMU, y_{rj} is output of j^{th} DMU and u_r and v_i are variable weights for linear programming. For presenting the inefficiency measure, Charnes reciprocated the above equation further, in order to convert the inefficiency measure of nonlinear and nonconvex form into linear programming system.

$$\max z_0$$

subject to:

$$-\sum_{j=1}^{n} y_{rj}\lambda_j + y_{r0}z_0 \leq 0\ r = 1, 2, \dots . s$$

$$\sum_{j=1}^{n} x_{ij}\lambda_j \leq x_{i0}\ \ i = 1,2, \dots . m$$

$$\lambda_j\ \geq 0\ j = 1,2, \dots . n$$

Equation 2: Linear programming model for inefficiency - input oriented (Charnes et al,. 1978)

For representing the above equation using duality theory, Charnes presented below equation

$$\min g_0 = \sum_{j=1}^{m} \omega_i x_{i0}$$

subject to:

$$-\sum_{r=1}^{s} \mu_r y_{rj} + \sum_{i=1}^{m} \omega_i x_{ij} \geq 0$$

$$\sum_{r=1}^{s} \mu_r y_{r0} = 1$$

$$u_r, \omega_i \ \geq 0$$

Equation 3: Dual problem of Equation 2 (Charnes et al,. 1978)

Further, Charnes with utilization of the linear fractional programming created a linear fractional programming equivalent to above equation i.e.

$$\omega_i = tv_i \ \ i = 1,2, \ldots m$$

$$\mu_r = tu_r \ \ r = 1,2, \ldots s$$

$$t^{-1} = \sum_r \mu_r y_{r0}$$

$$For\ t > 0$$

$$Min\ f_0 = \frac{\sum_{i=1}^{m} v_i x_{i0}}{\sum_{i=1}^{s} u_r y_{r0}}$$

subject to:

$$\sum_{i=1}^{m} v_i x_{ij} \ - \sum_{r=1}^{s} \mu_r y_{rj} \ \geq 0 \ j = 1,2, \ldots n$$

$$u_r, v_i \ \geq 0$$

Equation 4: Linear fractionally equivalent equation of Equation 3 (Charnes et al,. 1978)

DEA also indicate the inefficiencies magnitude and define the improvement units based on the identified inefficient units. Herein, for n DMUs (i.e., j = 1, 2....n), with consumption of amount X_j (i.e., $X_j = x_{ij}$) with m inputs (i = 1, 2...m) produces Y_j ($Y_j = y_{rj}$) amount with r outputs (r = 1,2...s). Input efficiency model under VRS based on BCC input-oriented model.

$$min_{\theta,\lambda,s^+,s^-} z_0 = \theta - \varepsilon . \vec{1}s^+ - \varepsilon . \vec{1}s^-$$

subject to:

$$Y\lambda - s^+ = Y_0$$

$$\theta X_0 - X\lambda - s^- = 0$$

$$\vec{1}\lambda = 1$$

$$\lambda, s^+, s^- \geq 0$$

Equation 5: VRS based DEA model - input oriented (Yang, 2006)

wherein, $s^+ \ and \ s^-$ represents the slacks in system

A DEA developer needs to choose the way of operating a concerned DMU wherein CRS (constant returns to scale) or VRS (variable returns to scale) characteristic of operations define the formulation that would be required for simulating DMU. With the application of CRS behaviour, DMU would be operating at optimal scale hence model would define the productivity ceilings and optimal decision making. However, in real time scenario of firms, the functioning of DMU is influenced by various factors like economic limitations, industry characteristics, or regulatory constraints which prevent the existence of perfect competition and application of optimal decision making. Hence, for developing an effective model to have real world applications of DEA model, VRS frontier is used (Coelli et al ., 2005).

4.5.2 Multistage DEA analysis

DEA analysis processed with more than one stage for the respective DMU is regarded as the multi stage DEA analysis. Herein leveraging the formulas, multistage DEA analysis enables the optimization of all model stages by considering the upstream stage outputs as the inputs for the successive stage. Converging the combined set of decisions, the efficiency based results is derived which represent the best aggregation of the respective DMU for combined model (Saini, 2018). Chen and Zhu (2004) presented a VRS two stage model wherein the business performance is determined by considering the impact of information technology and investment. The model can be presented as under.

$$\min \omega_1 \alpha - \omega_2 \beta$$

subject to:
<u>First stage -</u>

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \alpha x_{ij0} \;\; i = 1,2, \ldots m$$

$$\sum_{j=1}^{n} \lambda_j z_{dj} \leq \check{z}_{dj0} \;\; d = 1,2, \ldots D$$

$\sum_{j=1}^{n} \lambda_j$ = 1

$$\lambda_j \geq 0 \; j = 1,2, \ldots . n$$

$\alpha \leq 0$

<u>Second stage -</u>

$$\sum_{j=1}^{n} \mu_j z_{ij} \leq \check{z}_{dj0} \;\; d = 1,2, \ldots D$$

$$\sum_{j=1}^{n} \mu_j y_{rj} \leq \beta y_{rj0} \;\; r = 1,2, \ldots s$$

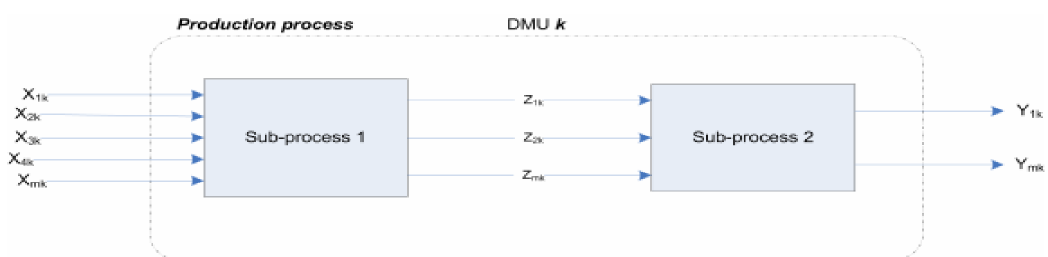
$\sum_{j=1}^{n} \mu_j = 1$

$$\mu_j \geq 0 \; j = 1,2, \ldots . n \beta \leq 0$$

Equation 6: VRS 2-stage DEA model (Chen & Zhu, 2004)

wherein, x_i define 1st stage inputs, z_d is 1st stage intermediate outputs and 2nd stage intermediate input, y_r is 2nd stage outputs, and W_1/W_2 are defined weights of two stage outputs (Chen & Zhu, 2004). Thus, the production process for the 2-stage DEA model could be represented (Kao & Hwang, 2008) as:

Figure 2 Two-stage DEA model production process (Kao & Hwang, 2008)



Hence, the multi-stage DEA analysis model enables the examination of the overall efficiency of different DMU at different operation levels by having the assessment at individual stage efficiencies.

4.5.3 Malmquist productivity index under DEA

Productivity is an important driver of profitability. In fact, the Total Factor Productivity (TFP) change is the most complete measure of productivity gain (Baulk, 2003). Productivity is therefore of crucial importance in raising living standards, which explains the focus on theoretical productivity indices (see Russell, 2018). A theoretical productivity index is based on the assumption that the technology is known and non-stochastic, and is often approximated by a nonparametric multiple-input, output specification with some form of distance function.

Nishimizu and Page's (1982) work was perhaps the first to divide productivity into two parts: technical change and technological efficiency change. Caves, Christensen, and Diewert (1982) investigated the discrete-time Malmquist production index, using distance functions as broad technical representations.

Caves et al. (1982) show that the Malmquist index is related to the Törnqvist productivity index when translog technology is taken into account. In contrast, the Törnqvist productivity index uses both price and quantity data and requires no knowledge of technology (Diewert &Fox, 2010).

Färe et al. (1994) proposed a method for estimating the distance functions in the Malmquist productivity index by leveraging their relationship with radial efficiency measures computed relative to nonparametric technologies, as well as incorporating the two-part (Nishimizu and Page 1982) decomposition. MPI shows that examining each component of the Malmquist productivity index produces comprehensive data. Such evaluations could prove extremely useful in accurately assessing a company's performance.

Finally, given that Caves et al. (1982) and the Luenberger productivity indices (Luenberger, 1992) are the most often used indices in empirical research, the popularity of both techniques cannot be denied. The Malmquist index, for example, is the most widely used instrument for measuring productivity change in air transport. Its attractiveness arises mostly from its computational simplicity, which needs no pricing information or underlying functional forms. Furthermore, the Malmquist index exhibits four of the most desired TFP index properties: monotonicity, separability, identity, and proportionality, with the exception of circularity (Fried, 2008; Ait Sidhoum, 2023).

The Malmquist index is mainly applied for measuring productivity change over a period of time by decomposition of the total effect into technological change index and technical change index. The index stated by Fare (1994) is based on usage of the efficient frontier model based on the value of distance of observations from the computed efficient frontier (Shahverdi & Ebrahimnejad, 2014). This formulated model using DEA output and input data could be expressed as

$$M_i^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) = \frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^t(y^t, x^t)} * \left[\frac{D_i^t(y^{t+1}, x^{t+1})}{D_i^{t+1}(y^{t+1}, x^{t+1})} * \frac{D_i^t(y^t, x^t)}{D_i^{t+1}(y^t, x^t)}\right]^{\frac{1}{2}}$$

Wherein,

- t and t+1 are different time periods,
- $M_i^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t)$ = tfpch (total factor productivity change)
- $\frac{D_i^{t+1}(y^{t+1}, x^{t+1})}{D_i^t(y^t, x^t)}$ = effch (technical efficiency change) = pech (pure technical efficiency change) * sech (scale efficiency change)
- $\left[\frac{D_i^t(y^{t+1}, x^{t+1})}{D_i^{t+1}(y^{t+1}, x^{t+1})} * \frac{D_i^t(y^t, x^t)}{D_i^{t+1}(y^t, x^t)}\right]^{\frac{1}{2}}$ = techch (technological change)
- tfpch = (pech * sech) * techch

Equation 7: Malmquist productivity index (Shen et al ., 2010)

In the above stated equation, the productivity index for the model could be represented by the ratio of production points i.e., the value of (x^{t+1}, y^{t+1}) relative to (x^t, y^t). Herein, in case:

- The values of technical efficiency change are 1 then the value depicts that the distance of the observations from there frontier is same for both the periods i.e., t and t+1; for the value of less than 1 depicts the movement of DMU far from frontier in t+1 compared to the position of it in period t; for the value of more than 1, DMU has moved closer to frontier in time period t+1 compared to its position in t period.
- Further, for the technological change in case the value is 1, there is no shift in the status of technological level for an industry whereas for the value of more than 1, the technological improvement could have been taken place leading to shift in the production frontier and hence production of higher output without any variation in the level of input used while the value of less than 1 represents that there has been degradation in the technological level of the industry leading to have regression in the output generation

possibility of the company from the given input (Ling et al., 2018). Thus, Malmquist index method of DEA analysis working with the balanced data measures the relative productivity of DMU and helps in decomposition of the entities economies of scale into technological change or technical efficiency so as to suggest the industries with regard to the required improvements (Gök, 2012; Ling et al., 2018).

4.6 Bootstrap MPI

Efron (1981) developed the bootstrap approach, which is a useful tool for determining the sensitivity of measuring efficiency scores to sample variance. Bootstrapping is a generating process (data-generating process) that consists of resampling and applying the original estimate to each simulated sample (see Efron & Tibshirani, 1985). The resulting estimate closely resembles the original estimator's sample distribution (Simar & Wilson, 1998).

One of the main issues with the DEA efficiency score methodology is that it does not account for noise or random error because it employs a linear programming approach to estimate the frontier. The bootstrap technique is used to counter this kind of problem by selecting a random sample of thousands of 'pseudo samples' from the observed set of sample data. Simar and Wilson (1999a) extended the DEA bootstrapping approach to account for any temporal correlation emerging from panel data features while estimating confidence intervals for Malmquist indices. They provided a consistent technique that accounts for temporal correlation via the covariance matrix of data from two consecutive years using a bivariate kernel density estimation. As new sets of inputs and outputs are produced, the steps are then repeated B times to generate the bootstrapped estimation for the Malmquist and its components (Assaf, 2011).

4.7 Robustness Checks in the DEA Approach

Robustness refers to the degree to which a model can operate efficiently in the presence of variation or stressful environmental conditions (Micskei et al., 2012). As robustness ensures stability under independent or other forms of determination, the result derived from the analysis is reliable and real, stating that with the presence of different numbers and mutually independent routes, the same conclusion can be derived (Shevlyakov & Vilchevsky, 2011). As they are influenced by the presence of various factors which are not considered for the examination, the linkage between the variables becomes weak, and even inappropriate information is derived. Thus, robustness testing includes the influence of these faults or vulnerabilities in the model, and by assessing these factors' impact on the associated variables, the sensitivity of the model with respect to these uncertain factors is stated (Neumayer & Plumper, 2017).

In the airline industry, DEA computes the efficiency and productivity of the DMU without any specific assumptions, but this analysis hampers the validity of the model, as comparison of the DMU in the absence of assumptions would omit the impact of uncertain factors. Thus, a strategy that is suggested for having the robustness testing of the DEA and having a comprehensive evaluation of DMU efficiency is the augmentation of DEA with successive analysis techniques (Saini, 2018). The most common methods in airlines for robustness testing are the augmentation of DEA with bootstrapping (Efron & Tibshirani, 1994; Simar & Wilson, 1999a; Simar & Wilson, 1999b; Simar & Wilson, 2011a) or DEA with second-stage regression analysis. When analysing the second-stage DEA regression, additional tests are often carried out, including the heteroscedasticity, multicollinearity, separability test and correlation assumptions, to guarantee more accurate and valid findings.

4.8 Variables' Description

4.8.1 Data for Stage-1 DEA

Apart from selecting the proper DEA model to be used in the context of evaluating airline efficiency, the optimal inputs and outputs are also critical for achieving the objectives of the research endeavours. The selection of the inputs and outputs should definitely take into account the scope of the research, thus dictating the need for prior meticulous determination in accordance with the needs of each individual topic under investigation.

- ***Descriptions of the input variables used in this study are stated below:***

- **Operating costs:** Measured in millions; all foreign currencies were converted to US dollars at the prevailing exchange rate at the time. The costs of operating and running an airline are referred to as operating costs, which includes navigation fees, fuel costs, employee pay and salaries, service desk costs and administrative expenditures (Mugun, 2019). Operating expense is a significant input variable for the analysis of an airline firm that works extremely hard to minimise costs and improve profits (Cronin & Alexander, 2019). Some of the previous research utilising operating expenses as an input includes Barros and Couto (2013), Barros and Peypoch (2009), Barros et al. (2013), Fethi et al. (2000), Lee and Worthington (2014), Schefczyk (1993), Scheraga (2004b), Sengupta (1999).
- **Number of employees:** The number of employees working in an airline firm is also an important variable for understanding the operational efficiency of a company (Cronin & Alexander, 2019). The workforce of an airline firm is an input variable, and for the successful running of operations of an airline firm, the number of employees as per the requirement is highly imperative. During losses, airline firms opt for staff reduction as well as better staff productivity; both have a direct relation to work efficiency (Appelbaum & Fewster, 2002). Some of the studies that have included employees as an input variable are Barros and Couto (2013), Barros and Peypoch (2009), Cui and Li (2017), Huang et al, 2021; Hong and Zhang (2010), Omrani and Soltanzadeh (2016), Tavassoli et al. (2014) and Wang et al. (2011).
- **The number of aircraft:** In an airline company, the number of aircraft operating for the firm represents the available seats for passengers to travel, and it also represent cost for the firm (Wittmer & Bieger, 2011). Therefore, the number of aircraft represents an important input variable (Barbot et al., 2008; Barros & Peypoch, 2009; Cao et al., 2015; Good et al., 1995; Wang et al., 2011; Zhu, 2011).

  - ***Descriptions of the output variables used in this study are stated below:***

- **Total revenue:** Measured in millions; all foreign currencies were converted to US dollars at the prevailing exchange rate at the time. The total revenue of an airline refers to the total earnings of the company (Qin, 2018). It is the gross income generated by the airline company, and it is considered an important variable to measure the performance of an airline (ICAO, 2021). Revenue of the company is considered the output derived by the firm as a result of the airline's operations (Barros et al., 2013; Cui & Li, 2017; Hong & Zhang, 2010).

- **Load factor:** Load factor metrics represent the total seating capacity of an airline that can be filled with passengers (Szabo et al., 2018). It is generally used to analyse how efficiently a transport provider can manage its seats and generate revenue. This is an important output factor, as it directly represents the revenue and profitability of the airline firm (Barros et al., 2013; Choi, 2017; Good et al., 1995; Joo & Fowler, 2014; Zhu, 2011).
- **RPK:** Measured in millions; all foreign currencies were converted to US dollars at the prevailing exchange rate at the time**.** RPK refers to the number of kilometres travelled by passengers (AirlineGeeks, 2016). The total revenue earned by the airline is an important performance indicator. It has been used as an output variable in many studies (Cui & Li, 2017; Joo & Fowler, 2014; Lozano & Gutiérrez, 2011; Merkert & Pearson, 2015; Min & Joo, 2016; Omrani & Soltanzadeh, 2016; Sjögren, 2016).

4.8.2 Data For Stage-2 Determinants of Airline Efficiency (Regression Analysis)

- Dependent Variable

The dependent variable in our second-stage regression analysis utilises the bootstrap efficiency change scores acquired from the MPI. Bootstrapping aims to estimate an accurate sampling distribution by mimicking the data-generating process (Simar & Wilson, 2000b). Since our dependent efficiency change scores are skewed, the logarithmic form is used. Our experiments with this variable have shown that logging the scores produces data with less skewness and better distributions.

Several factors usually influence the choice to use a logarithmic transformation for the dependent variable, including the preference for multiplicative or proportional reactions to a covariate of interest, convenient computation of an elasticity as in the log-log model, the utilisation of specific utility, demand, production, cost functions (such as the Cobb-Douglas and translog formulations), the estimation of the logarithm of the odds ratio for grouped data from a logit model or the necessity to handle dependent variables that exhibit significant skewness towards one side (Manning, 1998; Box & Cox, 1964).

- Independent Variables

The strategy tripod enables us to elaborate on the hypotheses created by the tripod's three legs, institution, industry and resource perspectives in order to completely appreciate the strategic mindset and behaviour. The variables listed below were as independent variables to test our hypotheses; each measure was carefully chosen to reflect the hypothesis under consideration.

- ***Institutional-based view***

- **Travel and Tourism Competitiveness Index:** The global TTCI index is the average composed score of multiple indexes, the higher the score the better the competitiveness. Tourism and aviation seem to be interconnected. Travel and tourism competitiveness impact inbound and outbound international transport service. Global tourism competition represents the number of arrivals in any particular region compared with others. Scholars have long established that tourism and aviation have undeniably strong reciprocal and synergistic connections (Beiger & Wittmer, 2006; Debbage, 1991; Forsyth, 2006; Forsyth, 2010). Therefore, we use the TTCI as an independent variable to measure the effect of passenger flow on airline efficiency.
- **The Trade Openness Index**: Trade openness is measured as the sum of a country's exports and imports as a share of that country's GDP (in %). International trade is the key source of revenue for nations. The aviation industry is also affected by trade openness between two countries. There is a common agreement on the importance of international trade in boosting the competitiveness and development of a country (Guadros et al., 2004; Kuledran & Wilson, 2000; Kumar & Hoffmann, 2002; Porter, 1990).
- **Visa openness:** Calculated from the Arton Capital's mobility scores [MS], a global ranking for the world passports see for example (Haynes, 2017; Keshavarz, 2018; Nitsch, 2019). Visa openness is significant in travelling to any nation, as the visa policy of that nation can put certain limitations on international travel that affect the growth and revenue of airlines (UNWTO, 2013). Neumayer (2010) and Neumayer (2011) carried out extensive

worldwide cross-sectional research showing that visa requirements reduce travel motivation by between 52% and 63%, reducing bilateral trade by approximately 21% and FDI amounts to 32%. Restrictions on visas often result in constraining passenger flow (Neumayer, 2006; Neumayer, 2010; Neumayer, 2011; Song et al., 2012; Thomas, 2012; UK Visa Bureau, 2012).

- **EFW:** Calculated from the (EFW) index. This index is a measure that guides the progress made in advancing economic freedom, which results in growth and development. It is an important variable, as it represents the economic advancement of a country, which affects airline industry profitability (Rajasalu, 2003). The EFW index has been widely utilised in the scholarly literature to conduct rigorous research on various topics (Hall & Lawson, 2014) and has been found to have a strong correlation with economic growth (De Hann et al., 2006).

- ***Industry-based view***

- **Fuel cost**: calculated as the average jet fuel cost in US dollars per gallon in each year of the study. The impact of crude oil prices on the industry is determined by the degree of reliance on crude oil of that particular industry, as measured by the percentage of oil cost in the overall cost (Phan et al., 2015). Airline fuel consumption accounts for more than 30% of their overall costs and is higher than all other costs linked with airline expenses (Yun & Yoon, 2019). The price of fuel globally impacts the cost incurred by airline firms. High fuel prices result in high expenditure of airlines (GAO, 2014). Therefore, our first industry-related variable is to see whether a change in the cost of jet fuel has an impact on airline efficiency.
- **Competition:** The number of airlines operating in a country with comparable BM. The airline industry is categorised as highly competitive. Market competitiveness is the presence of substitute airline firms for passengers that increases airlines' quality of service. Higher market competitiveness results in increased airline efficiency (Mrazova, 2013). As described earlier, it is difficult to quantify and localise competition in the

aviation industry. Therefore, we only consider the number of airlines operating in each country with a comparable BM.

- **BM:** Dummy variable takes the value of 1 for FSCs. The BM notion is used to analytically describe and analyse a particular set of firm strategic and structural design parameters at a given point in time by assessing several fundamental components and subdimensions (Mason & Morrison, 2008; Morris et al., 2005; Shafer et al., 2005). The BM on which an airline firm is operating plays a crucial role in deciding its competitive advantage (Schneider, 2013). A strategic and efficient BM results in high productivity and service quality; therefore, this is an important variable.

- ***Resource-based view***

- **Alliances:** Dummy variable takes the value of 1 for a member. Partners in an alliance have common specific business intentions (Morrish & Hamilton, 2002), whether that is resource orientation among partner airlines (Das & Teng, 2000), novel product development (Deeds & Hill, 1996) or an improved network (Beamish, 1987). Alliances in the aviation industry represent substantial cooperation between two or more airlines to provide effective services to passengers. It is an important variable affecting operational cost and network utilisation (Kuzminykh & Zufan, 2014). The variable is used as dummy and set at 1 for FSCs.
- **Number of Employees:** The total number of full-time employees. airline industry's labour expenditures per employee are among the highest. The airline sector is heavily unionised, in part due to its long history as a regulated industry. Even in the best of circumstances, all of this results in razor-thin profit margins. Hunter (2006) claims that unionisation is more significant than expected in the LCC industry. Employee costs account for approximately 25% of total airline costs, making them an important variable when measuring airline efficiency (Huang et al, 2021).
- **Ownership:** Dummy variable takes the value of 1 for state-owned. Ownership arrangements and government policies may help form organisational value or barricade its progress (Lawton et al., 2013). Private airlines are more performance- and efficiency-

focused than pure public or mixed-model airlines, demonstrating that ownership is critical (Chen et al., 2017; Chow, 2010). To investigate whether there is any substantial influence on our airline sample, we defined ownership as organisations holding more than 50% of the shares.

- **Air connectivity index:** Calculated on each country's average global ranking and obtained from the air connectivity reports (IATA, 2019), the higher the number the more connected a country is. A country's location and air connectivity are vital to the success of an airline. According to IATA (2018), a country's ability to reap economic gains from aviation is determined by its degree of connectivity, building competence, well-functioning institutions and policy implementation to foster growth in air connectivity. The report provides a measure for air connectivity at the global, regional and country levels. Our aim is to see if there is a link between higher air connectivity and airline performance.

4.9 Research Hypothesis

A summary of the final hypotheses to be tested in the regression analysis are listed below in **Table 2**.

Table 2 Research Hypothesis

Research Hypotheses	***Perspective***
H1: Measured by the TTCI, the more attractive a destination is, the more efficient the airline operating in that country is.	*Institution*
H2: The higher a country's Trade Openness Index, the more efficient the airline operating in that country is.	*Institution*
H3: The higher the Visa Openness Index, the more efficient the airline operating in that country is.	*Institution*
H4: The greater the economic freedom of a country, the more efficient the airline operating in that country is.	*Institution*
H5: The higher cost of jet fuel, the more efficient the airline is.	*Industry*
H6: In the airline industry, the higher the number of competitors in a country, the more efficient the airlines are	*Industry*
H7: *LCCs are more efficient than FSCs (BM)*	*Industry*
H8: Airlines that are members of global alliances are more efficient than non-member airlines.	*Resource*
H9: The higher the number of an airline's employees, the more efficient the airline is.	*Resource*
H10: Private airlines are more performance-and efficiency-focused than pure public-or mixed-model airlines	*Resource*
H11: The higher the connectivity index of a country, the more efficient the airline operating in that country is.	*Resource*

4.10 Dataset

The dataset comprises information collected from 35 leading global airlines' annual reports for the period from FY2011 to FY2018. The annual reports and the official websites of airlines have been used to collect the data, ensuring the reliability of the sources used. The second-stage data were collected from the official website of the World Bank and other reliable indices, such as the EFI and the Visa Openness Index. The airline companies selected for the research are the globally leading firms in the aviation industry. Herein, with the information on the productivity of the global aviation industry, attempts have been made to include leading airlines from across the world. Further, the access and the availability of the data have also been considered when selecting our sample. The following criteria are summarised below:

- Availability of data
- Size of the airline

The selected airlines reflect a wide range of sample size from different countries around the globe. The majority of our sample comes from Europe, North America, Asia, Africa, the Middle East, Australia, and finally, one from South America. The selection of the sample was limited due to the availability of data over a long period of time, eight years, as well as the readability of the annual reports and the breakdown of data. The size and type of BM were also factors when we considered sample collection. Finally, we considered varieties of ownership to make sure our data fulfilled the objectives of the research.

Table 3 Airlines Names, Types and Ownership

Airlines	BM	Ownership	One-highlight description
Aer Lingus	FSC	Private	Operates out of Ireland, primarily providing passenger and cargo transportation services
Aeroflot	FSC	Government	Leader of the Russian air transportation market/among the world's Top 20 airlines
Air Canada	FSC	Private	Air Canada is Canada's largest domestic and international airline, serving more than 190 destinations on five continents
Air China	FSC	Private	The company has a domestic and international network, with a total fleet size of 628 aircrafts
Air-France	FSC	Private	Flag carrier of France, subsidiary of the Air France–KLM Group, member of the SkyTeam

Alaska	FSC	Private	The airline operates out of five hubs, with its primary hub located in Seattle/Tacoma
Alitalia	FSC	Government	In June 2014, the Abu Dhabi-based UAE national airline Etihad Airways announced it was taking a 49% stake in Alitalia
British Airways	FSC	Private	British Airways is the largest international airline in the world
Cathay Pacific	FSC	Private	Cathay Pacific is the world's fifth-largest airline measured by sales and 14th-largest measured by market capitalisation
China Eastern	FSC	Private	China Eastern Airlines is China's second-largest carrier by passenger numbers after China Southern Airlines
Delta	FSC	Private	Became the best-performing airline in the United States in 2017
Easy Jet	LCC	Private	EasyJet's strategy is focused on primary airports, serving valuable catchment areas that represent Europe's top markets by GDP
Emirates	FSC	Government	Emirates airline was named 'Airline of the Year' at the 2018 Air Transport Awards
Etihad	FSC	Government	Etihad operates out of Abu Dhabi and is considered a top airline, providing a high level of service
Ethiopian Airlines	FSC	Government	Ethiopian was named Africa's most profitable airline for the year 2010 by Air Transport World
Finnair	FSC	Government	Finnair is the sixth-oldest airline in continuous operation. The state of Finland is the major shareholder (55.8%)
Hawaiian Airlines	FSC	Private	The flag carrier and the largest airline in the US state of Hawaii
Iberia	FSC	Private	Founded in 1927, Iberia is the largest Spanish airline and the leader between Latin American and Europe
Japan Airlines	FSC	Private	Japan Airlines has made partnership agreements with VietJet, Vistara, Hawaiian Airlines, Aeroméxico and Aeroflot
Jet Blue	LCC	Private	JetBlue ranked 'Highest in Customer Satisfaction Among Low-Cost Carriers in North America' by J.D. Power and Associates
Kenya Airways	FSC	Private	Kenya Airways continues to face strong headwinds with intense competition
KLM	FSC	Private	Air France and KLM agreed to a merger plan. Delta Air Lines, Air France–KLM and Virgin Atlantic decided to launch a long-term joint venture
Korean Air	FSC	Private	Korean Air is the largest airline and flag carrier of South Korea based on fleet size
LATAM Brazil	FSC	Private	LAN Airlines SA and TAM Linhas Aereas SA adopted the single brand: LATAM operating out of Chile
Lufthansa	FSC	Private	Lufthansa is the largest German airline, which when combined with its subsidiaries, is the second-largest airline in Europe in terms of passengers carried
Qantas Airways	FSC	Private	It is the third-oldest airline in the world, and Qantas is one of the most successful airline groups in the world
Qatar Airways	FSC	Private	Qatar Airways is one of the youngest Gulf airlines and considered a leader in acquiring innovative and high-level technological aircraft
Ryanair	LCC	Private	Ryanair operates an ultra-low fare, scheduled airline serving short-haul, point-to-point routes largely in Europe from 84 bases to airports across Europe
SAS	FSC	Private	SAS is one of Scandinavia's strongest and best-known brands
Singapore Airlines	FSC	Private	One of the world's best airlines, with a very innovative approach and high-quality services
South African Airways	FSC	Government	South Africa has an international as well as domestic operation

Southwest Airlines	LCC	Private	Pioneered the low-cost concept. Southwest carried the most domestic passengers of any United States airline
Thai Airways International	FSC	Private	Thai International was founded in 1960 as a joint venture with SAS
Turkish Airlines	FSC	Government	By the end of 2013, Turkish Airlines had increased their number of flight points to 241 destinations worldwide (199 international and 42 domestic)
United Airlines	FSC	Private	One of the largest airlines in the United States
WestJet	LCC	Private	WestJet is currently the second-largest Canadian air carrier

4.11 Data Sources

The first-stage data for the 35 airline firms operating in different nations were sourced from the airlines' annual reports for the period from 2011 to 2018 (refer to **Appendix 13**). The second-stage data for the regression analysis were sourced from the following: the World Bank, TTCI, Visa Openness Index, EFW, and finally, from IATA (see **Table 4**). The Centre for Asia Pacific Aviation [CAPA] analysis on airline leaders reported that the top airlines are the companies utilising the opportunities in airport travel business with utmost focus on corporate travel, cargo, as well as commercial flight travel (CAPA, 2021).

Table 4 Summary of Data Sources

	Data	**Source**
1	Airline Data	See Appendix-13 for official airline annual reports source
2	TTCI	The Travel & Tourism Competitiveness Report 2019 | World Economic Forum (weforum.org)
3	Trade Openness Index	Trade Openness, 2017 (ourworldindata.org)
4	Visa Openness	Arton Capital Passport's Global Mobility Score: The Passport Index - Arton Capital.
5	EFW	Economic Freedom of the World: Promoting Economic Opportunity and Prosperity by Country (heritage.org)
6	Fuel Cost	IATA - Fuel Price Monitor
7	Competition	The number of airlines operating in the same country with comparable business model
8	BM	Annual airline reports
9	Alliances	Annual airline reports
10	Employment	Annual airline reports

11	Ownership	Annual airline reports
12	Location	Air Connectivity (iata.org)

4.12 Return-to-Scale Tests for the DEA

Testing for returns to scale of the underpinning technology is critical in DEA, since different returns-to-scale axioms might lead to different conclusions (Camanho & Dyson, 2005; Dyson et al*.,* 2001; Ray & Desli, 1997). Färe and Grosskopf's (1985) initial approach lacked any statistical support. Meanwhile, the Kolmogorov–Smirnow test was proposed by Banker and Natarajan (2008) as a semi-parametric returns-to-scale test (Simar & Wilson, 2002). To determine the presence of scale economies, we use Simar and Wilson's (2002) and Simar and Wilson's (2011b) bootstrapped test technique. Critical values, also known as P-values (refer to **Table 5**), must be estimated in order to test them statistically. Because of noise or random error, the bootstrapping approach is used to find the correct critical values. The return to scale test is used to test whether the technology is CRS versus VRS (Mahlberg & Url, 2010; Simar & Wilson, 2002; Tortosa-Ausina et al*.,* 2012). This method evaluates the scale efficiency of the entire sample, what is called the global returns to scale. In addition to testing the nature of scale assumption, this test justifies whether evaluating the scale efficiency of firms is essential. The null hypothesis indicates that the technology is CRS. Testing indicates that the test statistic is significant at 1%. Therefore, we reject the null hypothesis of CRS.

Table 5 Return to Scale Test

$\boldsymbol{H_0}$; ψ is **CRS**	$\hat{S}_1$	$\hat{S}_2$	$\hat{S}_3$	**Conclusion**
Test Statistic	0.9477425***	0.9821648***	−0.05298914***	**Reject CRS**
Critical				
1%	0.984388	0.9802853	−0.0152913	
***P < 0.001%				

4.13 Research Instrument

Each airline company is a homogenous unit. Therefore, we can apply the DEA methodology to assess the comparative performance of these companies. DEA is conducted using multiple software, such as the DEAP (Coelli, 1996), PIM software (Emrouznejad & Thanassoulis, 2014) and the DEA Slover (Cooper et al., 2007), as well as multiple packages used with RStudio (FEAR, rDEA, Benchmarking). All these software have their advantages and disadvantages and are capable of producing the same results, as all of them use a linear programming algorithm to solve data. Each software has its operating procedure and data entry instructions, and they all produce more or less similar output and results. DEA scores calculated for each period (year) and the panel data or time period MPI, which compares company efficiency between two periods of time. Färe et al. (1992) constructed the DEA MPI as the geometric mean of the two MPIs of Caves et al. (1982): one measures the change in efficiency, and the other measures the change in the frontier shift technology (Färe et al., 1992).

4.14 Tobit Regression

Probit models are often associated with binary variables (0 and 1). Tobit models, on the other hand, are entirely different; they form an extension of linear regression. Specifically, when a continuous dependent variable has to be regressed but is skewed to one side, the Tobit model is most often utilised. The Tobit model allows for regression of such a variable while censoring it, resulting in regression of a continuous dependent variable. It allows the analyst to choose a lower or upper threshold for censoring the regression while preserving the linear assumptions necessary for linear regression (Nelson, 1990; Greene, 2004).

Tobin (1958) was the first to develop the Tobit methodological model. The Tobit model is an excellent statistical tool for dealing with discrete and restricted dependent variables. The Tobit, a censored or truncated regression model, calculates the coefficient between variables when the dependent variable has both either left or right censoring limitations. The efficiency scores calculated by DEA or MPI are non-negative between zero and one in the DEA efficiency scores and continuous in the MPI, suggesting that scores theoretically begin above zero and above as they measure the efficiency change over two successive periods.

This makes the Tobit model excellent since it creates a latent variable when data falls on either side of the filtering limits (Zhu et al., 2023). This allows the coefficient slope to produce a more accurate estimate of the variables and a better slope-fitting prediction than the standard ordinary least square (OLS) regression slope. Scanning the DEA literature, we reveal that the Tobit regression analysis model is employed in most published studies (Emrouznejad & Yang, 2018).

The Tobit model is used in the subsequent phase of our study to examine contextual variables that might influence the efficiency change scores. In particular, this two-stage approach has gained popularity, where DEA or MPI are used to determine the efficiency of DMUs in the first stage and the impact of factors on efficiency in the subsequent stage (Adam & Tsarsitalidou, 2019; Wang et al., 2020). Moreover, the Tobit regression is often used in innovation research (Kafouros et al., 2015). For example, after examining the R&D efficiency of Chinese universities, Qin and Du (2018) used the Tobit model to show how environmental factors are connected with efficiency. Kekezi and Klaesson (2020) explored the elements that influence the creative performance of Sweden's knowledge-intensive business service organisations. Amara et al. (2020) utilised the Tobit model in panel data to demonstrate how seniority, public funding sources and the renown of a business school might improve the research efficiency of Canadian management professors. We used the Tobit regression model, which can handle skewed data and works with continuous or categorical variables (Dutta et al., 2020; Singh & Thake, 2020; Tandon et al., 2014). The widespread use of Tobit regression in various publications has confirmed the reliability of using this specific type of regression.

4.15 Assumptions on Regression Analyses

Econometric techniques can be applied in almost any field of applied economics (Wooldridge, 2015). Regression analysis is a statistical quantitative analytic approach for determining the connection between the response and explanatory variable(s). Building on the connection, regression analysis assists the researcher in understanding the role of various factors affecting the response variable (Sarstedt & Mooi, 2014). Multiple regression analysis lends itself to ceteris paribus analysis because it allows us to explicitly correct for many other factors that influence the dependent variable at the same time. This is critical when non-experimental data is employed to test economic theories and examine policy implications. Because multiple regression models may include different explanations that may be related, we can draw conclusions about cause and effect in situations where simple regression analysis may be misleading. As a result, we are able to account for greater variance in the dependent variable (y) by adding more features to our model.

Panel datasets are more complex to collect than pooled cross-section data since they need to be replicated over time. Observing the same units over time provides many advantages over cross-sectional data, or even pooled cross-sectional data. The benefit of having several observations on the same unit throughout time is that we can account for unobserved characteristics of people, firms, etc. Wooldridge (2015) emphasises the importance of utilising several observations, as they aid in causal inference in cases where inferring causality would be complex if just a single cross-section was employed.

The second advantage of panel data is that it often enables us to study the importance of behavioural or decision-making delays. This understanding is critical since many economic initiatives are expected to have an impact only after a certain amount of time has elapsed (Wooldridge, 2015). With the evaluation of efficiency using DEA results in the first part of this analysis, the variance in the contribution of technology and technological development has been identified; nevertheless, there are other factors, such as institutional, industry-level and resource-based variables that contribute to influencing efficiency.

In the second part of the analysis, we apply regressions to estimate each slope and quantify the partial influence of the relevant independent variable on the dependent variable while controlling for all other independent variables. The regression measures the percentage of the sample variance in the dependent variable that the independent variables can explain. When assessing econometric models in OLS, it is critical not to emphasise the value of R2, as the estimators are unbiased under the first four Gauss–Markov assumptions (Wooldridge, 2015). This means that including an irrelevant variable in a model does not influence the unbiasedness of the intercept or other slope estimators. On the other hand, OLS becomes biased when a crucial variable is omitted. In many cases, the bias direction may be established.

Normality in regression is one of the tests that is used to determine if the dataset is normally distributed and well-modelled or not. In multiple regression, the assumption of normal distribution applies only to the disturbance term and not to the independent variables. In simpler words, the normality assumption considers that the sampling distribution of the mean is normal.

The Wald Chi-Square test statistic is the squared ratio of the estimate to the standard error of the predictor. The Wald test is run to find out if the explanatory variables in the model are significant. The variables are internal and external; therefore, the Wald test is conducted to analyse the efficiency of outcomes, and RStudio is used to test the command.

Heteroscedasticity in regression refers to a situation where the variance of the residual is unequal over a range of measured values. When running regression analysis, heteroscedasticity results in an erroneous and unequal scatter of the residuals. A Breusch–Pagan test is conducted to test the heteroscedasticity in regression. It tests whether the variance of error from regression is dependent on the values of independent variables. The Breusch–Pagan test is one of the most commonly used tools in econometrics for analysing the presence of heteroscedasticity. In our research, the Breusch–Pagan test is conducted to test the variance of error, as regressors are both external and internal.

Multicollinearity is another overfitting problem that arises when independent variables in the regression model are highly correlated with each other. A variance inflation factor (VIF) is a test that measures the amount of multicollinearity in a dataset of multiple regression variables. It quantifies the extent of collinearity between two factors. VIF has been conducted in this research to test multicollinearity between variables and to achieve the outcome and extract better information on the productivity of airlines.

Separability testing is an essential assumption that must be validated prior to analysing second-stage external variables. Emrouznejad and Yang (2018) claim that two-stage DEA is the second most frequently used concept in the DEA literature. McDonald (2009) emphasises that the simplest and most popular ways of analysing the linear relationship between DEA efficiency scores and contextual variables are Tobit and OLS regressions. However, one has to be cautious while performing the second stage, as there is no clear agreement among scholars regarding the separability issue (Daraio et al., 2018).

The problem is that second-stage analysis introduces bias into efficiency evaluations (Simar & Wilson, 2007) since environmental or contextual factors may be directly related to first-stage variables. Nevertheless, the second-stage analysis is very intuitive for policymakers and regulators. Complex error model estimations for the DEA's second stage were proposed by Banker and Natarajan (2008) and Simar and Wilson (2007). They use a data-generating process model, which resembles the OLS and Tobit regression models in several ways (Da Silva et al., 2019). As a consequence, the regression residuals are handled differently in each process. Additionally, compound errors call for the separation of the model's residuals into two unidentified elements: noise and technical inefficiency.

There are a number of statistical presumptions made about the probability distribution of these components. One of the conditions of the argument is that these contextual variables have no direct effect on the production possibilities in DEA, but they have an impact on the disruption of efficiency, which is captured in the second-stage regression. To a large extent, our analysis' contextual variables have no direct impact on the DEA input and output variables used in the first-stage DEA. Using non-parametric spearmen rank correlation tests (refer to **Appendix 15**), we assume that the separability assumptions hold true for the second-stage analysis.

A combination of various types of regressions are applied, including ordinary least square (OLS), generalised least square (GLS) and Tobit regression (truncated); the latter was recommended by Simar and Wilson (1998). GLS is a technique for estimating the unknown parameters in a linear regression model when there is a certain degree of correlation between the residuals. With the help of RStudio, several OLS, GLS, FGLS, Newey West SE, and Tobit are conducted to evaluate the model's reaction to the different assumptions (Fox & Weisberg, 2018; Griffis & Stedinger, 2007).

The general regression model is expressed as follows:

$$\boldsymbol{EC_{it}} = \boldsymbol{\beta_0 + \beta_1 TTCI_{it} + \beta_2 Trade_{it} + \beta_3\ Visa_t + \beta_4 Economic_{it} + \beta_5\ Fuel\ Cost_{it} + \beta_6 Competition_{it} + \beta_7 BM_{it} + \beta_8 Alliance_{it} + \beta_9 Number\ of\ Employee_{it} + \beta_{10} Owner_{it} + \beta_{11} Air\ Connectivity_{it} + \varepsilon_{it}}$$

Where the dependent variable is Efficiency Change scores. TTCI, Trade, Visa, Economic, Fuel Cost, Competition, BM, Alliance, Number of Employee, Owner and Air Connectivity are explanatory variables representing the variables explained earlier. The bootstrapped results for the dependent variables will be used in the study, thus avoiding any bias or error that might occur as a result of using the original DEA scores.

4.16 Endogeneity and Separability

Endogeneity occurs when a variable, observable or unobservable, that is not included in the model is linked to variables that are included in the model (Wang & Gao, 2021). The error term is endogenous if associated with one or more explanatory factors. Unreliable and biased estimations might be the outcome of endogeneity. The problem is that endogeneity has a broad paradigm, and the difficulty lies in the fact that unobservable variables are linked to other variables in very complex ways, whether or not they are apparent (see the paper by Simar et al. (2016) for more details). Many econometricians have attempted to solve the problem of endogeneity, which is common in studies that use time series or panel data methods.

When endogeneity exists, one of the most prevalent approaches is to use instrumental variables (IVs) or simulate the association between unobserved variables (Cheng & Choi, 2022; Lu et al., 2018). For example, Koo et al. (2017) used the air liberalisation index as the IVs to analyse the relationship between direct air service and tourist demand. Hsiao and Hansen (2011) used the unit jet fuel cost as the IVs for average pricing in their analysis to forecast air travel demand. Wang et al. (2018) employed the Herfindahl-Hirschman Index at the route and airport levels, as well as the proportion of LCCs, to develop a regression equation for airline yield.

Another set of studies tackles the endogeneity problem using Two-Stage Least Squares regression (Boonekamp et al., 2018) and Three-Stage Least Squares regression (Elwakil et al., 2013; Hofer et al., 2018; Scotti & Dresner, 2015). In time-series research, lagged explanatory variables may be used as IVs to address endogeneity issues. Examples include Akinyemi (2018), Albayrak et al. (2020), Boonekamp et al. (2018), Chi et al. (2010), Fildes et al. (2011), Hakim and Merkert (2019), Koo et al. (2017), Mueller (2015), Sun et al. (2019) and Zhang (2015).

The separability issue is also a concern in DEA's second-stage analysis. It should be noted that all of these two-stage techniques have one additional disadvantage: they are based on a separability constraint between the input-output space and the space of environmental variables. Daraio and Simar (2005) created a revolutionary non-parametric approach that solves the abovementioned concerns. They discussed conditional boundaries based on external environmental components and conditional order-m frontiers, as well as the efficiency scores and non-parametric estimators that go with them. See also critical studies that address the topic in further detail (Badin et al., 2012, 2014; Dario et al., 2010; Taleb et al., 2023).

The employee variable in our study is one of the inputs used in the first stage of DEA analysis. DEA analysis may defy serial correlation assumptions in this scenario by claiming a two-way causation effect and a strong separability assumption. Wilson (2000) developed two separate routines in the R package FEAR 3.1: one for the continuous case (test.sep.cont) and one for the discrete case. However, unfortunately, the procedure (test.sep.disc) was recently published and has a few problems that prevented from obtaining reliable confirmation of separability for discrete variables (this was reported in Lisciandra et al., 2022). Other strategies for reducing the impact of the separability assumption included multivariate statistical methodology, Monte Carlo simulation and data generation process (bootstrap).

Furthermore, to guarantee our models' reliability, the employee variable was subjected to further analysis. We emphasise that:

- Our empirical analysis focused on efficiency change rather than DEA efficiency score. Therefore, the strong assumption of separability does not apply to our model. Exogeneity refers to the situation in linear regression when the independent variables are not correlated with the error term. The Wu-Hausman test may be used to verify if the independent variables in a linear regression are uncorrelated with the error terms (exogenous).

The endogeneity tests, conducted using the Wu-Hausman and Sargan tests (Janot et al., 2016), yielded a p-value that indicates strong evidence to support the accuracy of the model. Furthermore, the findings of the corelations tests are very consistent. (See combined Table-17).

-The causality impact is being evaluated, the variable employee was eliminated and a regression analysis was performed to check whether the coefficients were affected; we found no change in the coefficient direction, although a minor change in their values was observed. This robustness check (refer to the Table-16), which is a standard procedure in modern empirical investigations in which the researcher checks the stability of some core regression coefficient estimates after making changes to the regression specification, most commonly by adding or eliminating regressors (Lu & White, 2014).

- The Spearman correlation coefficient evaluates the monotonic relationship between variables based on ranked values rather than the raw database. The Spearman correlation test assessed the relationship between efficiency change results and the external variables (Sordero et al., 2017; De Silva et al., 2019). The results showed no correlation (refer to the combined **Table-6**).

Table 6 Combined table part-1 correlation tests part-2 Wu-Husman &Sargan tests

Part-1 Correlation Tests											
	ε, z_1	ε, z_2	ε, z_3	ε, z_4	ε, z_5	ε, z_6	ε, z_7	ε, z_8	ε, z_9	ε, z_{10}	ε, z_{11}
Pearson	1.381e-19	-2.350e-16	-2.932e-17	1.788e-16	2.004e-16	1.448e-17	-8.258e-17	-7.168e-17	1.293e-16	-6.765e-18	7.999e-17
Kendall	0.0178716	-0.0315747	0.0078656	-0.041580	0.0827363	0.0014722	-0.0580143	0.01338102	0.0028710	0.0349878	0.0059669
Spearman	0.0269082	-0.0385922	0.00974734	-0.053325	0.1215086	-0.003066	-0.0709082	0.01635499	0.0127669	0.05776407	0.0149647
Correlation between the residuals ε and the exogenous variables (z), names as they appear in the final regression models.											

Part- 2 Wu-Hausman and Sargan tests (employee variables)				
Wu-Hausman	df1 df2	statistic	p-value	*The Wu-Hausman and Sargan tests below utilises the employee variable as an IV in order to identify any potential correlations with the error term.* The null hypothesis is that there is no correlation between the errors and the regressors in the model. P-value >0.05 $H_{0\ accepted}$
	5 233	1.060	0.383	
Sargan	0 NA	NA	NA	

4.17 Research Ethics

Knowing what constitutes ethical research is important for all people who conduct research projects or use and apply the results of research findings. All researchers should be familiar with the basic ethical principles and have up-to-date knowledge of policies and procedures designed to ensure the safety of research subjects. They are also meant to prevent sloppy or irresponsible research because ignorance of policies designed to protect research subjects is not considered a viable excuse for ethically questionable projects. Therefore, it lies with the researcher to seek out and fully understand the policies and theories designed to guarantee upstanding research practices.

Research is a public trust that must be ethically conducted, trustworthy and socially responsible if the results are to be valuable. To be deemed ethical, all aspects of a research endeavour must be upstanding, from project conception to the submission of results for peer review. When even one aspect of a research endeavour is questioned or executed unethically, the integrity of the entire project is cast into doubt. Attempts to resolve ethical quandaries caused by differing societal standards and opposing philosophical perspectives have led to the widespread creation of codes of ethics (Saunders et al*.,* 2015). In part one of the research, we used data that is publicly available and regularly used by researchers undertaking various investigations. Therefore, there is no ethical risk in utilising this sort of data in this part of the research.

4.18 Chapter Conclusion

The study is based on an analysis of factors contributing to airline efficiency, and the research was based on econometric measures of secondary data. The proposed research approach can adequately measure the efficiency of airlines using the planned model. DEA was applied to test the efficiency of airlines by considering external and internal variables. Several software packages DEA-Solver, DEAP, (rDEA, FEAR, Benchmarking) packages for R were utilised and compared to assess the efficiency and productivity of our airline samples. To ensure the reliability of our data, we applied bootstrapping techniques to our efficiency results. Prior to conducting the regression analysis, various tests were carried out, such as multicollinearity, heteroscedasticity and VIF, to ensure our data was free from any assumptions that might affect the reliability of our regression model. A returns-to-scale test was carried out to ensure the nature of the scale assumption was correct. Finally, several regressions tests were carried out to evaluate the variables using different types of regression models to determine the best possible outcomes and reach a comprehensive result, some of the models tested in **Table-7**.

Table 7 Various regression model testing

	Model-1-T Tobit with log DV	Model-2-T Tobit with sq DV	Model-3-T Robust Newey West SE	Model-4-T GLS with Sq all	Model-5-T FGLS with log all
(Intercept):1	-7.98E-02	1.70E-01***			
(Intercept):2	-2.69E+00***	-5.00E+00***	1.04E+00***	1.24E-01***	
log(ACI)	-5.13E-04	5.73E-05	-2.75E-04	1.80E-03***	-0.07002.
BM	-7.84E-02*	-6.00E-04	2.88E-03	1.12E-02	
Competition	1.48E-04	5.52E-05	3.07E-04	2.19E-03	
log(Cost)	4.17E-02***	2.24E-03**	2.52E-02***	1.68E-02*	0.036986*
log(ECI)	8.04E-04	-2.49E-04**	-7.96E-04.	-2.44E-04	-0.10621
log(Employee)	1.47E-07	3.07E-08.	1.95E-08	1.75E-07	-0.10423***
Member	9.77E-02**	-4.08E-04	6.35E-03	6.80E-03	
OP	-1.25E-02	4.98E-03***	1.66E-02*	-2.31E-04	
log(TCI)	-2.67E-02	-2.39E-03	-1.74E-02	8.29E-02***	-0.03442
log(TO)	-2.87E-04*	-1.72E-06	3.38E-06	-6.68E-05	0.046658
log(VO)	1.71E-04	-4.49E-04***	2.39E-04	-6.56E-03***	0.07226.
Note: *, ** and *** indicate the significant level at 10%, 5% and 1%, respectively.					
More details on each model are available upon request					

Chapter 5 Data Analyses

This chapter focuses on the empirical examination of the dataset for the global airline industry by conducting DEA and regression analysis. In the first stage, the global airline industry will be examined using the DEA-Solver software (Cooper et al., 2007) to formulate an initial view by presenting a comprehensive DEA, wherein returns to scale, efficiency and slack analysis will be examined.

Further, the DEAP software (Coelli, 1996) will be used to generate the Malmquist index results that will expand our examination, deriving information about the level of productivity change of each global airline. Utilising pure scale efficiency and technological change, the contribution of technical aspects and innovation will be determined. With this, the existing efficiency and productivity will be determined. To increase the credibility of the results and provide a more accurate assessment of our global airline sample, bootstrapping (Simar & Wilson, 1998; Simar & Wilson, 1999a; Simar & Wilson, 2000; Simar & Wilson, 2011c) with 2,000 replications for the two year ends of 2011 and 2018 will be performed using FEAR software with RStudio.

5.1 Descriptive Analysis

Descriptive analysis reviews a full sample dataset in order to summarise the relevant facts and metrics. According to Sharma (2020), a descriptive review is necessary in order to form a broad idea of the available data. This evaluation is not primarily concerned with making technical or statistical inferences but rather with providing a broad description and breaking down a large volume of data in the simplest way possible. Herein, the dataset consists of the details of 35 airlines between FY2011 and FY2018 for the input and output variables used for the DEA. A summary of the descriptive statistics can be found in **Table 8** for our global airline sample, split into six of the variables used in our DEA for the regions of Europe, North America, Asia-Pacific, the Middle East, Africa and South America.

Table 8 Input-Output Descriptive Summary

Variables	Year	Mean	SD	Minimum	Maximum	Skewness	Kurtosis	SE
No of Employee	2011	28072.71	25659.03	3491.00	116400.00	1.69	2.61	4337.17
	2012	28655.40	25195.38	3566.00	117000.00	1.65	2.66	4258.80
	2013	29241.06	25732.00	3615.00	118300.00	1.60	2.45	4349.50
	2014	29731.54	25968.43	3766.00	118800.00	1.55	2.23	4389.47
	2015	30319.23	26403.84	4002.00	120700.00	1.56	2.21	4463.06
	2016	30519.40	27372.33	3870.00	124300.00	1.58	2.23	4626.77
	2017	31696.20	27789.19	3582.00	129400.00	1.66	2.63	4697.23
	2018	32524.20	28487.79	3905.00	135500.00	1.74	3.07	4815.31
Load Factor	2011	0.78	0.05	0.69	0.87	-0.30	-0.92	0.01
	2012	0.79	0.05	0.67	0.89	-0.32	0.10	0.01
	2013	0.79	0.05	0.69	0.89	-0.21	-0.59	0.01
	2014	0.79	0.05	0.66	0.91	-0.38	0.18	0.01
	2015	0.80	0.06	0.63	0.91	-0.70	0.29	0.01
	2016	0.80	0.06	0.68	0.93	-0.10	-0.11	0.01
	2017	0.81	0.06	0.68	0.94	-0.28	0.53	0.01
	2018	0.82	0.06	0.67	0.95	-0.42	1.02	0.01
No of Aircraft	2011	235.60	240.70	31.00	1253.00	2.45	6.92	40.69
	2012	247.74	242.15	34.00	1253.00	2.28	6.21	40.93
	2013	255.14	241.53	43.00	1265.00	2.29	6.37	40.83
	2014	260.00	239.41	45.00	1257.00	2.24	6.21	40.47
	2015	269.94	240.57	46.00	1239.00	2.10	5.27	40.66
	2016	275.69	245.36	47.00	1231.00	1.94	4.40	41.47
	2017	294.37	250.99	46.00	1263.00	1.90	4.21	42.42
	2018	308.23	264.94	45.00	1329.00	1.91	4.19	44.78
Operating Expense (Million USD)	2011	9366.39	9205.73	1004.00	38030.00	1.87	2.89	1556.05
	2012	10346.98	9545.15	1203.00	39652.00	1.78	2.65	1613.43
	2013	10650.86	9466.54	1268.00	39221.00	1.71	2.43	1600.14
	2014	10992.45	9721.74	1265.00	39261.00	1.71	2.37	1643.27
	2015	10505.49	9197.38	1420.00	41920.00	1.81	3.07	1554.64
	2016	10468.48	9099.23	1196.00	39686.00	1.61	2.22	1538.05
	2017	11388.32	9779.50	1044.00	43510.00	1.67	2.43	1653.04
	2018	12367.54	10538.08	1133.00	44241.00	1.56	1.87	1781.26
Revenue (Million USD)	2011	9943.30	9589.80	1077.00	38996.00	1.82	2.75	1620.97
	2012	10807.19	9877.10	1218.00	41291.00	1.75	2.56	1669.53
	2013	11185.57	9961.60	1160.00	40285.00	1.69	2.31	1683.82
	2014	11592.26	10237.11	1049.00	40362.00	1.67	2.22	1730.39
	2015	11729.59	10485.84	1015.00	43863.00	1.74	2.50	1772.43
	2016	11654.37	10303.15	1155.00	42423.00	1.59	2.00	1741.55
	2017	12458.55	10954.84	1053.00	47451.00	1.67	2.37	1851.71
	2018	13450.25	11524.86	1126.00	47741.00	1.57	1.96	1948.06
RPK (Million USD)	2011	71533.71	53973.29	4870.00	207531.00	0.95	0.31	9123.15
	2012	77599.71	53277.65	9943.00	205485.00	0.82	0.05	9005.57
	2013	80946.46	54831.65	9579.00	209652.00	0.74	-0.22	9268.24
	2014	84952.49	59223.97	9308.00	215353.00	0.79	-0.27	10010.68
	2015	90438.51	64089.24	9793.00	257000.00	0.85	-0.07	10833.06
	2016	95526.03	67483.70	10066.00	276608.00	0.82	-0.08	11406.83
	2017	101585.97	72156.12	9079.00	292221.00	0.84	-0.01	12196.61
	2018	107467.20	77120.73	11287.00	304700.00	0.84	-0.07	13035.78

Overall, the descriptive statistics show that the employee number, load factor, number of aircraft, operating expense, revenue and RPK values all increased over time due to technological development and efficiency-based improvements. However, the difference in the size and capability of the individual airlines resulted in more variability in all the datasets across the selected global airlines.

5.2 Correlation Analysis

Correlation is the process of examining the linkage between different variables to understand whether any relationship exists. The correlation analysis will determine the degree and strength of the relationship between variables (Kumar & Chong, 2018). Correlation analysis is a statistical measure that studies use to identify the presence of essential and relevant collinear relationships among different dataset characteristics (Senthilnathan, 2019), as it helps in identifying strength based on form, dispersion and direction. Before having any determination about the efficiency and productivity of any selected global airline, it is important to have more knowledge about the linkages between the selected inputs and outputs. The results of the correlation analysis are shown in **Table 9**.

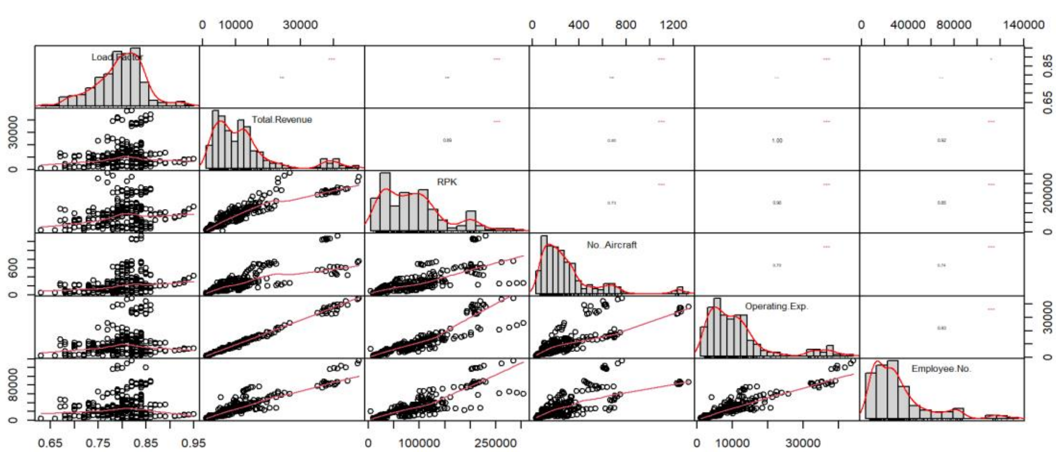
Table 9 Input-Output correlation Matrix

Year	Variables	No. Aircraft	Operating Exp.	Employee No.	Load Factor	Total Revenue	RPK
	No. Aircraft	1.00					
	Operating Exp.	0.83	1.00				
	Employee No.	0.76	0.90	1.00			
	Load Factor	0.33	0.24	0.17	1.00		
	Total Revenue	0.83	1.00	0.90	0.25	1.00	
2011	RPK	0.77	0.92	0.87	0.27	0.92	1.00
	No. Aircraft	1.00					
	Operating Exp.	0.83	1.00				
	Employee No.	0.77	0.93	1.00			
	Load Factor	0.31	0.22	0.14	1.00		
	Total Revenue	0.82	1.00	0.93	0.22	1.00	
2012	RPK	0.78	0.94	0.89	0.24	0.94	1.00
	No. Aircraft	1.00					
	Operating Exp.	0.82	1.00				
	Employee No.	0.75	0.93	1.00			
	Load Factor	0.40	0.28	0.21	1.00		
2013	Total Revenue	0.81	1.00	0.93	0.29	1.00	

	RPK	0.76	0.94	0.89	0.29	0.94	1.00
	No. Aircraft	1.00					
	Operating Exp.	0.79	1.00				
	Employee No.	0.73	0.92	1.00			
	Load Factor	0.37	0.29	0.21	1.00		
	Total Revenue	0.80	1.00	0.91	0.31	1.00	
2014	RPK	0.73	0.92	0.87	0.32	0.92	1.00
	No. Aircraft	1.00					
	Operating Exp.	0.75	1.00				
	Employee No.	0.72	0.94	1.00			
	Load Factor	0.32	0.27	0.22	1.00		
	Total Revenue	0.78	0.99	0.92	0.29	1.00	
2015	RPK	0.70	0.89	0.85	0.26	0.89	1.00
	No. Aircraft	1.00					
	Operating Exp.	0.77	1.00				
	Employee No.	0.72	0.94	1.00			
	Load Factor	0.28	0.13	0.07	1.00		
	Total Revenue	0.78	0.99	0.92	0.16	1.00	
2016	RPK	0.72	0.89	0.84	0.16	0.88	1.00
	No. Aircraft	1.00					
	Operating Exp.	0.78	1.00				
	Employee No.	0.74	0.94	1.00			
	Load Factor	0.22	0.10	0.02	1.00		
	Total Revenue	0.78	1.00	0.94	0.13	1.00	
2017	RPK	0.70	0.89	0.84	0.14	0.87	1.00
	No. Aircraft	1.00					
	Operating Exp.	0.77	1.00				
	Employee No.	0.74	0.93	1.00			
	Load Factor	0.25	0.08	0.04	1.00		
	Total Revenue	0.77	1.00	0.93	0.12	1.00	
2018	RPK	0.71	0.89	0.84	0.14	0.88	1.00

In general, there is a significant and strong correlation between the input and output variables with the exception of the load factor, which has lower values but still has substantial positive correlations with all of the other variables. **Figure 3** represents a visual summary of all the data correlations.

Figure 3 Input-Output Correlation Matrix



To summaries, there exist a very strong relationship between all the variables, reflects the competitive nature and the very difficult environment the airline industry operates in.

5.3 Isotonicity Test

The isotonsity test was performed to ensure that the properties of the variables used in the DEA were not violated. It requires that the relationship between inputs and outputs should not be erratic. Increasing the value of any input while keeping other factors constant should not decrease any output, but instead should lead to an increase in the value of at least one output (Emrouznejad & Podinovski, 2004).

Table 10 Input-Output Isotonicity Test

	Load Factor	Total Revenue	RPK	No. Aircraft	Operating Exp.	Employee No.
Load Factor	1					
Total Revenue	0.23**	1				
RPK	0.25**	0.89**	1			
No. Aircraft	0.32**	0.80**	0.73**	1		
Operating Exp.	0.20**	1**	0.90**	0.79**	1	
Employee No.	0.14	0.92**	0.85**	0.74**	0.93**	1
** p < 0.01						

Table 10 shows that, since all inputs show a significantly positive association with all outputs, the isotonsity property of DEA, which requires that an output should not decrease with an increase in an input (Dyson et al., 2001; Honma & Hu, 2008; Wanke et al., 2015), is not violated.

5.4 Stage-1 DEA Using DEA-Solver

DEA refers to examining the inputs and outputs of the selected DMUs to measure efficiency. Herein, focusing on understanding the selected global airlines' efficiency, the examination of DEA using DEA-Solver for FY2011 to FY2018 has been shown in **Appendices 1, 2, 3, 4, 5, 6, 7, 8 and 9.** More detailed individual analysis of each year is available from the author. Here, we summarise the main findings of the DEA-Solver results:

In the African region, the efficiency score value for Kenya Airways was 1, meaning the airline is efficient; there is no requirement for changes, and constant returns to scale exist. South African Airways' only efficient performances were in FY2013 and FY2014. For other periods with low-efficiency value, there is a requirement to change how companies conduct their business; there is a need to increase or decrease operating expense, employee number, load factor, total revenue or RPK to derive efficiency. Further, Ethiopian Airlines' efficiency score was 1, depicting no change requirement for FY2011 to FY2015 and constant returns to scale. However, from FY2016, the value decreased, i.e., 0.95 in FY2016, 0.96 in FY2017 and 0.88 in FY2018, possibly because of the airline expanding with a substantial increase in fleet size. The tendency to expand has created a deficiency in performance, necessitating a change in the inputs or outputs to regain efficiency.

The efficiency examination of the Asia-Pacific region showed that Air China, Cathay Pacific and Korean Air operate at an efficiency score value of 1 with constant returns to scale, indicating that they perform efficiently with no requirements to change inputs or outputs. China Eastern Airlines had an efficiency score of less than 1 for FY2011 to FY2012, showing decreasing returns-to-scale presence for the airline. To improve efficiency, the number of aircraft, employee number and load factors must be increased or decreased. Japan Airlines initially had an efficiency score value of 1, but by FY2015, the score had reduced to below 1, representing a requirement to adjust how the airline operates to derive efficient performance. Qantas and Thai Airways, with efficiency scores of less than 1 and decreasing returns to scale, defined those changes in the number of aircraft and load factor for Qantas. For Thai Airways, employee numbers and load factor need to be changed to derive efficient performance. Singapore Airlines initially had a value of 1, but by FY2016, their value decreased to below 1 due to intense competition. The airline needs to look at changing its operating performance, decreasing its operating expenses by 7% and the number of employees by approximately 8% to regain its efficiency.

In the European region, Aer Lingus had an efficiency score of 1, representing no change in input or output is required. Furthermore, Aeroflot and Alitalia had efficiency values less than one, indicating that as returns to scale vary, there is a need to increase or decrease employee number, load factor and RPK significantly in order to achieve efficient performance. Alitalia indicated a solid need to change its operations; the airline needs to review its operating expenses, its number of employees and reduce the unutilised number of aircraft. British Airways initially had fluctuations in their efficiency score value, depicting a requirement for change in employee number and load factor to improve efficiency. In later years, the airline witnessed a remarkable adjustment and return to efficiency. EasyJet and Finnair also witnessed lower efficiency score values, showing the need for a slight increase or decrease in operating expense, load factor, total revenue or RPK to derive effective performance. Iberia initially had a very low efficiency score, wherein a change in employee number, operating expense, load factor and RPK was required to derive efficiency. However, as the airline restructured and joined British Airways, and later the International Airline Group (IAG), we see a better performance; by FY2016, the value derived was 1, showing no further change is required.

Furthermore, KLM, Lufthansa and Ryanair all had efficiency scores of 1, indicating effective operation; however, minor changes in the number of aircraft, employee numbers and RPK are required for completely effective performance. Indeed, Ryanair has proven to be one of Europe's most competitive and efficient airlines. SAS and Turkish Airlines had low efficiency score values, i.e. less than 1, depicting the need for change in operating expense, load factor and RPK to attain complete efficiency.

In the Middle Eastern region, Etihad Airways, with an efficiency score of 1 and constant returns to scale, required no change in input or output to improve performance in the early years. Nevertheless, for FY2014, Etihad Airways, with decreasing returns to scale and an efficiency score of 0.95, needed either the employee number or total revenue to increase or decrease to derive efficiency. Similarly, for FY2015 to FY2016, though constant returns to scale existed, as efficiency scores were 0.86 and 0.85, respectively, a significant change in employee number or total revenue is required to attain efficient performance. Emirates' efficiency score was 1 for FY2011 to FY2018, representing no change required in the input or output for better performance. Qatar Airways, though initially having a value of 1 and showing the presence of efficiency, over time there was a reduction in value to a level below 1, showing the need for an increase or decrease in employee number, load factor and RPK to derive effective performance.

In the North American region, Air Canada had an efficiency score of less than 1, showing the need for an increase or decrease in the number of aircraft, employee number, load factor and RPK to derive effective performance. Alaska Airlines, on average, had an efficient performance with a score of 1. However, their fluctuations represented that to maintain efficiency, a change in employee number, aircraft, load factor and RPK was required. Delta Air Lines and Hawaiian Airlines were efficient, with score values of 1, and no change in input or output was required to influence the existing efficiency. Furthermore, JetBlue, Southwest, United Airways and WestJet Airlines had efficiency scores less than 1; as a result, there is a need to increase or decrease the number of aircraft, employee number, load factor and RPK in order to achieve more efficient performance.

Lastly, in the South American region, LATAM Airlines Group had an efficiency score of less than 1, which means an increase or decrease in the number of aircraft, employee number and load factor is required to improve the efficiency of the airline.

In summary, our results confirm previous research on airline efficiency by reflecting the nature and competitive environment this industry operates in. Our small African sample indicates that African airlines are relatively small in size and operate with a limited network. On the other hand, Asia has a large variety of samples; most of the airlines in this region operate at an outstanding level of efficiency, owing to the large domestic markets in China and Japan and the high brand quality of Singapore and Cathay. Europe is very competitive, and due to this extreme competition, airlines tend to operate at an optimal scale and efficiency level. In the Middle East, Emirates has indeed proven to be the dark horse, operating at a constant and efficient level. Qatar and Etihad, although initially efficient due to limited size and network, show a lag in their performance and issues with scale deficiency. Due to the enormous domestic market, North America has also shown a very high level of efficiency, but the overall noticeable element in this region is the high number of aircraft owned by the airlines, especially Southwest. LATAM is the only airline in our sample, operating in South America, that needs to reduce operational expenses, especially the number of employees (see the summary in **Appendix 9**).

5.5 Malmquist Index Analyses

The Malmquist index compares firms' efficiency and total productivity between two periods of time. Two products, the catch-up and the shift in the frontier, must be defined. The first term relates to the DMUs' efforts to improve efficiency, while the latter reflects the change in the efficient frontiers surrounding the DMUs between the two periods. The Malmquist index is among the most popular methods for measuring productivity change among different DMUs over time. Based on the DEA methodology, the Malmquist index measures productivity change by examining the role of technological and technical change over time. Even the term 'technical change' can be further decomposed into the scale, along with 'pure technical EC' (Bjurek, 1996; Worthington, 1999). The popularity of this index stems from its simplicity and the lack of any restriction on the number of inputs and outputs for examining productivity; thus, the Malmquist index is essential for analysing not only productivity but also productivity change over time (Tone, 2004). Herein, the requirement is to differentiate between the most effective and least effective airlines and understand whether technical or technological change contributes more to influencing productivity. The DEAP software (Coelli, 1996) has been used in this part of the analysis to derive the Malmquist index for our selected global airlines' dataset for FY2011–FY2018.

Distance summaries are the initial step in Malmquist index analysis. They focus on examining the efficiency scores that differ from the efficient production frontier. Herein, the value of 1 indicates that the company is operating at the production frontier and is efficient, but a value below 1 represents the existence of a gap between the current efficiency level and the production frontier-required value; hence, a change in input or output is required to regain efficiency (Paço & Pérez, 2013; Şişman, 2017). For understanding the selected global airline's productivity, the input- and output-orientated distance summaries for different regions have been summarised in **Appendices 10 and 11**.

5.6 The Overall Malmquist Index for Airlines' Means

The Malmquist index analyses for all the airlines in **Table 11** provides information on the total efficiency and productivity of the selected 35 airlines from FY2011 to FY2018.

Table 11 Overall Malmquist Productivity Index Input Oriented

Region	Firm	effch	techch	pech	sech	tfpch
Africa	Ethiopian Airlines	0.98	0.98	0.98	1.00	0.96
Africa	Kenya Airways	1.00	1.00	1.00	1.00	1.00
Africa	South African Airways	0.99	0.98	1.00	1.00	0.97
Asia-Pacific	Air China	1.01	1.00	1.00	1.01	1.01
Asia-Pacific	Cathay Pacific	1.00	1.00	1.00	1.00	1.00
Asia-Pacific	China Eastern Airways	1.01	0.99	1.01	1.00	1.00
Asia-Pacific	Japan Airlines	1.00	0.99	1.00	1.00	1.00
Asia-Pacific	Korean Air	1.00	0.98	1.00	1.00	0.98
Asia-Pacific	Qantas Airways	1.01	1.00	1.00	1.01	1.01
Asia-Pacific	Singapore Airlines	0.99	0.98	0.99	1.00	0.97
Asia-Pacific	Thai Airways	1.00	0.99	1.00	1.00	1.00
Europe	Aer Lingus	1.00	0.99	1.00	1.00	0.99
Europe	Aeroflot	1.02	0.99	1.02	1.00	1.00
Europe	Alitalia	0.99	1.00	0.99	1.00	0.99
Europe	British Airways	1.02	1.00	1.01	1.01	1.02
Europe	EasyJet	0.99	1.00	1.00	0.99	1.00
Europe	Finnair	1.03	1.00	1.03	1.00	1.03
Europe	Iberia	1.02	1.01	1.02	1.00	1.03
Europe	KLM	1.00	0.99	1.00	1.00	0.99
Europe	Lufthansa	1.01	1.00	1.00	1.01	1.01
Europe	Ryanair	1.00	1.00	1.00	1.00	1.00
Europe	SAS	1.02	1.01	1.02	1.00	1.03
Europe	Turkish Airlines	1.01	1.01	1.01	1.00	1.02
Middle East	Emirates	1.00	1.03	1.00	1.00	1.03
Middle East	Etihad Airways	1.00	0.98	1.00	1.00	0.98
Middle East	Qatar Airways	0.97	0.99	0.97	1.00	0.96
North America	Air Canada	1.01	1.00	1.02	1.00	1.01
North America	Alaska Airlines	0.99	1.01	0.99	1.00	1.00
North America	Delta Air Lines	1.02	1.00	1.00	1.02	1.02
North America	Hawaiian Airlines	1.00	0.98	1.00	1.00	0.98
North America	JetBlue	0.99	1.00	0.99	1.00	1.00
North America	Southwest Airlines	1.02	1.00	1.02	1.00	1.02
North America	United Airlines	1.01	1.00	0.99	1.01	1.01
North America	WestJet	0.99	1.00	0.98	1.00	0.99
South America	LATAM Airlines Group	1.00	0.97	1.00	1.00	0.97

The Malmquist index summary of firms' mean analysis depicts that, in the Africa region, only the TFP of Kenya Airways was 100%, with an equal contribution of technical efficiency and technological change, i.e. 100%. However, for Ethiopian Airlines and South African Airways, the TFP was lower than 100%, i.e. 96% and 97%, respectively. Both Ethiopian Airlines and South African Airways have low technical efficiency, i.e. 98% and 99%, due to a lack of innovation and technological change, i.e., 98% for both.

For the Asia-Pacific region, among eight airlines, six have a TFP of 100% or more, i.e. Air China with 101%, Cathay Pacific with 100%, China Eastern Airlines with 100%, Japan Airlines with 100%, Qantas with 101% and Thai Airways with 100%. Herein, for all the airlines with TFP of 100%, technical EC was 100% or higher, i.e. Air China with 101%, Cathay Pacific with 100%, China Eastern Airlines with 101%, Japan Airlines with 100%, Qantas with 101% and Thai Airways with 100%, but technological change was 100% or more only for Air China, Cathay Pacific and Qantas. However, all other airlines, i.e. Korean Air and Singapore Airlines, had low productivity, with 98% and 97% TFP, respectively. For these airlines, technical EC was 99% or more, and the total technological change was lower than 100%, resulting in reduced TFP below 100%.

In the European region, 12 airlines were considered, wherein most of them (nine) had a TFP of 100% or higher. Herein, Aeroflot and British Airways had TFP of 100% and 102%, with a technical change of 102% but a technological change of 99% and 100%, respectively. EasyJet's TFP was 100% by having 100% technological change but technical efficiency of 99%. Finnair's technical efficiency had a significant role (103%) in improving TFP, i.e. 103%, wherein technological change was 100%. Iberia had a technical efficiency score of 102% and a technological change score of 101%, leading to higher TFP, i.e. 103%. Even for Ryanair, Lufthansa, SAS and Turkish Airlines, TFPs of 101%, 100%, 103% and 102% were derived from significant technical efficiency contributions, i.e. 101%, 100%, 102% and 101%, and technological changes of 100%, 100%, 101%, and 101%, respectively. The remaining airlines, Aer Lingus and KLM, had low TFPs because their technological change did not work well. Their TFPs were 99%, their technical efficiencies were 100% and their technological changes were also 99%. Lastly, the change was 99% for Alitalia despite having 100% technological efficiency.

Also in the Middle Eastern region, Emirates had a technical EC of 100% and a technological change of 103%, contributing to a TFP of 103%. However, Etihad Airways, with a technical efficiency of 100% and a technological change of 98%, resulted in a TFP of only 98%. For Qatar Airways, too, technical EC was 97% and technological change was 98%, resulting in a lower TFP of 96%. Thus, with the exception of Emirates, Middle Eastern airlines were inefficient.

The American region had six airlines with a TFP of 100% or more, i.e. Air Canada, Alaska Airlines, Delta Air Lines, JetBlue, Southwest and United Airlines. All these airlines, except Alaska (99%) and JetBlue (99%), had more than 100% technical efficiency, i.e. 101% for Air Canada, 102% for Delta Air Lines, 102% for Southwest Airlines and 101% for United Airlines. Technological change for all the airlines in this region was 100% or more, showing the contribution of technological innovation in improving productivity. For Hawaiian Airlines, technological change was low, i.e. 98%, contributing to a low productivity of 98%, while for WestJet, a low technical efficiency level, i.e. 99%, resulted in a reduced productivity of 99%. Thus, most North American airlines, were efficient, with technological change being the main contributor. Finally, in the South American region, LATAM Airlines Group had a TFP of 97%, with a 100% contribution of technical efficiency but 97% of technological change, indicating that LATAM was not efficient.

From analysing the above Malmquist mean scores, we can derive two important conclusions. The first is that, among the selected global airlines, European airlines are the most efficient, with technical efficiency (the industry) playing a significant role in improving productivity and performance. Second, our results show that the airline business is very competitive because the total productivity measure has not changed much over the years.

5.7 The Bootstrapped Malmquist Index

The Simar and Wilson (1999a) bootstrapping procedure was introduced to account for possible temporal correlations arising from the panel data characteristics. The purpose of the bootstrap technique is to obtain confidence intervals for Malmquist productivity changes, pure ECs, scale ECs and technology changes. Bootstrapping herein is carried out with the help of the FEAR package (Wilson, 2008) and incorporated with RStudio to compute the Malmquist index (Wilson, 2013). The Malmquist results and components for the FY2011 and FY2018 are shown in **Table 12**. Results for all years are available from the author.

The examination of the bootstrapped results showed that, still, technical efficiency is a major component influencing the efficiency of different regions. The results show that, in the African region, the Malmquist index TFP was significantly below 1, indicating that this region has experienced lower productivity mainly due to technological change (innovation). The African region needs to adopt more innovative and better managerial practices to regain positive productivity.

In the Asia-Pacific region, we witnessed a better productivity change from the year 2011 to the year 2018, mainly due to efficiency and not technological change. Korean Air and Singapore Airlines need to be aware of the drop in their productivity levels, mainly due to technological change and innovation. The contribution of technological change in influencing productivity is verified by the bootstrapping results, wherein the TFP value was less than 100% for five airlines out of eight; this was mainly because technological change was less than 100% in six airlines.

For the European region, the Malmquist index identified 100% or more productivity for most airlines, with technical efficiency playing a significant role in influencing the productivity score. Alitalia was the worst airline in terms of a total productivity score of 0.925, mainly due to inefficiency. Due to the efficiency of their operations, Finnair scored a high productivity change of 1.20. Bootstrapping confirmed this by showing the majority of our European sample (7 out of 12) having more than 100% productivity; this was due to the significant technical EC. Technological change, though, witnessed a significant reduction in most airlines, with only Turkish Airlines achieving a significant growth of 6.3%.

The Middle East airline Malmquist index shows that only Emirates remained productive throughout the years, with a significant increase in the TFP of about 7.5%, mainly due to the innovative approach Emirates has adopted. Qatar and Etihad Airways seemed to have difficulties gaining positive productivity, as they both had a significant reduction in their efficiency, Qatar Airways especially, with a 20% reduction over the years, mainly stemming from low and pure efficiency. Bootstrapping verified the role of both technical and technological change by stating that, as long as the role of technical and technological change is below 100%, the TFP for airlines will suffer.

In the North American region, the Malmquist index analysis showed that TFP for the airlines has been dependent on technical efficiency, with a significant role in reducing TFP. Bootstrapped results supported these findings by stating that having technical change lower than 1 reduced TFP to below 1 in most airlines. Hence, technical change in the North American region had a significant role in influencing productivity.

With a technological change of 0.81 and a technical efficiency of 100%, the LATAM Airlines Group was shown to be inefficient. In bootstrapped results, technological change lowered productivity to a significant level of 19% below unity, i.e. 0.813.

Hence, the comparison of the Malmquist index results with the bootstrapped findings showed that technical efficiency has a major role in productivity in different global airlines. Despite the fact that technological change or innovation provides more opportunities to improve capacity with limited technical efficiency, effective productivity is not obtained. Airlines such as Air China, Qantas, British Airways, Lufthansa, Hawaiian Airlines, Emirates and United have significant scale efficiency, indicating that these airlines are taking advantage of operating at the optimal size.

Table 12 Bootstrap Malmquist Productivity Index for year ends 2011-2018 FEAR results

Region	DMU	Malm (tfp) - b	effch - b	techch - b	pech - b	sech - b
Africa	Kenya Airways	0.934579439**	1	0.934579439**	1	1
Africa	South African Airways	0.892857143**	0.952380952	0.934579439**	0.980392157	0.970873786
Africa	Ethiopian Airlines	0.819672131**	0.869565217**	0.943396226**	0.877192982**	0.99009901
Asia-Pacific	Air China	1.136363636**	1.086956522**	1.041666667**	1	1.086956522**
Asia-Pacific	Cathay Pacific	0.99009901	1	0.99009901	1	1
Asia-Pacific	China Eastern Airways	1.041666667	1.086956522**	0.952380952	1.098901099**	0.99009901
Asia-Pacific	Japan Airlines	0.980392157	1.030927835	0.952380952	1.030927835	1
Asia-Pacific	Korean Air	0.877192982**	1	0.877192982**	1	1

Asia-Pacific	Qantas Airways	1.098901099**	1.052631579**	1.030927835	1.01010101	1.052631579**
Asia-Pacific	Singapore Airlines	0.833333333**	0.925925926**	0.892857143**	0.934579439**	0.99009901
Asia-Pacific	Thai Airways	0.970873786	1.020408163	0.952380952	1.020408163	1
Europe	Aer Lingus	0.952380952	1	0.952380952	1	1
Europe	Aeroflot	1.086956522**	1.111111111**	0.980392157	1.149425287**	0.970873786
Europe	Alitalia	0.925925926**	0.917431193**	1.01010101	0.917431193**	1
Europe	British Airways	1.162790698**	1.123595506**	1.030927835	1.041666667	1.075268817**
Europe	EasyJet	0.99009901	0.961538462	1.030927835	1	0.961538462
Europe	Finnair	1.204819277**	1.204819277**	1	1.204819277**	1
Europe	Iberia	1.030927835	1.123595506**	0.909090909**	1.123595506**	1
Europe	KLM	0.943396226**	1	0.943396226**	1	1
Europe	Lufthansa	1.041666667	1.063829787**	0.99009901	1	1.063829787**
Europe	Ryanair	0.943396226**	1	0.943396226**	1	1
Europe	SAS	1.136363636**	1.176470588**	0.970873786	1.176470588**	1
Europe	Turkish Airlines	1.136363636**	1.063829787**	1.063829787**	1.063829787**	1
Middle East	Etihad Airways	0.943396226**	1	0.943396226**	1	1
Middle East	Emirates	1.075268817**	1.020408163	1.052631579	1	1.020408163
Middle East	Qatar Airways	0.806451613**	0.819672131**	0.99009901	0.819672131**	1
North America	Air Canada	1.111111111**	1.098901099**	1.01010101	1.111111111**	0.99009901
North America	Alaska Airlines	0.943396226**	0.934579439**	1.01010101	0.925925926**	1.01010101
North America	Delta Air Lines	1.162790698**	1.149425287**	1.01010101	1	1.149425287**
North America	Hawaiian Airlines	0.819672131**	0.980392157	0.840336134**	1	0.980392157
North America	JetBlue	0.970873786	0.952380952	1.020408163	0.952380952	1
North America	Southwest Airlines	1.123595506**	1.123595506**	1	1.136363636**	0.99009901
North America	United Airlines	1.041666667	1.030927835	1.01010101	0.961538462	1.075268817**
North America	WestJet	0.892857143**	0.900900901**	0.99009901	0.884955752**	1.01010101
South America	LATAM Airlines Group	0.81300813**	1	0.81300813**	1	1

Notes*: malm: Malmquist Productivity Index; effch: EC; techch: Technological change; pech: Pure EC; sech: Scale EC.*

*** indicates that the index is significantly different from unity at the 5% level.*

5.8 Stage-2 Regression Analysis Results

The panel data analysis has been performed for FY2011 to FY2018, utilising bootstrapped technical EC (Eff). First, the OLS regression model is used to examine the connection, in which the distribution of data is assessed by simply fitting the best line. Though OLS allows for evaluation, it is necessary to have fundamental assumption testing, such as linearity, heteroscedasticity, multicollinearity or normality before constructing the model for effective result derivation (Burton, 2021). By testing the OLS results, we can develop more advanced and complicated regression models that can be used to more accurately estimate the results.

5.9 Ordinary Least Square

OLS is one of the most utilised estimators in research. When the OLS conditions are fulfilled, it is the best unbiased linear estimator of a variable of interest. Alternative strategies should be employed to resolve difficulties when one or more OLS assumptions are violated (Dismuke & Lindrooth, 2006).

In **Table 13,** we show the OLS regression model for EC (Eff) with the inclusion of air connectivity index, BM, competition, fuel cost, EFW, employee number, member, ownership, TTCI, trade openness and visa openness as independent variables.

5.9.1 Model-1 EC OLS (Eff)

The OLS model is built to examine the aspects leading to change in technical efficiency. Technical efficiency represents the efficiency of producing the output with a given input. Consisting of two aspects, i.e. scale and pure efficiency, technical efficiency defines the success of any industry in converting input to output by selecting adequate returns to scale. Though airlines' focus is mostly on minimal use of resources, this effectiveness is influenced by different factors. Thus, the OLS model is built considering industrial-, institutional- and resource-based factors, which are shown in **Table 13**.

Table 13 Model-1 Efficiency Change OLS(Eff)

Eff	Estimate	Std. Error	t value	Pr(>|t|)	VIF	R-squared	Adjusted R square	F-value	Breusch–Pagan test P-value
Intercept	1.08	0.10	10.40	0.00***		0.12	0.06	1.90	0.04
ACI	0.00	0.00	-1.30	0.20	8.81				
BM	0.00	0.02	0.10	0.92	2.44				
Competition	0.00	0.00	0.18	0.86	2.04				
Cost	0.03	0.01	3.92	**0.00*** **	1.34				
EFW	0.00	0.00	0.01	0.99	10.58				
Employee	0.00	0.00	0.51	0.61	1.36				
Member	0.00	0.02	0.11	0.91	3.35				
Ownership	0.02	0.01	1.25	0.21	2.46				
TTCI	-0.03	0.03	-1.20	0.23	18.52				
TO	0.00	0.00	-0.28	0.78	2.64				
VO	0.00	0.00	0.38	0.71	8.63				

Note: **, ** and *** indicate the significant level at 10%, 5% and 1%, respectively.*

Table 13 shows that the value of the Breusch–Pagan test significance is 0.04, which is less than the required level of 0.05; thus, the null hypothesis of having constant variance is rejected. Hence, the assumption of having homoscedasticity for the built OLS model is not fulfilled (Cabo et al., 2019). The F-value for the model is 1.90 > 1; thus, precision is present in the model by having the institutional-, resource- and industrial-based factors as independent variables (Sureiman & Mangera, 2020). The adjusted R2 value for the model is 0.06, showing that only 6% of the variation in technical efficiency is represented by including independent variables. Lastly, for the examination of the multicollinearity assumption, the VIF value of the model is assessed. Herein, as all the VIF results except EFW (10.58) and TTCI (18.52) have values less than 10, for all variables except EFW and TTCI, multicollinearity is not present (Daoud, 2017; Kim, 2019).

5.10 Tobit Regression Analysis

Regression analysis with restricted dependent variables, such as the DEA efficiency index, often employs econometric models with censored errors or truncated terms. The Tobit model, introduced by Tobin (1958), is often used when the dependent variable has a limiting value (see, for example, Fethi et al., 2000; Merkert & Hensher, 2011; Scheraga, 2004b). This model may examine how macroeconomic and socioeconomic issues affect airline efficiency. The Tobit regression model has been identified as the most effective and appropriate multivariate statistical method for understanding efficiency and productivity characteristics, allowing for the resolution of issues such as heteroscedasticity and multicollinearity, as well as overcoming the limitations of the basic OLS model (Fethi et al., 2000).

5.10.1 Model-2 Logged Technical EC TOBIT (Log Eff)

The Tobit model has been developed to determine the influence of many factors on technical efficiency by including a logged form of different factors, i.e. technical efficiency score, air connectivity index, cost, EFW, employee, TTCI, trade openness and visa openness. As dummy variables have less skewness in their data and are thus essential for understanding categorisation, a simple form of data, instead of logged form, is considered. The results are shown in **Table 14**.

Table 14 Model-2 Logged Technical Efficiency Change TOBIT (LogEff)

Log (Eff)	**Estimate**	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept):1	−0.18	0.26	−0.70	0.48
(Intercept):2	−2.68	0.07	−39.50	0.00***
log (ACI)	0.02	0.01	1.45	0.15
BM	−0.08	0.04	−2.01	**0.04****
Competition	0.00	0.00	0.53	0.60
log (Cost)	0.07	0.02	3.27	**0.00*****
log (IEFW)	−0.06	0.08	−0.75	0.45
log (Employee)	0.02	0.01	1.74	**0.08***
Member	0.09	0.04	2.28	**0.02****
Ownership	−0.01	0.02	−0.50	0.62
log (TTCI)	0.16	0.14	1.12	0.26
log (TO)	−0.03	0.02	−2.15	**0.03****
log (VO)	0.01	0.04	0.22	0.83

Note: **, ** and *** indicate the significant level at 10%, 5% and 1%, respectively.*

Table 14 shows that the standard error value for all the variables is low, i.e. either below 0.1 or close to 0.1; thus, there is less bias in the dataset, and even the model formulated for computing the impact is effective (Sileshi & Anglong, 2015). Further, the P-value shows that all the variables except BM, log (Cost), log (Employee), Member and Log (TO) have values higher than 0.05 and 0.10, thus showing that the null hypothesis of having no significant impact on respective variables on the technical change is not rejected. However, the values of variables BM, log (Cost), Member and log (TO) are 0.04, 0.00, 0.02 and 0.03, respectively, which are less than 0.05; thus, the null hypothesis of having no impact on these variables of technical change is rejected.

Even the variable log (Employee) has a P-value of 0.08, which is more than 0.05 but less than 0.1; thus, at a 10% level of significance, the null hypothesis of the employee having no impact on technical change is also rejected. Coefficient value helps in understanding the impact of each variable, i.e. with 1% rise in jet fuel cost and employee number, the technical change capacity of airlines improves by $[(1.01)^{(0.07)} - 1 \approx 0.0007]$ 0.0007% and $[(1.01)^{(0.02)} - 1 \approx 0.0002]$ 0.0002%. Further, as the airline becomes a member, the technical efficiency rises by $[\exp(0.09) - 1 \approx 0.094]$ 0.09%. However, with the adaptation of FSC BM technical efficiency decreases by $[1-\exp(-0.08) \approx 0.077]$ 0.08% (in another words LLCs, are 8% more efficient than FSCs). Even rise in trade openness by 1% decreases technical efficiency by $[1 -(1.01)^{(-0.03)} \approx 0.0003]$ 0.0003%. Thus, the technical efficiency of airlines is influenced by jet fuel cost, employee number, membership status, BM and trade openness . Benoit (2011) provides an excellent explanation of how to interoperate regressions with log transformation.

5.11 Comparative Analysis of European Airlines with the Rest of the World

Though China and the US hold dominance in military and economic aspects, for the aviation industry, the existence of regional alliances has strategic significance for economies. With the initiation of many diplomatic activities, Europe plays a stabilising role in the growth of the aviation industry with the usage of technologies. Creating an environment that promotes LCC BMs for airlines, European airlines significantly contribute to defining global aviation industry productivity and growth (IATA, 2018a). Herein, as the study mainly consists of European airlines, i.e. 12 out of 35, a comparison of the industrial-, institutional- and resource-based factors on technical efficiency of European airlines, and those of the rest of the world, is carried out.

5.11.1 Model-3 Logged EC Europe TOBIT (Log Eff)

Table 15 shows that the standard error value for European airlines has been below 0.10 or close to 0.15, depicting that there is low bias in the model and that the Tobit model is effective in computing the impact of various institutional-, industrial- and resource-based factors (Sileshi & Anglong, 2015).

Table 15 Model-3 Logged Efficiency Change Europe TOBIT (LogEff)

Log (Eff)	**Estimate**	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept):1	−0.27	0.28	−0.95	0.34
(Intercept):2	−2.68	0.07	−39.57	0.00***
log (ACI)	0.02	0.01	1.54	0.12
BM	−0.07	0.04	−1.75	**0.08***
Competition	0.00	0.00	0.49	0.63
log (Cost)	0.08	0.02	3.34	**0.00*****
log (EFW)	−0.02	0.09	−0.22	0.82
log (Employee)	0.02	0.01	1.87	**0.06***
Member	0.08	0.04	1.97	**0.05****
Ownership	−0.01	0.02	−0.44	0.66
log (TTCI)	0.12	0.15	0.79	0.43
log (TO)	−0.04	0.02	−2.29	**0.02****
log (VO)	0.00	0.04	0.02	0.99

***Note:** *, ** and *** indicate the significant level at 10%, 5% and 1%, respectively.*

The P-value examination represents that, for all variables except BM, log (Cost), log (Employee), member and log (TO), the value is more than 0.05 or 0.10; thus, the null hypothesis of having no impact on the variables influencing the technical efficiency of European airlines has not been rejected. However, for log (Cost), member and log (TO), the values are 0.00, 0.05 and 0.02, which are not more than 0.05; thus, the null hypothesis of having no impact on the variables of technical efficiency is rejected. Further, even for variables BM and log (Employee), the values are 0.08 and 0.06, which are more than 0.05 but less than 0.10; thus, in some cases, the null hypothesis has no impact on the variables of technical efficiency and is rejected.

The coefficient value of the model determines the contribution of each factor, wherein with a 1% rise in jet fuel cost and employee number, the technical efficiency of European airlines rises by [(1.01) $^{(0.08)}$ -1 ≈ 0.0008] 0.0008% and [(1.01) $^{(0.02)}$ -1 ≈ 0.0002] 0.0002%. As airlines become a member, the technical efficiency rises by [exp (0.08) -1 ≈ 0.083] 0.08%. Further, with the adoption of FSC BM, the technical efficiency decreases by [1-exp (-0.07) ≈ 0.068] 0.07% (in another words, LLCs are 7% more efficient than FSCs). Lastly, a 1% increase in trade openness results in reducing technical efficiency by [1 -(1.01) $^{(-0.04)}$ ≈ 0.0004] 0.0004%. Hence, for European airlines, fuel cost, membership, BM, employee number and trade openness influence technical efficiency.

5.11.2 Model-4 Logged EC Rest of the World TOBIT (Log Eff)

Apart from European airlines, the aviation industry of the rest of the world has also shifted its functioning process to meet the competitive environment needed by switching their BM or making a change in their technical efficiency; thus, there is a requirement to examine different factors' influences on the technical efficiency of the airlines of the rest of the world. Hence, the results of the Tobit model formulated for examining the impact is shown in **Table 16**.

Table 16 Model-4 Logged Efficiency Change Rest of the World TOBIT (LogEff)

Log (Eff)	**Estimate**	**Std. Error**	**t value**	**Pr (>|t|)**
(Intercept):1	−0.09	0.37	−0.26	0.80
(Intercept):2	−2.69	0.08	−31.97	0.00***
log (ACI)	0.01	0.02	0.36	0.72
BM	−0.10	0.05	−2.10	**0.04****
Competition	0.00	0.00	−0.09	0.93
log (Cost)	0.10	0.03	3.39	**0.00*****
log (EFW)	−0.06	0.15	N/A	N/A
log (Employee)	0.02	0.01	1.50	0.13
Member	0.08	0.04	1.86	**0.06***
Ownership	−0.01	0.03	−0.41	0.68
log (TTCI)	0.06	0.23	0.26	0.80
log (TO)	−0.03	0.02	−1.38	0.17
log (VO)	0.02	0.06	0.31	0.75

Note: **, ** and *** indicate the significant level at 10%, 5% and 1%, respectively.*

In **Table 16**, though the value of standard error varies between 0.01 to 0.23, the approximate value is close to 0; thus, there is less bias in the dataset, and the built model is effective in computing the impact of different factors (Sileshi & Anglong, 2015). Further, the P-value for all the variables except BM, log (Cost) and member is more than 0.05 or 0.10; thus, the null hypothesis of having no impact on the variables of the technical efficiency of the rest of the world's airlines is not rejected. As for the BM and log (Cost), the P-values are 0.04 and 0.00 < 0.05, and member is 0.06 > 0.05 but less than 0.10; thus, the null hypothesis of having no impact on the variables of technical efficiency is rejected.

The coefficient value depicts that with a 1% rise in cost, the technical efficiency increases by $[(1.01)^{(0.10)} -1 \approx 0.0010]$ 0.0010%. Even becoming a member, increases technical efficiency by $[\exp(0.08) - 1 \approx 0.083]$ 0.08%. But, with the adaptation of FSC BM, the technical efficiency decreases by $[1-\exp(-0.10) \approx 0.095]$ 0.095% (In another words, LLCs are 8% more efficient than FSCs). Hence, for the rest of the world's airlines, only BM, cost and member are significant factors influencing technical efficiency. Comparison between Europe and the rest of the world shows that though jet fuel cost, BM and airline membership are essential factors for each airline's productivity, European airlines' trade openness and employee number also contribute. The result that European airlines witness more changes in their efficiency and productivity is verified by Assaf and Josiassen (2012), who mention that European airlines have slightly better productivity and efficiency growth than US airlines.

5.12 Summary of Statistical tests

A reminder of the various statistical tests that were carried out to verify that our findings attain the best possible outcome and are as consistent as possible:

- The initial DEA scores were subjected to the bootstrap resampling technique to remove any bias in the scores and adequately handle statistical noise that might be encountered in the general deterministic nature of non-parametric measures; for additional information on the bootstrap argument, refer to Chapter 4, Section 14.

- The RTS test was performed to ensure the best possible and correct returns-to-scale orientation was employed while conducting the DEA tests; **see Table 5.**
- The isotonicity test was performed to check that the DEA input–output correlation was fulfilled; see **Table 9.**
- A separability test was conducted utilising the basic correlation matrix between the variables of the first stage and the second-stage regression analysis to guarantee minimal overlap between the two (Banker & Natarajan, 2011). Additionally, the Spearman's rank correlation test (MacFarland & Yates, 2016) was conducted to confirm that the separability assumption holds; see **Appendix 15** for the correlation index (summary of Spearman's rank) and graphic displaying the correlation coefficient (Lee Rodgers & Nicewander, 1988; Wanke et al., 2016).
- Finally, our robustness test for the regression analysis was put through a number of different tests and investigations. These included several different regression analyses, such as GLS and FGLS, Newey–West and Tobit, as well as many different manipulations of the dependent and independent variables. Our ultimate choice of regression type was based on best practices and the most often used and acknowledged regression type in DEA second-stage analysis (Emrouznejad & Yang, 2018). Therefore, out of the many regression analyses, Tobit regression was used to depict our final results.
- A 'robustness check' is also carried out as it become a routine process in empirical research. Researchers examine the behaviour of specified 'core' regression coefficient estimates when the regression specification is altered, often by introducing or eliminating regressors (Leamer,1998; Klees, 2016). **Table 17** lists the results of a few of the constructed models by deleting certain explanatory factors and monitoring the change in coefficient and P-value for each of our significant variables.

Table 17 Various regression models by adding /removing variables

	Model-1-S	Model-2-S	Model-3-S	Model-4-S	Model-5-S	Model-6-S
(Intercept):1	-0.18017	-0.14209	-0.04647	-0.07606	0.022854	-0.10557
(Intercept):2	-2.67525***	-2.67503***	-2.67071***	-2.65998***	-2.66004***	-2.6558***

log(ACI)	0.016813	0.014728	0.006438	0.010368	0.00263	
BM	-0.08107**	-0.08288**	-0.08514**			
Competition	0.001191					
log(Cost)	0.074521***	0.075992***	0.076069***	0.072513***	0.081815***	0.08087***
log(ECI)	-0.05742	-0.0645	-0.04068	0.03668	-0.04772	
log(Employee)	0.015356*	0.015446*				
Member	0.088568**	0.088007**	0.104029***	0.039241**	0.040754***	0.04418***
OP	-0.00913	-0.00859	-0.01325	-0.00412	0.001011	
log(TCI)	0.155949	0.137821	0.105941	0.140569		
log(TO)	-0.03329**	-0.03368**	-0.02794*	-0.03775**	-0.03017**	-0.02885***
log(VO)	0.008189	0.014661	0.013677	0.00653	0.035199	0.019634
Note: *, ** and *** indicate the significant level at 10%, 5% and 1%, respectively.						
Model-1-S original , Models 2-S-6-S are with variables removals (Blank indicating variable removed)						

5.13 Discussion on the Tobit Regression Results

The OLS models failed to adequately explain most of the variables' connections. However, jet fuel costs played a substantial role in airline efficiency in the basic model. This finding corroborates those of several researchers in the area of airline fuel efficiency studies, including but not limited to Assaf (2011), Lim and Hong (2014), and Miyoshi and Fukui (2018).

Consequently, the Tobit regression model built for understanding the variation in technical change highlighted that jet fuel cost, BM, trade openness, membership and employee number are the factors that significantly affect airlines' productivity and efficiency. Finally, one needs to be cautious that better operational efficiency does not automatically lead to superior financial performance in the airline industry (Scheraga, 2004b).

5.13.1 Air Connectivity

Our regression results indicate that air connectivity does not directly contribute to productivity or efficiency but serves as a component in influencing other factors associated with airline efficiency.

The measurement of air connectivity is complex, and airline efficiency does not seem to be entirely affected by hub connectivity. For example, when two distinct BMs are combined in a study, connectivity becomes less critical since most LCCs do not have a high-capacity network and rely mainly on point-to-point services. 'Network coverage', on the other hand, has an inverted U-shaped curve, with profitability rising steadily until it reaches a plateau (Low & Yang, 2019). Initial advances in network efficiency, imply that airlines may enjoy larger traffic densities on their flights, resulting in better operational profitability. A more robust network with fewer routes and departure frequencies employing larger aircraft may increase traffic density. However, once the efficiency of 'network coverage' hits a saturation point, additional increases in traffic density cause network congestion and insufficient coverage, resulting in a decrease in profitability (Low & Yang, 2019). This is especially true if more traffic density is enticed by cheaper rates, lowering the passenger or cargo contribution margin. For airlines that operate beyond the saturation limit of 'network coverage', expanding the network by providing more routes, longer distance flights and greater frequencies is considered helpful.

This conclusion is consistent with Low and Lee (2014), who claimed that having direct flights may assist full-service legacy airlines in distinguishing themselves from LCCs by flying longer distance journeys, lowering fuel consumption per kilometre flown, resulting in cost savings and increased operational profitability. Airlines may charge premium fees and attract consumers who seek connection by providing higher connectivity at the cost of poorer network efficiency. Low and Yang's (2019) findings reveal that a significant number of airlines are operating beyond the saturation threshold, leading to lower load factor and less operational efficiency (IATA, 2020; Wiltshir & Jaimurzina, 2017), defining air connectivity as a measure of improved economic potential and productivity, but a significant contribution in enhancing labour capacity or providing more R&D opportunities.

5.13.2 BMs

Our BM result indicates that LLCs model have a positive impact on efficiency more than FSCs. Although there is no universally accepted definition for BMs, there appears to be a trend towards one that describes the BM through enterprises executing their strategy (McGrath, 2010; Nielsen et al., 2009; Nielsen & Montemari, 2012). Hence, we can better understand how value is created and captured (Osterwalder & Pigneur, 2010; Teece, 2010).

The BM idea allows managers and entrepreneurs to comprehend the value creation process and identify value drivers, organisational concerns and how strategic obstacles are tackled (Montemari & Chiucchi, 2017). Several definitions of the BM have been offered, with a focus on its features, in order to give a framework for references (see, for example, Al Debie & Avison, 2010; Fielt, 2013; Nielsen & Montemari, 2012; Zott et al., 2011). BMs have been shown to be highly efficient in determining airline efficiency. The differences in operational models undoubtedly impact how airlines operate. Consider the Southwest experience. Southwest's average gate turnaround time is 17 minutes, compared to 45 minutes for other full-service airlines (Hallowell, 1996). This results in less time spent on the ground and more aircraft utilisation, leading to greater efficiency.

Lee and Worthington (2014) emphasised the importance of private ownership, low-cost business strategy and load factor in determining airline efficiency. When the performance of the two subgroups, FSCs and LCCs, were examined, FSCs were less efficient on average than their low-cost BM colleagues. Nonetheless, since FSCs are less efficient in all phases of business activity, they would find it simpler to reallocate resources to improve efficiency (Duygun et al., 2016). Our findings support previous findings (Barros & Couto, 2013; Barros & Peypoch, 2009; Duygun et al., 2016; Lee & Worthington, 2014; Lu et al., 2012; Yu et al., 2019) that LCCs are more efficient due to their cost structures. Furthermore, the operational methods of LCCs enable them to modify their operations according to market demand.

Further, Choo and Oum (2013) and Roh et al. (2018) identified that the LCC model emerged as a method of controlling airlines' cost structures. As well as enhancing the capability of airlines to convert inputs into outputs for competitive advantage, the technical efficiency of airlines improves. Though it significantly enhances productivity for some airlines, the BM is the key contributor to technical efficiency, and shifting away from it results in decreased technical efficiency.

As discussed in Vasigh et al. (2015), the proliferation of LCCs is one of the most significant developments in the US airline industry since the industry's deregulation in 1978. While achieving higher efficiency and profitability, the competition brought on by these LCCs has put tremendous financial pressure on full-service network carriers. The two BMs see disparate operating outcomes and advantages under different economic states. FSCs are naturally able to generate greater profits when the broader economy is strong. LCCs are better off when demands are volatile and the competition is mainly cost-driven.

5.13.3 Competition

Competition in the aviation business is notoriously difficult to study, owing to the difficulty of developing a coherent metric for examining the impact of competition. Our regression results show no impact of competition to airline efficiency. The problem here is there is no clear definition of what defines a competitor, the challenge is to quantify rivals on a national, regional or global scale. Do FSCs compete with LCCs? Or do they need to be looked at differently? Is the assessment of competition based on the number of routes served, the network structure or the number of airlines serving the same destination? Due to all of these, airline rivalry is one of the most challenging areas to pinpoint precisely.

To that extend, our airline competition variable was restricted only to airlines that operate in the same country and have comparable flight operation. These issues do not exclude comparison but rather accentuate the need for higher quality. Duke and Torres (2005), Fallon (2004) and Ng and Seabright (2001) identified the presence of intense competitive pressure as resulting in evolution for airlines through adopting more efficient technologies like LCCs. However, as there is variation in the competition level of different economies' market structures, there is weak or no influence on productive efficiency.

Brueckner et al.'s (2013) empirical study results, based on a panel of 12 European and seven major United States airlines, confirmed that state ownership substantially increases rents to labour, while the effects of competition are more subtle and ambiguous. Another study demonstrated that collaboration is more likely to produce better results for airlines than competition. Furthermore, competition is more likely to embody the airline with the lowest environmental efficiency (Li & Cui, 2021). This is also the case in our research. Competition may create an intense atmosphere, but it does not necessarily result in efficiency improvement.

5.13.4 Jet Fuel Cost

Jet fuel cost has a positive impact on airline efficiency. The cost of jet fuel is a systemic problem that affects all carriers in the market. Because of this, the influence of jet fuel costs is not a company-specific variable but a universal one. The cost of jet fuel has more than quadrupled in the last 30 years, and efficiency has increased by 31%. According to Brueckner and Zhang (2010), a rise in fuel costs leads to reduced fuel usage and a greater load factor, leading to more efficient airline operations. Mollick & Amin (2021) found that oil price return volatility is negatively associated with airline carrier stock returns, with an almost zero correlation coefficient of − 0.009. Narayan and Sharma (2011) claim that businesses in the energy and transportation sectors see a rise in revenue when oil prices rise.

There was considerable variation in fuel economy among the 15 largest US carriers studied by Zou et al. (2014), indicating that greater efficiency might save money on fuel. However, until there is a significant shift in technology, there will not be a sufficient reduction in demand for jet fuel (Chèze et al., 2011). Furthermore, the cost of alternative fuel remains high (Winchester et al., 2013). When fuel costs rise, carriers will look for ways to reduce the amount of fuel they use by maximising other resources.

At the same time, as fuel costs rise, airfares rise quickly. However, the reverse impact on demand is less pronounced owing to the statistically significant asymmetric effects on aviation demand (Wadud, 2015). Studies such as Assaf (2011) and Merkert and Hensher (2011) confirm that jet fuel plays an important role. This infers that airlines are more cautious as fuel prices go up. Instead, they become more productive because they can better use their aircraft allocation and network. When it comes to hedging their fuel expenses, the vast majority of airlines use this strategy (Morrell & Swan, 2006). Even if their costs are being hedged, businesses have greater leeway to raise their prices and charge more during these times. Because of this, it was noted that using fuel cost as a metric for comparing efficiency is not desirable.

The empirical evidence shows that airlines cannot lower their financial risk exposure only by hedging fuel (Berghöfer & Lucey, 2014). Hence, several airlines have recently stopped using fuel hedging. A report by the GAO (2014) supported the results and highlighted that jet fuel prices had more than quadrupled over the years. Higher fuel prices result in higher costs and contribute to lowering the profitability of airlines while at the same time driving airlines to utilise better fuel consumption, leading to enhanced efficiency. The focus is on shifting to low fuel consumption technology by raising technical efficiency to improve the efficiency and profit capacity of airlines. Hence, jet fuel cost rises result in the improved technical efficiency of airlines.

5.13.5 Economic Freedom of a country

EFW results indicate no effect on the efficiency of airlines. An economy's development is dependent on economic activities that result in the establishment of new firms and the production of new commodities and services. In turn, institutions have an impact on economic and commercial activity. Public policy is a feature of the institutions that govern the economy. One component of the institutional environment is the degree of economic freedom with which enterprises create and operate their commercial activity.

The volume and kind of economic activity pursued by enterprises are influenced by the degree of economic freedom. Between 1998 and 2015, research in Romania found that the clear link between the degree of economic freedom and the growth of land and air transportation (Gabriel, 2017) of domestic and regional aviation markets in Europe, such as the European Economic region and the rising number of Open Skies agreements, has shifted from a controlled tariff structure to a market-dominated system (Button, 2007). In this latter setting, the old legacy and charter airlines' commanding position and pricing leadership are steadily undercut.

On the other hand, Turkey has witnessed significant success in airline liberalisation, which began in 1983. As a result, many airlines entered the market quickly, fuelling the tourism sector, which increased rapidly and amplified demand for air travel, leading to increased passenger traffic. Turkish air carriers' share of the international market increased, and competition between Turkish and foreign air carriers increased (Gerede, 2010). Further, the EFW defines the freedom of economies to undertake choice-based economic activities and leads to higher movement of labour and an improvement in workforce quality. Thus, the variable influencing associated inputs for airline efficiency indirectly contributes to productivity but has no direct contribution to airline efficiency (Tolcha et al., 2021; Tran, 2019).

5.13.6 Number of Employees Effects

Efficiency is positively impacted by the number of employees in our regression estimate, with a significant level only reaching 8%, falling short of the 5% significant threshold. The airline industry is a highly service-intensive industry, which leads to the importance of having the right number of the work force and the optimal employee allocation. Managing a firm's resources is a challenging endeavour. Hoskisson et al. (1999) claimed that this is because the RBV empathises with the unique character of a firm's resources and skills. However, empirical verification of the RBV hypothesis provokes significant hurdles.

In the aviation sector, the nature of the interaction between employers and employees should be of great consequence to airline performance. Given its service-intensive nature, the cost-to-total cost ratio is relatively high. On the other hand, unions represent around 40% of all transport sector workers and more than 60% of non-management staff at major airlines (Hirsch & Macpherson, 2000; Johnson, 2002). Wu and Liao (2014) reaffirmed the benefits of using DEA models to evaluate airline performance and stressed the critical nature of airlines' resource allocation capabilities. On the other hand, the empirical findings indicate that the number of full-time employee equivalents negatively affects operational efficiency, implying that high personnel expenses continue to impede airlines' efforts to improve their efficiency (Huang et al, 2021).

Labour expenses are the second-highest operational cost in the aviation sector, and a significant share of labour costs are fixed costs. Given that inefficiency in the labour force is not commonplace in a highly regulated company environment, determining ways to enhance labour productivity, measured by revenue earned per employee, becomes an urgent priority for carriers. Ahmad and Khan's (2011), Assaf's (2011), and Barbot et al.'s (2008) studies identified that a higher number of employees associated with size contributes to supporting airlines' performance, resulting in an economy of scale and more market power, hence raising the technical efficiency of airlines. Though some studies define its role in productivity, it is primarily employees that contribute to an airline's efficiency; this is also true in our examination model.

5.13.7 Alliances

The alliances hypothesis is well supported, suggesting that airlines affiliated with international alliances operate more efficiently. The biggest advantage of being part of a global airline alliance is to facilitate the network collaboration and cut human cost through sharing resources (Brueckner, 2001; Douglas & Tan, 2017; Gaggero & Bartolini, 2012; Iatrou & Alamdari, 2005; O'Connell & Bueno, 2016).

It is a natural progression for airlines operating on a hub-and-spoke basis to create alliances in the airline industry. When airlines form alliances, they may expand their network without increasing the number of flights and enhance passenger density in their home network by bringing in customers from the alliance partner's home network. The economies of density enhance the load factors and lower the average cost for all alliance participants.

Passengers do indeed benefit from the alliance because of more destinations and cheaper rates (Brueckner & Whalen, 2000). However, probable collusion between carriers on routes connecting the hubs of alliance participants is a matter of worry. When American Airlines and British Airways teamed up in 1998, they agreed to give up 267 London Heathrow and London Gatwick slots (representing nearly 5% of all weekly landings and take-offs), primarily to create a competitive route between London and New York.

According to Brueckner and Whalen (2000), airline alliances and code-sharing agreements are generally seen as advantageous from a social perspective. Collaborative pricing reduces rates for interline markets, creating an attractive pricing strategy for feeding routes while increasing fares between hubs. With increased demand, fares might be reduced even more due to economies of density. As a general rule, airlines that belong to global alliances should be more efficient than those that do not. Additionally, Zuidberg (2014) emphasised the significance of the load factor, aircraft usage and aircraft size on airline efficiency. According to Kottas and Madas (2018), Lin (2013) and Min and Joo (2016), airline alliances contribute to market expansion, cost savings, increased traffic for partner airlines, practical cooperation and a more flexible structure, which enhance the technical efficiency of airlines by improving their capacity.

5.13.8 Ownership

The non-significance of the ownership results in our models suggests that ownership is not a driver of airline efficiency, results were similar to those of Merkert and Wiiliams (2013). Many academics and policymakers base their privatisation and deregulation recommendations on comparative studies of the relative technical efficiency differences between the two ownership types. Private companies are thought to be more technically efficient than public companies. Several interconnected strands of hypotheses have played a role in reaching this conclusion. Niskanen (1971), claims that public sector managers, bureaucrats and politicians maximise their budgets when functioning in insufficiently competitive situations. This self-interest behaviour harms cost-cutting incentives. The last strand contends that regulatory agencies, which may be made up of self-serving bureaucrats, are 'captured' by special interest groups and serve the producers' interests above the 'public interest'. Although all three sets of theories agree that private corporations are more efficient than government-owned businesses (Boardman & Vining, 1989; Millward & Parker, 1983), the globalisation of economic activity threatened most airlines in the 1990s, whether commercial or public.

Both governmental and private airlines prefer to operate on a more business basis than non-economic political aims to remain in the dynamic aviation industry. Furthermore, the empirical data shows that state ownership did not act as a hindrance to efficiency in this sample. Being privately or government-owned makes little difference when airlines operate on a business basis without any regard to political agendas. In addition, airlines must maintain their service quality – boosting load factors – to stay competitive and efficient. Generally, private ownership is identified as the component contributing to deriving better productivity or efficiency for airlines. Although other studies conclude the opposite, what we are sure of is that both airline types operate on a commercial basis and both encounter restrictions in the way they accomplish their tasks; thus, ownership does not have a significant contribution on airline efficiency (see, for example, Backx et al., 2002; Fethi et al., 2000).

5.13.9 Destination Attractiveness (TTCI)

The TTCI result is not significant meaning that TTCI has no impact on airline efficiency. When investigating destination attractiveness, we found that the best available index to use is the TTCI. However, this index has several criticisms. Research by Wu et al. (2012) challenged the TTCI to rate destinations based on their economic situations rather than their competitiveness in supplying a quality tourist product. The TTCI's top destinations were mainly in developed countries, whereas the TTCI's worst destinations were in developing or less developed countries, despite the latter's abundant natural and cultural resources (Blanke & Chiesa, 2013). Economic discrepancies between nations will continue to impact the significant findings of tourist competitiveness since the TTCI report gives equal weight to all subindices/pillars. Furthermore, as long as existing frameworks and definitional systems of destination competitiveness cannot be cast in solid cause–effect linkages, their practical advantages remain restricted. It is now more of a collection of facts than a model that illustrates a clear and testable link between the variables of interest. Furthermore, since it solely considers the current situation, the TTCI ignores the implications of future-orientated components, such as investment choices. It also fails to distinguish between the supply and demand sides of the competition and assumes a shared viewpoint across local and foreign markets.

The non-significant of this variable might be due to the nature of the operation in our airline sample. The majority of our sample operate on a global connection and, for the most part, operate on a hub-and-spoke basis, which means that their operations are not limited to a specific location or destination. Second, when studying a destination's attractiveness, one should look at bilateral operations between countries (a destination–origin type of operation) rather than hub activities to see how the attractiveness of a destination affects its popularity. Lastly, the TTCI measures the economy's effectiveness in attracting tourists. To improve the index value, the economy focuses on improving the infrastructure and raising the efficiency of the workforce. These factors have an indirect impact on airlines and are beyond management's control; thus, the TTCI has little impact on airline productivity and efficiency.

5.13.10 Trade Openness

The trade openness regression coefficient results are negative and significant indicating that trade openness negatively affects airline efficiency. The Trade Openness Index is calculated as the sum of exports and imports as a percentage of GDP. This means that for some large countries with a large population, this index is relatively small; for example, China, Japan and the US have Trade Openness Indices of 37, 36 and 27, respectively; within these countries, there are several highly efficient airlines, demonstrating that trade openness substantially influences airline efficiency.

Opening your country to foreign trade can result in high competition and a free market, forcing established companies to modify and adapt their existing practices to survive. Barros and Peypoch (2009) evaluated 27 European airlines from 2000 to 2005 using traditional DEA and bootstrapped truncated regression and found that population demographics and participation in an alliance network impacted airline efficiency. Gittens et al. (2019) mention that with liberalisation, there was a rise in trade openness for economies, rising competition for the aviation industry, and even the expanding middle class and rising population had created a surge in air travel demand. A higher trade openness leads to a higher vulnerability, especially in developing countries (Montalbano, 2011). When trade restrictions are lifted, local companies are put under tremendous pressure to succeed or perish (Belloumi, 2014).

The rising burden and competition resulted in the introduction of more LCCs, putting more pressure on legacy or FSCs. Even when airlines strive to maintain their competitive position and fulfil expanding demand, they turn to cheap, eco-friendly or readily accessible products, resulting in lower technical efficiency (Duman & Kasman, 2017). The benefits of trade liberalisation, as argued in traditional trade theories, are conditional in a number of requirements that are difficult or impossible to achieve in practice (Rodrik, 2006).

5.13.11 Visa Restrictions

The non-significant of the visa openness regression results suggest that visa openness is not a driver of airline efficiency. The potential advantage of bilateral visa abolition in a specific country is significant. However, since the visa openness Index has little impact on airline efficiency. The main reasons are that our sample and the origin of the airlines chosen to perform the research on might be the first significant factors for the lack of any association between efficiency and the visa openness Index. The other reason is that more of our airline samples operate in large nations, such as the US or China, or in regional settings, such as Europe. Travelling within these countries or regions does not require the acquisition of a visa. As a result, our regression coefficient was not statistically significant for this variable.

A more realistic approach to investigating this index would be to study nations with no domestic market and no transit passengers. This would help to better evaluate the impact of visa restrictions on airlines; otherwise, this would make caging the influence of the visa variable challenging to pinpoint. For example, Ethiopia’s visa openness is among the lowest globally. However, Ethiopian Airlines is a highly efficient airline, implying that the visa openness indicator does not necessarily represent the company’s efficiency. Furthermore, the argument can be investigated more using the cases of Emirates and Etihad Airways, both of which are based in the UAE, with the highest global ranking for Visa Openness Index ratings. However, we see two distinct efficiency scores, with Emirates having a very efficient score. On the other hand, Etihad Airways fails to attain high efficiency, confirming our regression model’s findings that visa openness has no direct impact on airline performance.

Travel and tourism are restricted by visa prerequisites, but with more liberal visa restrictions, the aviation industry has indirectly witnessed an improvement in performance (IATA, 2015; Wiltshir & Jaimurzina, 2017). However, according to the conditions previously stated, the visa openness variable is does not seem to have a direct impact on airline efficiency.

5.14 Discussion on the European Carriers’ Results

We obtain a different conclusion when we examine our samples solely utilising carriers from the European region. Throughout our analysis, whether we use the full-world sample or simply the European nations, fuel cost remains the variable that has a direct and highly substantial influence on airline efficiency.

Ownership has little impact on efficiency among European carriers, which is understandable given that the vast majority of European carriers are privately held and operate in a highly competitive market with stringent rules.

At the 10% significant level, BM and employment are significant, indicating that FSCs are less efficient than LCCs. Interestingly, in Europe, we have two of the most efficient low-cost airlines, Ryanair and EasyJet. Employees have a favourable influence on efficiency, but only at a 10% level. This suggests that manpower utilisation and efficient use of HR may have a direct and beneficial influence on airline efficiency.

Trade openness has a negative and significant influence on airline efficiency in Europe, demonstrating that operating inside the European region with open skies and open trade agreements leads to heated competition, reducing service quality and, hence, efficiency level. Moreover, trade openness may not correctly represent the shift in efficiency, which might explain the observed findings. Despite the fact that many trade barriers have been lifted for member countries, trade restrictions may have little effect on the volume of commerce within Europe. Another cause might be the close proximity of European countries, which could employ more efficient and cost-effective modes of transportation to link the countries in the area.

The introduction of strict emission rules and regulations within the EU also adds to the difficulties airlines face in terms of managing emissions and associated costs. Even the rise of the middle class led to an increase in air travel demand. Boeing Commercial Aircrafts (2008) attributes about two-thirds of the rise in traffic to GDP development, which boosted competition and led to the arrival of even more low-cost airlines, leaving the legacy or FSCs more susceptible to inefficiency.

5.15 Discussion on the Rest of the World's Results

When we removed European airlines from our global sample, a new trend emerged. Fuel remained constant across all of our regression models, illustrating the variable's global importance in influencing airline operating efficiency. Other notable developments included the fact that we no longer see any influence of the employee numbers variable on airline efficiency, which can be explained by the fact that most airlines operating in Asia, the Middle East and Africa are either without unions or have weak unions, and labour productivity in these regions is lower than in Europe.

Furthermore, excluding European airlines from the comparison, trade openness deteriorated from being significant to non-significant in a global setting. The efficiency of airlines is determined by how they choose to operate, as evidenced by the significant level of their BM, with full-service airlines being less efficient than low-cost counterparts. Finally, membership in an alliance has a significant impact on airline efficiency. Whether operating in an open skies zone or a large domestic market, being a member of a global alliance has a significant and direct impact on airline efficiency.

5.16 Chapter Conclusion

The Tobit regression model built for understanding the variation in technical change highlighted that jet fuel cost, BM, trade openness, membership and employee number are the factors that significantly affect airlines' productivity and efficiency. Our conclusion about the cost of jet fuel is consistent with the GAO's (2014) findings, which emphasised that airline profitability has decreased as jet fuel prices have risen. The focus is on migrating to low-fuel-consumption technologies and enhancing technical efficiency in order to improve the profitability and efficiency of airlines. As a result, a rise in jet fuel prices decreases the company's current profitability, increases technical efficiency, and diminishes airlines' concentration on innovation (technological change).

Further studies (Choo & Oum, 2013; Roh et al., 2018) identified that the LCC model emerged as the method of controlling the cost structures of airlines. It enhances the capability of airlines to convert inputs to outputs and even provides them with an incentive to adopt best practices and operations for deriving competitive advantage. Thus, the technical efficiency of the airlines improves. The majority of BM operations contribute to technical efficiency, and shifting away from those operations reduces technical efficiency.

The impact of alliance membership has been thoroughly studied; research findings from Kottas and Madas (2018), Lin (2013) and Min and Joo (2016) highlight that airline alliances contribute to an expanding market base, cost-saving potential, traffic increase for partner airlines, effective cooperation and a more flexible structure, thus enhancing the technical efficiency of airlines by improving capacity, reducing costs and increasing consumer choices.

According to the findings of Ahmad and Khan (2011) and Barbot et al. (2008), the presence of a higher number of employees helps airlines perform better, thereby increasing the technical efficiency of airlines. Some of the studies defined its role in productivity as well, through employees' contributions towards enhancing capacity.

Liberalisation in aviation intensifies the competition level with additional pressure arising from the expanding middle class and increases in air travel demand. The rising burden and competition have resulted in reducing the existing efficiency of airlines. The shift to more affordable products, as well as the concentration of competition at the lower end, may reduce airline efficiency (Duman & Kasman, 2017).

Air connectivity is defined by IATA (2020a) and ISU (2014) as a measure of improving economic potential and productivity but is also a major contributor to enhancing labour capacity or providing more R&D opportunities. In this regard, the emphasis should move from additional routes to network seat capacity (PWC, 2013), since increasing the number of routes without a sufficient number of filled seats may result in decreasing efficiency. As a result, while air connectivity does not directly influence productivity or efficiency, it does serve as a component influencing other factors associated with airline productivity.

Generally, private ownership has been identified as the component contributing to deriving better efficiency for airlines, as airlines operating on a commercial basis exclude political objectives, and some restrictions are imposed with each type of ownership style; thus, ownership does not significantly contribute to the airline. Backx et al. (2002) and Fethi et al. (2000) found the same results.

The competition of airlines is difficult to quantify precisely, as airlines operate on a domestic, regional and global level and with diverse BMs, leading to more vagueness of this variable. Duke and Torres (2005), Fallon (2004) and Ng and Seabright (2001) recognised that the presence of intense competitive pressure, though, results in airlines' evolution by adopting more efficient technologies like LCCs, but as there is variation in the competition level of different economies' market structures, there is weak or no influence on productive efficiency.

Further, the EFW defines the freedom of economies to undertake choice-based economic activities and leads to higher labour mobility and an improvement in the quality of the workforce. Thus, the variable influencing associated inputs for airline efficiency indirectly contributes to productivity but has no direct contribution (Tolcha et al., 2021; Tran, 2019).

The visa restrictions hinder travel and tourism, but with more visa openness, the tourism industry could witness an improvement in performance. However, in countries where the domestic market is large, or in regions like the EU or where airline operations mainly depend on transit traffic, the visa is not required. Thus, it does not influence airline productivity or efficiency (IATA, 2020b; ISU, 2014).

Lastly, the TTCI measures an economy's effectiveness in attracting tourists. Though, to improve the index value, economies focus on improving infrastructure and raising the workforce's efficiency, as these components indirectly influence airlines and are outside managerial control. As a consequence, we found the TTCI had no significant effect on airline productivity and efficiency across our airline sample.

Chapter 6 How COVID-19 is Revolutionising the Airline Industry

6.1 Introduction

This chapter investigates the impact of COVID-19 on the airline industry. In particular, this chapter takes the results from the first part and scrutinises significant variables to determine how COVID-19 impacted them. Continuing on the STP perspective, the study's objective is to understand how the airline industry responded to key operational elements during and after the pandemic. There is no doubt that policymakers are becoming more anxious about the consequences of COVID-19. The pandemic has exacted a tremendous cost, killed people, wrecked companies and profoundly transformed society. Consequently, the crisis has hampered the global economy, causing unemployment, a crash in tourism and a drop in consumer spending (Khan et al., 2021). Two-thirds of commercial airlines were closed due to social isolation and travel restrictions. Up to 7.5 million flights were cancelled, and customers were requesting compensation. The majority of aircraft were parked on the ground, resulting in huge costs and one of the most challenging tasks to mitigate in aviation history (IATA, 2020b).

The aviation sector remains vulnerable and one of the first casualties (Sun et al., 2021). Throughout the past century, aviation has had a constant and unparalleled expansion despite earlier global calamities, such as the 9/11 terrorist attacks, and the global financial crisis of 2008. Having achieved one billion passengers in 1987, airlines doubled in size in less than two decades, reaching two billion in 2005, three billion in 2013 and 4.5 billion in 2019 (O'Connell, 2019). Low airfares coupled with the expanding middle class have altered the dynamics of global travel. Today, air travel accounts for 58% of all international travel, up 14% from 20 years ago (UNTWO, 2020). The consequences of COVID-19 are triggering thoughtful anxiety among government policymakers and airline owners. This section discusses the current COVID-19 discourse and reviews the relevant literature.

6.2 Airline Industry and External Shocks

External shocks have a considerable effect on the air transport industry. Brown and Kline (2020) classify exogenous shocks into three types: macroeconomic, security and health threats. Most of these shocks have undergone extensive research to evaluate how they shape the industry and the speed of recovery. The problem is that we see little agreement on whether these shocks have a long-term or short-term impact on the sector's development prospects (Gudmundsson et al., 2021). What the pandemic provides is an ideal opportunity to investigate the impact of such exogenous shocks on the industry.

Researchers from different industries investigated the impact of such shocks (Gössling, 2020; Magdalina & Bouzaima, 2021; Scheiwiller & Zizka, 2021), with airline responses to the pandemic being the first to draw attention to the crisis (Sun et al., 2021). Past crises, such as SARS and the 9/11 terrorist attacks, have shown that it is feasible to learn from these crises in terms of managerial responses to external shocks. Albers and Rundshagen (2020) group these initial responses into four categories: retrenchment, preservation, innovation and exit-and-resume strategies. In these first responses, some thought was given to airline communication methods during a crisis (Scheiwiller & Zizka, 2021). Furthermore, Amankwah-Amoah (2020) presented a conceptual framework for short- and long-term strategic and tactical responses. Brown and Kline (2020) emphasised the fact that environmental scanning is crucial when dealing with external shocks. Furthermore, Linden's (2021) work includes a few recommendations for aviation management on how to prepare for and survive external shocks.

COVID-19 has provided an opportunity to restructure social issues such as climate change and sustainability (Suau-Sanchez et al., 2020). Gössling (2020) provides a critical perspective on the aviation industry prior to the pandemic, emphasising its fragility and reliance on government assistance. He emphasises that the industry's negative externalities, such as the spread of diseases and the impact of climate change, need a significant shift in airlines' current BMs. However, in fairness to airlines, Amankwah-Amoah (2020) highlights the challenge of looking after these practices during times of crisis.

The third stream of research investigated how governments and public policies impacted airlines during the financial crisis. Abate et al. (2020) investigated governments' willingness to assist airlines and listed the different types of assistance programmes. Akbar and Kisilowski (2020) provide a contrasting perspective on the intricacy of airline nonmarket strategies in the COVID-19 context, focusing on governmental regulation, reliance on aid programmes and legitimacy perception. Macilree and Duval (2020) expand the research's scope by looking at the most important policy issues facing the industry after COVID-19.

6.3 Air Transport and Viral Dissemination

When COVID-19 began to spread among individuals and across national borders, governments began to impose travel restrictions and close their borders to prevent disease transmission (Luo et al., 2020; Vaidya et al., 2020).

Unfortunately, this was done in a disorderly and almost chaotic fashion in some countries (Sun et al., 2020). The irregularity in travel restrictions among countries has discouraged people from wanting to fly (Salari et al., 2020; Taylor, 2020). According to the UNTWO (2020), this is the first time that international travel has been limited in this way, with so many nations enacting travel restrictions. Many potential passengers were either discouraged from travelling or advised that they could only fly if they followed a strict quarantine. Thus, according to Adrienne et al. (2020), the air travel industry shrunk by 64% by mid-April 2020, with 17,000 planes grounded, forcing airlines to reduce flying operations in order to save money.

Another contributing factor was the uneven implementation speed of the vaccination programmes. This further limited the choices available to prevent the spread of the virus to control and containment measures, including social distance, quarantining and travel limitations (Kim & Liu, 2021). Studies by Lau et al. (2020) and Petersen et al. (2020) confirmed that travel restrictions and control measures were effective in preventing the spread of the virus. According to Hufnagel et al. (2004), isolating big cities was a successful control strategy for SARS. Brownstein et al. (2006) investigated the spread of influenza in the US and emphasised the importance of flight restrictions in reducing infection rates. France, for example, saw an accelerated spread of the influenza virus because no flight restrictions were imposed.

Tuncer and Le (2014) looked at a two-city dispersal model of avian influenza spread via air travel. They argued that the effectiveness of control measures (e.g. isolation and quarantining) is heavily dependent on the air travel proportion or the share of air passengers based on the population of the departure city. All of this supports the idea that restricting air travel is critical in lowering pandemic risk. On the other hand, other researchers argue that travel restrictions are unsuccessful in preventing the spread of contagious illnesses. The reality is that travel restrictions did not significantly limit the global spread of the influenza pandemic (Cooper et al., 2006). According to Ferguson et al. (2006), restrictions can only constrain the spread for two to three weeks. Chinazzi et al. (2020) used a population transmission model to examine the link between travel limitations and the spread of COVID-19. They found that the Wuhan shutdown was ineffective in slowing the virus' spread to other domestic locations compared with international travel restrictions. Furthermore, there is a possibility that the virus spreads domestically via everyday activities (Borkowski et al., 2021; Zhang et al., 2021).

6.4 COVID-19 and the Stream of Research

The pandemic's impact on passenger traffic has mostly focused on two distinctive viewpoints. The first component is the pandemic's traffic-inhibiting influence. For example, Iacus et al. (2020) investigated the critical implications for global passenger traffic. Graham et al. (2020) investigated how senior travellers were affected by COVID-19. Zhang et al. (2021) examined changes in airline traffic, focusing on the Chinese market; they found that China's international market is struggling to recover because of the strict pandemic control, whereas the domestic market is recovering quickly. Hensher et al. (2021) revealed that the pandemic induced a significant shift in the way people travel, from using public transportation to more personalised vehicles, with many short-distance flights now substituted with driving. Sun et al. (2020) conducted a rigorous empirical assessment of the impact of COVID-19 on air transportation using multigrain network analysis. Their results indicate that the pandemic had a substantially more significant impact on overseas flights than on domestic flights. Dube et al. (2021) explored the pandemic's detrimental impact on airline financial status and provided potential recovery pathways for global airline firms. Choi (2021) evaluated the impact of COVID-19 on airport operational procedures and found that the most evident benefit was enhanced procedures for assessing passengers' health status. Hou et al. (2021) created a comprehensive economic model to modify international flight slots at hub airports for domestic routes. As a result of airport slot reallocations, airlines' competition and strategies were changed.

The second stream of research focuses on how airline travel may aid in spreading the virus. Gilbert et al. (2020) investigated African countries' international ties with China to estimate the import risk of COVID-19. Tang et al. (2020) utilised the population outflow of different modes of transportation (e.g. air, train and coach) from Wuhan to other locations in China to predict the speed and rate of the virus' spread throughout China. The importance of the air travel bans in restraining the pandemic was also investigated by Lau et al. (2020), who revealed that the ban significantly slowed the spread of COVID-19 in China. Chinazzi et al. (2020) predicted the impact of the Wuhan shutdown on virus spread using a worldwide population transmission model. They pointed out that the prohibition would only delay the outbreak's spread within China by three to five days, while international travel restrictions would help delay the outbreak's transmission from China to the rest of the world more effectively.

Zhang et al. (2020a) studied the influence of different modes of transportation on COVID-19 transmission in China. They observed that flying was more strongly associated with viral transmission than high-speed trains. Zhang et al. (2020b) proposed a method for predicting the likelihood of importing COVID-19 through international passengers with real-time global flight data and pandemic records. It was then applied to specific Chinese provinces to estimate the risk of importing viruses through international routes. The problem is that air travel contributes to the spread of the virus worldwide (Tatem et al., 2006; Wilder-Smith et al., 2003).

Both the aviation and tourism segments are especially vulnerable to infectious disease outbreaks due to their face-to-face and contact-intensive nature and the high movement of people and goods inside and beyond national borders. Furthermore, several past studies have confirmed that airline travel may influence the spread of viruses, such as influenza (Grais et al., 2003), SARS (McLean et al., 2005), Ebola (Bogoch et al., 2015), Zika (Bogoch et al., 2016) and dengue (Tian et al., 2017). According to Oztig and Askin (2020), airlines played a significant role in spreading the SARS virus to 37 countries, whereas the Middle East respiratory infection spread to 27 countries. In a similar vein, Wilder-Smith (2006) found that the avian flu (H5N1) outbreak spread to around 60 countries, reducing tourist visits to the Asia-Pacific region by approximately 12 million. According to Wen et al. (2005), SARS lowered tourists' willingness to travel due to the health hazards associated with travel activities. Kuo et al. (2008) confirmed Wen et al.'s (2005) findings by observing a significant decline in tourist arrivals to SARS-affected countries. Rosselló et al. (2017) examined the impact of numerous outbreaks on tourist arrivals using econometric techniques. They observed that the advent of the pandemic significantly lowered visitor numbers. For example, the spread of malaria reduced tourist visitation by 47%. According to Blake et al. (2003), foot and mouth disease reduced the number of visitors and their spending in the United Kingdom.

However, the COVID-19 pandemic has surpassed all previous pandemics due to its rapid spread on a global level, with the aviation industry playing a significant role in spreading the pandemic (Sun et al., 2020). The COVID-19 outbreak has been a commercial disaster for the world's aviation industry. Rapidly, global traffic levels fell by 21% in March 2020 compared with the same month the previous year, with global traffic levels falling by 66% by April. As the harmful virus spread worldwide, the decreasing trend continued at an alarming level, falling to 69% by May 2020. According to UNTWO (2020), international tourist visits dropped by 70% in 2020, resulting in a 700 million visitor and 730-billion-dollar loss in tourism profits in the inbound tourism industry. COVID-19's devastation in 2020 was eight times more than the loss caused by the 2008/09 global financial crisis (UNTWO, 2020). As they work hand in hand, the situation of the tourist industry was mirrored in aviation, with airline passenger revenues falling by 69% in 2020, amounting to a 421 billion US dollar loss compared with the pre-pandemic year of 2019, while aggregated losses are expected to be around 118 billion US dollars, more than four times the losses experienced by the industry following the global financial crisis of 2009 (IATA, 2020a). COVID-19 has emerged as the most significant threat to the aviation industry in recent history (Amankwah-Amoah, 2020), with consequences expected to last until at least 2024 (IATA, 2020c). Gudmundsson et al. (2021) predicted a similar recovery path, with the best-case scenario being mid-2022 and the worst-case scenario being 2026. Some researchers agree with this point of view. In fact, Thams et al. (2020) went further to say that the pandemic could completely destroy the global tourism industry.

6.5 Oil Prices and COVID-19

Fuel is a significant expenditure for airlines, and the industry has made various efforts to increase fuel consumption efficiency by changing aircraft fleets or performing enhanced ground and air operations. According to Ateş et al. (2018) and Zhang et al. (2017), the highly competitive environment, fluctuating fuel prices and environmental constraints imposed by governments or international organisations, as well as high fixed and variable costs, compelled airline operators to invest in technological developments, operational improvements or alternative fuels to reduce fuel consumption (Singh et al., 2018). IATA (2018) set an ambitious objective in 2008 of increasing fuel efficiency by 1.5% per year between 2009 and 2020 and lowering net aviation CO2 emissions by 50% by 2050 compared with 2005. As the industry resumes operations following the pandemic, obstacles will persist despite the risk reduction (Suk & Kim, 2021). Unfortunately, the pandemic has made 2020 the worst year in airline history, with net losses of 118 billion dollars in 2020 and an additional 38 billion dollars expected in 2021 (IATA, 2020b).

In reality, the pandemic crisis was a big wake-up call for the aviation industry to restructure, but the pattern and speed of restructuring after the outbreak will remain unknown for at least the near future. Recovery will differ per country since it relies on vaccination programmes, status of the countries' health systems, government efforts and a range of other factors (Chang et al., 2020; Zhu et al., 2021). Airlines must strictly monitor their fuel costs and risk exposure to oil price volatility in this uncertain situation, with the industry's escalating debt levels of 120 billion dollars in 2020, of which 79 billion dollars backed by government loans, delayed taxes and loan guarantees must somehow be repaid.

Furthermore, low passenger yields and rising operational costs complicate matters (Pearce, 2012). Moreover, oil prices directly affect airline stock market share prices (Kristjanpoller & Concha, 2016). A study by Yun and Yoon (2019) revealed that the share prices of South Korean and Chinese airlines were affected differently by the three different international oil prices (WTI, Brent and Dubai). Fuel prices may have declined at the height of the pandemic as demand for flights decreased. However, as we emerge from COVID-19 and confront another external obstacle, the conflict in Europe (Ukraine–Russia), this will further complicate how fuel costs are more efficiently controlled.

6.6 COVID-19 and Air Transport Recovery

The spread of COVID-19 has resulted in significant losses for domestic and international airlines. New strategies for adapting up-to-date management systems to an uncertain environment are being sought by many airlines beyond COVID-19. The pandemic kept airlines on their toes, always looking for novel ideas. Fortunately, most of them saw COVID-19 as a catalyst for reform and a move towards more sustainable development objectives.

Mckinsey (2021) consultants anticipated that business travel will only return to around 80% of pre-pandemic levels by 2024. Many researchers have studied the impact of COVID-19 on the tourist sector (Qiu et al., 2020; Yang et al., 2020) and forecasted the recovery route (Liu et al., 2021; Qiu et al., 2021). COVID-19 has fundamentally changed airline passenger demand, and many of these changes are projected to last long after the pandemic. Looking beyond COVID-19, several airlines are looking for new ways to adapt to a world where many of the products offered are adaptable and refundable. There is a good chance that flexible working options, such as remote employment, will continue after the pandemic. Long-haul flights, in particular, should be re-evaluated by airlines. We may even see a decrease in business traffic, which needs a change in pricing strategy. For instance, most airlines charge a premium for point-to-point nonstop trips, with these nonstop flights being popular with corporate travellers that prioritise time over cost. Budget-conscious travellers, on the other hand, choose an alternative route to save money. The two nonstop and connect flight prices may need to be more closely aligned. Network adjustments may also be necessary due to a decrease in business traffic. In the past, small aircraft with higher frequencies were utilised more for business travellers. These flights were feasible possibilities due to high-yielding business demand. What the future is informing is that the large long-haul airlines may need to rethink the economics of flying larger aircraft with reduced unit costs in the near future. Finally, airlines may modify their cabins to better suit the expected demand for tourist travel. Some airlines have already reorganised in reaction to the pandemic, while others are just going through the motions.

It is clear that airlines will struggle to regain normal operation in the near future. The circumstances of how fast the recovery is going to be depends on government assistance programmes, vaccination protocol and how effective these vaccinations are. Those airlines that do not aggressively reshuffle risk losing long-term structural value. Crises have benefits; they assist people in understanding why and how a continuous and dynamic management system may enhance airline survivability in the future.

6.7 Methodology

The phrase 'research design' refers to a broad range of study components, including the 'philosophy', 'approach', 'strategy', 'method' and 'sampling plan'. Qualitative methods are descriptive and enable the researcher to obtain a thorough understanding of a phenomenon in its natural setting (Creswell & Poth, 2016). This strategy is referred to as a 'brew' of many approaches that work together to 'get to the heart' of a phenomenon (Denzin & Lincoln, 2007). The methodological literature concurs that several research designs are included in qualitative research (e.g. case studies, ethnography, grounded theory, narrative inquiry and phenomenology). Each has distinct methodologies for data gathering, analysis and design assumptions (Nolen & Talbert, 2011).

In a sense, coding is a task that necessitates the researcher posing precise queries about the data (Bernard et al., 2016). A thematic coding analysis technique is derived from both deductive coding (themes obtained from the philosophical framework) and inductive coding (themes generated from participant conversations). Urquhart (2013) claims that saturation is 'the moment in coding when you recognise that no new codes occur in the data' (p. 192). Given (2016) agrees that saturation happens when ‘more data doesn’t lead to any new emerging themes’ (p. 135). We use a qualitative research design based on sentiment analysis to determine how subject-matter experts feel about the effect of COVID-19 and possible preventive measures.

As part of the qualitative data analysis, opinions expressed via interviews and other sources were manually processed and categorised. We follow the advice of Tranfield et al. (2003) and offer further details on the approach used to analyse the interviews. Through the use of a word frequency query, the most frequently occurring words and phrases in the text are retrieved. Saunders et al. (2018) asserts that it is possible to find out which words and phrases are most important to the study by sorting the most used words and phrases from the text of the respondents.

6.7.1 Pilot Study

Conveniently, a major aviation conference was held in Saudi Arabia (Future Aviation Forum, May 2022), providing an excellent opportunity to travel and meet/network with professionals from all around the globe. Even better, I managed to meet and conduct my pilot study with industry experts. People were delighted and supportive, and the reaction was overwhelming. Once the study was introduced, the questions were posed, and respondents were allowed to comment on how difficult or related each question was, as well as its practicality. With the exception of the trade openness-related question, which was altered to evaluate the future implications post-COVID-19 on the operations of airlines, the rest of the questions were rated extremely useful and concise. The rationale for modifying the trade openness question is that it adds a third dimension to the arguments and is very specific to our first study findings, and most respondents did not want to remark on it. Instead, they advised that I explore how the future performance of airlines would be post-COVID-19.

6.7.2 Sample Size and Questionnaires

For the purpose of gathering primary data, a questionnaire with a series of open-ended, semi-structured questions was utilised. The questionnaire consisted of 10 open-ended questions with the goal of determining COVID-19's impact on the industry. The sample size for the research was set at 15 experts as the intended number of participants. Nevertheless, I only managed to interview 13 experts. The research conducted by Vasileiou et al. (2018) was taken into account while determining the ideal sample size, as 12 and above might be regarded as ideal in qualitative investigations. In this research, data analysis was carried out using thematic analysis. By analysing and classifying recurring patterns, thematic analysis examines a collection of qualitative data to identify common themes. The questionnaire employed in this research additionally included a variety of inquiries designed to comprehend how the airline business evolved during and after COVID-19.

The transcripts were read numerous times, and notes were taken from each one in order to identify any common themes. Our themes aided in the creation of specific codes based on the salient characteristics of the transcripts produced in response to each question, which was consistent with the objectives and aims of the research. The topics that could be adequately substantiated and specified were those that were chosen for the investigation. In order to explain the particular effects of the pandemic and how airlines have reacted to these changes, the results produced in accordance with the topics were ultimately presented with supporting transcripts. Last but not least, this study complied with all regulations pertaining to academic research's ethical issues. The online Durham University ethical clearance was attained and approved from the study supervisors. The study's aims, anticipated results and expectations from the interviews were all clearly outlined in an introduction email that was also provided to potential participants along with the questionnaire. A confidentiality form was distributed among them as evidence that their identities would be concealed in order to protect their privacy and that the feedback they provided would not be used for any private reasons or shared with anyone else in a way not already disclosed in the introductory letter.

6.8 Findings

6.8.1 Demographics Analysis

Table 18 presents the demography of the respondents who participated in the interviews.

Table 18 Experts demographics

Profession	Experience/ Average Years	No. of Participants
Pilot	34	3
Airline CEO (Founder)	30	3
Aviation Lawyer	20	1
Airline Industry Consultant	20	3
Air Traffic Management	27	1
Aero-Political Strategist	7	1
Airline Safety & Planning	32	1

6.8.2 Thematic Analysis

The aviation industry saw a decline as a result of little to no travel and the control of international boundaries. Unconditional changes in many facets of life resulted from the COVID-19 shutdown. For airlines to survive and recover after the COVID-19 period, they need to change their economic and operational practices. This section examines the highs and lows experienced by the aviation industry and its stakeholders. The impact and transition are the subjects of this qualitative study, which is based on sentiment analysis of aviation industry specialists.

In connection to our preliminary results, the expert responses focused on the following topics:

- Perception of an evolving pattern of BMs in aviation
- Current measures being taken to curb the descent caused by COVID-19
- Employment-specific impacts
- Collaborations as measures to mitigate future risks and uncertainties
- Perception concerning oil price-specific impacts
- Influence of COVID-19 on strategic implications

6.8.3 Theme 1: Perception of an Evolving Pattern of BMs in Aviation

The thematic analysis addresses the issues concerning the impact of COVID-19 on the airline industry and how it is revolutionising the industry. In light of this discussion, the transcripts of experts have been coded as per the pattern identified. The code that has been generated from the common pattern in the responses of the experts is presented in **Table 19**.

Table 19 Code generated from pattern in theme-1

Common Pattern	Code
Higher financial viability through thinner routes Sustainability through cost efficiency (hybrid approach) Evolved business recovery through system transformation Technology in use The leisure and business sector impacted	Evolving pattern of BM in aviation

There was a prevalence of common patterns in the major experts' sentiments, wherein cost efficiency and the need for financial viability were repeatedly stated. Further, sustainability and the evolution of a transformed system due to technology and disruption were also recurrent.

Figure 4 Perception of evolving pattern of business model

COVID-19 is reshaping civil aviation worldwide, and there is a huge transition in the way the aviation industry is perceived. The objectives of the aviation industry have shifted from profit-making and providing a delightful experience to a more concrete and sustainable function. Aviation players have realised the need to recoup in such a way that significant dependency on fixed and rigid systems can be reduced. The analysis reflects the hub-and-spoke model as being vulnerable to risks, and lean substitutes will find better methods in the upcoming revolutionised aviation arena. The conventional, intricate and heavy BMs need to be transformed and ways to reduce their costs must be found. **Expert 8** highlights that 'the experience gained in cost reductions will probably be the main change to the business model of most airlines. Post-COVID, there is a realisation that airlines need to adapt to a more comprehensive, cost-efficient system, wherein a balanced financial recovery can be ensured. Those airlines that have strategically kept their ticket prices competitive and incentivised travel plans post-COVID have been able to survive in the time of less travel, thereby bringing the prospect of stability.

Legacy airlines and flag carriers have realised the need to transform their structure and modify operations so that low-cost, lean and flexible management can be adapted as per the needs of the changing times. Low-cost airlines, on the other hand, do not need to make major changes because their operations are moderate, flexible and technologically lean and efficient. **Expert 3** discussed the importance of ULH (ultra-long-haul) flights and said, 'Recent trends in aircraft procurement point to the smaller, more fuel-efficient'. Due to the abrupt economic downturn and the severe hit faced by the airline industry, using new aircraft to fly economically viable, thinner and longer routes is considered to be more effective than conventional aircraft. Technology is rapidly taking over almost all industries worldwide, making a gradual transformation in the overall techno-based infrastructure of countries (George et al., 2021). Similarly, in aviation, businesses have evolved from traditional manual patterns to a technologically advanced system with lower costs.

Expert 7 stated, 'The lines between low-cost carriers and premium carriers will become narrower due to cost inputs. Airlines need to evolve as an integrated system so that they not only develop competitive relations but simultaneously a healthy growing environment that can benefit all, as suggested by **Expert 9,** he stated, 'Full-service carriers and low-cost carrier models will get closer'. When the gap between FSCs and LCCs is narrowed, the fundamental financial obstacles as realised by companies during the pandemic can be minimised in the future. It is very imperative for airline companies to evolve with the passage of time as per the demand of the market and adapt to the changing environment in which they flourished pre-COVID.

The leisure sector saw a major setback, as the pandemic brought fear to travellers. However, post-COVID, premium leisure travel will recover soon, as people have a zest for travel, and it will help the sector recover fast. **Expert 3** revealed, 'There is a possibility that there would be an increase in the number of premium leisure passengers since individuals would choose to utilise seats that are broader and less crowded premium cabins. Furthermore, post-COVID, business sector travel will decrease as businesses shift to online and remote working cultures, potentially leading to a slower recovery in business travel. **Expert 2** felt the business sector will see a declining number of travellers and stated, 'Without a doubt, business, given that the number of people travelling for business purposes will decrease as a result of the rise of virtual meeting technologies.

Thus, summing up, as an impact of COVID-19, aviation has evolved, and the demand for a changing pattern of business is needed in this industry. There is an intrinsic need for low-cost, lean and fuel-efficient systems so that material and operational costs can be minimised. It is important to acclimatise to meet the needs of travellers after a pandemic, which means adapting to routes that are sustainable, digitalised and longer but thinner. By narrowing the gap between high-end flag carrier aircraft and low-cost lean operations, an integrated, sustainable and flexible system can be evolved that would adapt to the rapidly changing face of industries nowadays.

6.8.4 Theme 2: Current Measures Being Taken to Curb the Descent Caused by COVID-19

The qualitative analysis underlines the issues at hand to highlight the impact of COVID-19 on the airline industry and how it is revolutionising the industry. The transcripts of experts and the coded description as per the pattern identified are presented in **Table 20**.

Table 20 Code as per the pattern in theme-2

Common Pattern	Code
Cost of plane tickets Safety and health needs Recover losses Vaccine campaigns	The current measures taken to curb the descent caused by COVID-19

There was a prevalence of common patterns in the statements and revelations, wherein the cost of tickets and fare prices and the need for safety measures due to the pandemic were given importance by the majority of experts. Further, recovery of losses also was highlighted in the analysis.

Figure 5 Current measures to recover from COVID-19

The post-COVID airline-based organisations have strategised, restructured and modified their daily operations and infrastructure in such a way that the long-term position of the companies can be secured. Heavy debts, losses and downturns in aviation can be limited by ticket price rises so that the viability of economic bounce-back can be increased. In the analysis, it was observed that the majority of experts suggested possible price rises as a measure to curb the descent caused by the pandemic. **Expert 12** replied to this concern and said, 'YES, for sure. Airlines are making money nowadays because people have not flown for a long time'. However, there is a strong yearning in the airline sector to attract traffic, and for that, it is imperative that travel and tickets are incentivised. For that purpose, initially, airlines may keep the prices low, but there is a requirement to increase the prices to secure the health needs of travellers in current times. Further, **Expert 7** considers oil prices and the situation of war to be responsible for the rise in prices for airlines and stated, 'Yes, because of the war and oil price rise'. War caused an increase in the price of oil, which inflated airfares. Other factors affecting airlines include inflation rate and increases in airport taxes. As a result, airlines are taking immediate measures to increase ticket prices to balance their expenses. To promote a sustainable trajectory, the government is also aiding the airlines and vaccination drives all across Europe and other continents, which may heal the impacts created by COVID-19 in less time.

The descent caused by the pandemic will have a slight influence on business travel needs as major operations worldwide shift to online platforms and virtual modes. In this respect, **Expert 1** stated, 'As soon as the vaccination campaigns around the world come to a complete or near-complete, we will see progress'. Further, **Expert 4** felt the country, the region, and the airline to be a significant factor determining the pace of the recovery of aviation post-COVID. He stated, 'It all depends on the origins and the BM of the airline. During COVID-19, Southwest Airlines was the largest carrier in the United States'. Thus, the recovery of airlines from the impact of COVID-19 largely depends on the country and the airline firm that has brought the least disruption to their customers, employees and the nation. When airline firms are stable during the downturn phase, it stabilises their brand value in the eyes of the stakeholders, making the company sustainable. If airlines and the economy had considered value-based norms and policies during COVID-19, people would have returned with a good appetite to travel. Nations such as China minimised their variable payloads but did not downsize their workforce, thereby making it easier for them to recover their losses in less time.

Summing up, it can be said that airlines have adopted various measures to recover from the pandemic's impact, and some of these measures include ticket price revision, incentivising travel plans and offering additional precautions to satisfy the health protocols and safety needs of travellers. With these measures, they are able to recover their losses, and domestic travel especially can recover fast, while international travel is soon expected to reach pre-pandemic levels. Due to government support, balanced workforce management and ease of regulations, recovery of the domestic and international sectors is soon expected.

6.8.5 Theme 3: Employment-Specific Impacts

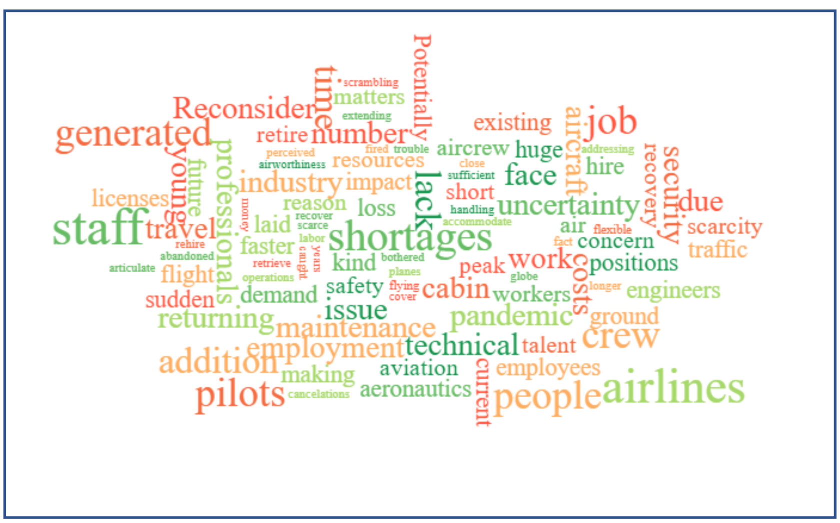
The ongoing thematic analysis considers employment impacts an important issue to be included and understands how they are revolutionising the industry. The transcripts of experts and the coded description as per the pattern identified are presented in **Table 21**.

Table 21 Code as pattern identified for theme-3

Common Pattern	**Code**
Job loss Uncertainty Shortage of pilots, cabin crew, technical staff	Employment-specific impacts

Common patterns were identified in the statements and sentiments of experts, wherein the job losses and uncertainty associated with disruption were repeated several times. Staff shortages, especially for pilots, technical staff and cabin crew, were also considered important by most experts.

Figure 6 Employment - specific impacts



Airline employment saw the most brutal and shocking downsizing in the wake of the current global pandemic. The hardest hit were passenger handling and flight operations, and slightly lesser impacts were seen in management employees. Due to these indefinite timelines of job security, airlines are foreseeing an HR shortage, and it may continue to take place as people lose faith in sectors where employee layoffs, renegotiations of labour contracts and continual job losses are common. In this respect, **Expert 7** said, 'Many airlines are scrambling to find trained pilots and ground staff to meet the sudden spurt in domestic travel demand'. Due to the wounded stimulus of separated and surviving employees, a scarcity of employees is prevalent post-COVID, as it is not easy to train aeronautical professionals in a short time. However, many existing employees reconsidered their employment contracts, but this situation created an overall afterthought in airline labour for the uncertainty of work, salary and security. **Expert 3** revealed, 'There is a good chance that some companies may reconsider their existing employment contracts because of the unpredictability and the potential loss of jobs'. A shortage of cabin crew staff is most dominantly seen in airlines, and there is a shortage of young talent due to a lack of sustainability. Also, it was observed that many workers are assigned out-of-base duties to compensate for the shortage caused by the unavailability of cabin crew members. **Expert 11** stated, 'This is an important question for safety; it's my main concern that there are not enough people with the necessary skills, training, and crew resource management [CRM]'. Unskilled employees and technical staff shortages can create long-term challenges for the aviation sector, and therefore, as per the observations from experts, there is an intrinsic need to transform HR policies and practices and make them more sustainable. Employee retrenchment is not fruit-bearing for aviation, as it may create a skill gap in the industry that can have catastrophic results. This issue can be curbed with the help of pay revisions, lucrative compensation and job security for cabin crew, pilots, ground staff and technical support teams.

COVID-19 brought extreme employment issues, resulting in the retrenchment of middle-level and lower-level employees, and this volatility in the sector requires urgent attention from professionals post-COVID. Employees at major airlines were hit hard during the global pandemic and, as a likely response to this, there is a staff shortage, especially for pilots, cabin crew and technical support. Therefore, the airline industry needs to rethink their HR practices concerning these uncertain times. There is a need to reduce the magnitude of employees' damage caused by job losses and to search for more optimal and sustainable ways out. Training and competency are of the utmost need for this sector, and therefore, it is required that HR practices and employment goals be made more employee-centric after the revolution caused by COVID-19.

6.8.6 *Theme 4: Collaborations as Measures to Mitigate Future Risks and Uncertainties*

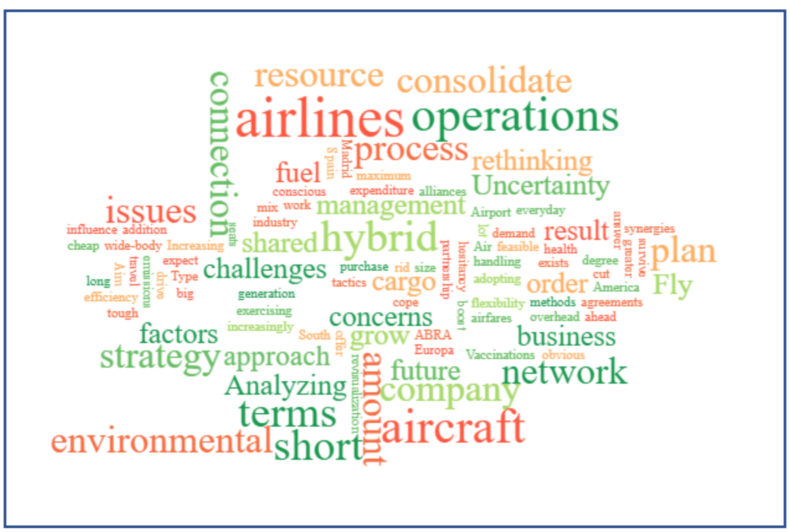
The analysis of the outbreak of COVID-19 and its impacts highlights collaboration as an imperative measure to curb risks. The transcripts of aviation professionals and the coded descriptions as per the pattern identified are presented in **Table 22**.

Table 22 Code identified as per pattern in theme-4

Common Pattern	Code
Alliances Mergers Consolidated approach	Collaboration as a measure to mitigate future risks and uncertainties

Common patterns were identified in the statements and sentiments of experts, wherein mergers and consolidated approaches were repeated several times. Establishing alliances with other airlines, hotels and other companies involved in hospitality was also considered important by most experts.

Figure 7 Collaboration as measure to mitigate future Risks and uncertainties



It is important for the aviation sector to address the preliminary issues with the help of solutions driven by a sustainable and integrated approach that could stabilise the sector and bring exponential value-added stimulus from employees, customers and the community. For this, alliances and partnerships to mitigate the risks and balance the displaced aviation industry are imperative. Better collaboration and global cooperation can bring ripe solutions to the diminishing competence of airlines. In this regard, **Expert 6** suggested, 'Establish alliances with actors from other segments or industries, such as hotels or mobility companies, cultural activities agencies, some public bodies or health centres'. By evaluating the opinion of an expert, it can be said that the issues of interest will obtain an integrated approach and holistic interrelated dynamics will be created by external players, thereby making the airline and aviation sector much more stable and fundamentally balanced. It will also accelerate workforce management and create a continuum of operations, as industries being interlinked will lessen the impacts and prepare the industries for any further disruption. Further, **Expert 2** also stated, 'We may expect to see a rise in alliances and cooperation in the near future'. Airlines need to reduce their overhead costs, and for that purpose, alliances play a vital role. Alliances seize the revenue drop faced by companies and protect flag carriers from major losses during any disruption. Collaborations with other airlines may also merge and consolidate goals, inducing easy filling of seats and prevention of losses for airlines. **Expert 3** expressed this need and said, 'The aviation sector has to open itself up to a greater degree of cooperation and partnership. I am sure we will see more cooperation in the future and more consolidations between airlines'. When airlines share planning and an integrated approach towards passenger and cargo, cost efficiency, competitive advantage, maximum utilisation of resources and defence against future disruptions will increase.

Thus, summing up, it can be said that mergers and cooperation from other entities can minimise the risks created by the pandemic in the aviation sector. The sector saw the hardest hit, and it is important to sustain disruptions and create a stronger and more resilient system in which the competitive viewpoint transition into a collaborative, value-based and integrated approach, wherein optimisation of structure can be achieved. With the help of the above-mentioned small and big revisualisations of the aviation transformation, stake owners can sustain hybrid operations and be environmentally sound and responsible. Already, airlines are sharing and utilising the big data concerning vaccination status and other documentation work, creating a standardised process, but there is still a larger scope for the creation of an integrated approach that may lead to no waste of resources, effective utilisation of cargo and passenger flights and result in a sustained and consolidated group of airlines for the future.

6.8.7 *Theme 5: Perception Concerning Oil Price-Specific Impacts*

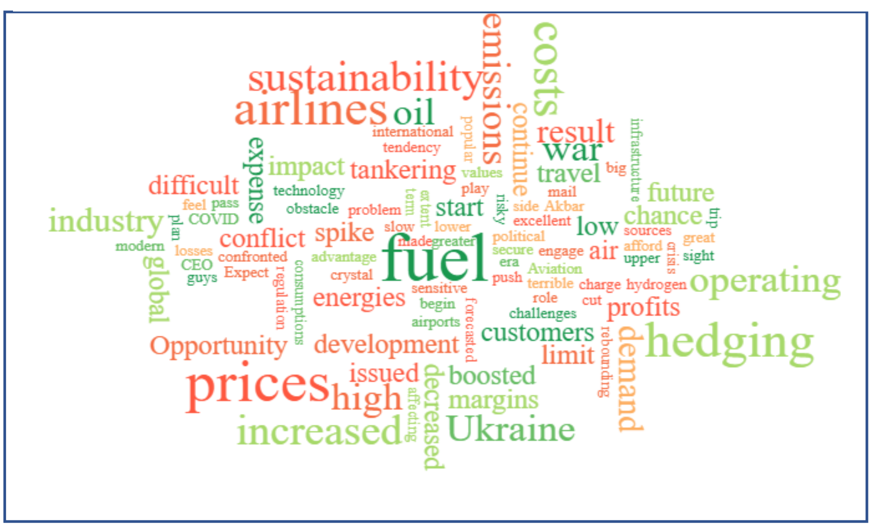
The thematic analysis herein highlights the perception of professionals concerning oil prices and related impacts. The transcripts of aviation professionals and the coded description as per the patterns identified are presented in **Table 23**.

Table 23 Code identified as per pattern in theme-5

Common Pattern	**Code**
Fuel emission War, price rise Global crisis Sustainability	Oil price-specific impacts

There were recurring themes in the opinions and remarks of experts, and the bulk of them emphasised the spikes in oil prices brought on by the conflict between the Ukraine and Russia. On a number of occasions, the necessity for sustainable fuel and the world crisis were also mentioned.

Figure 8 Oil Prices-specific impacts



COVID-19 had a gradual impact on many industries in various ways. There are several unprecedented outcomes arising out of the revolution caused by the pandemic. Sustainability has emerged as a need that could withstand any disruption, and therefore, aviation must opt for sustainable options for fuel capacity build-up. COVID-19 has provided an opportunity to consider the various ways in which exceptional transformations can be imagined. **Expert 9** exclaimed the seriousness of fuel sustainability and stated, ‘This industry needs to become serious about developing a global solution to sustainable aviation fuel [SAF]’. There are long-term and exponential setbacks to conventional fuel utility and the industry must shift to SAF.

The next market for aviation fuel will be green hydrogen technology, and electricity-based solutions must be found to build a global infrastructure for zero-carbon fuel. Further, fuel prices saw a major impact due to increased turbulence in fuel supply as a result of the Ukraine–Russia war, leading to a fuel price rise. **Expert 5** revealed, ‘Fuel is sensitive to political situations, and the current war is affecting the price of it’. Airlines and other organisations are engaging in hedging to protect themselves against rising prices. With the prolonged war and its repercussions on fuel prices, future fuel-based impacts can be curbed with hedging against the soaring prices, as there are no chances of slowing down prices. The airline industry has already suffered a setback as a result of COVID-19; therefore, it is critical to address fuel price issues so that customers and travellers are not burdened with a price increase.

On this matter, **Expert 5** stated, ‘Qatar Airways CEO Akbar issued a warning of another recession if fuel prices continue to go up’. **Expert 2** revealed the financial pain of the aviation sector and stated, ‘Fuel is a significant expense that frequently accounts for 20%–30% of an airline’s overall operating expenses. The financial linkage between jet fuel supplies and prices makes it difficult for airline operators to curb economic losses worldwide (Melas & Melasová, 2020). Thus, it can be said that fuel prices have a huge impact on airlines, and to curb these significant losses, hedging, SAF and efficient operations with new technology can provide the necessary results.

6.8.8 *Theme 6: Influence of COVID-19 on Strategic Implications*

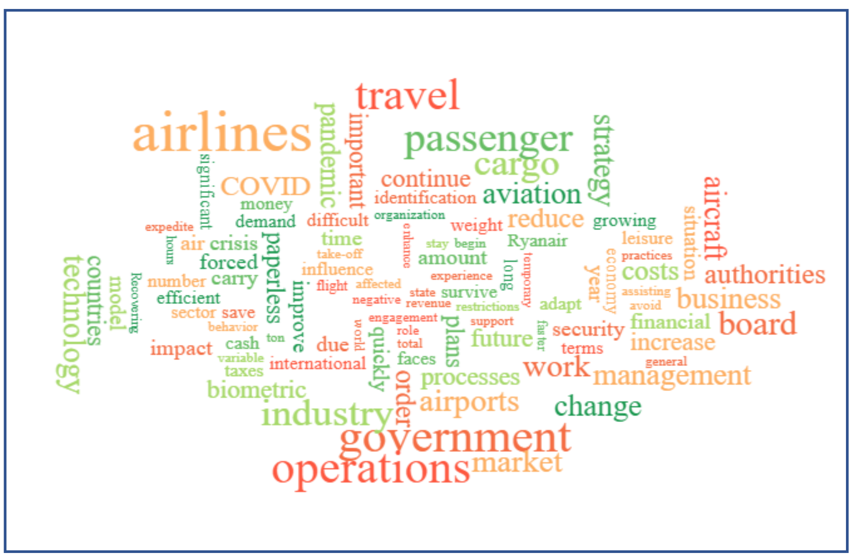
The analysis based on the transcripts highlights the perception of professionals on the strategic implications desired by the aviation sector. The statements of aviation professionals and the coded description as per the identified pattern are presented in **Table 24**.

Table 24 Code identified as per pattern in theme-6

Common Pattern	Code
Paperless operations Technology Hybrid model Cargo operations	Strategic implications

Common patterns were identified in the transcripts of the experts, wherein the majority of experts highlighted the need for data-driven, cargo-orientated, paperless operations, as technology can be helpful in the current times.

Figure 9 Strategic implications



There are unprecedented opportunities in the airline sector if efforts are made towards a change in their strategic implications and operations. For better utilisation of the nature and extent of aviation, it is highly important that government interventions be reduced to enable companies to transform and adapt to modern-day cultures. **Expert 11** explained, 'There are some exceptions, but generally speaking, support from governments will continue to play an important role'. Support from the government and their engagement provides huge aid in the case of bankruptcy or economic crisis, but strategic growth and transitions are the outcomes of the liberal outlook of airline companies to lead by remarkable difference.

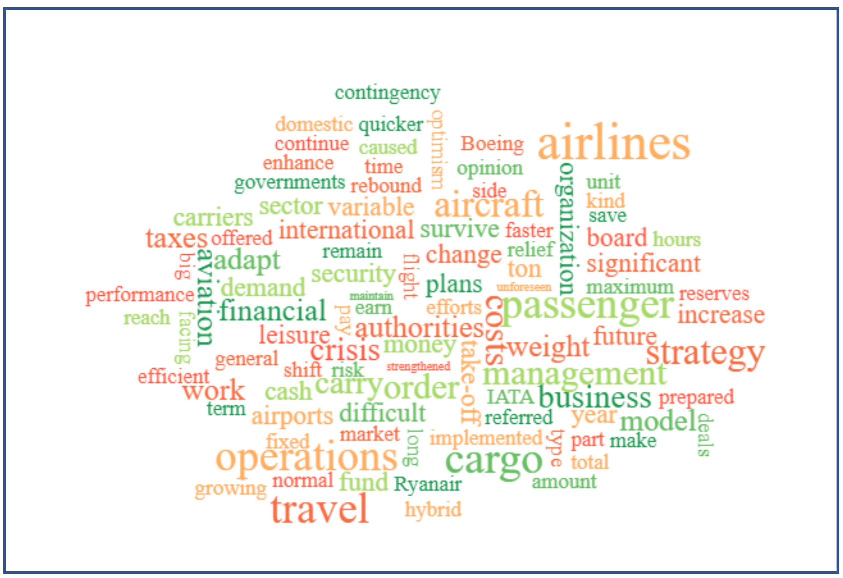
The strategic change brought by COVID-19 is largely going to influence the airline industry and the travelling public in the long run. **Expert 1** stated, 'Technology that can recognise people's faces is quickly becoming standard at airports across the world, this technology is efficient in expediting a variety of operations while also removing potential hazards to airport security'. When companies remove barriers to change and shift to a newer and easier solution, a feeling of trust is inspired in the stakeholder and the owners involved, thereby boosting their economic positions. Therefore, strategic implications concerning facial recognition, paperless travel, robotics and the usage of big data bring materialistic and cognitive benefits to the involved travellers and communities. **Expert 5** suggested that 'cargo activity will continue growing due to the expansion of e-commerce in all markets. The tendency of governments will be to open and facilitate the travel process due to the impact it has on their economies'.

Thus, it can be said that whether it is international or domestic travel, airline companies need to re-evaluate their plans and create a better setup that is more extensively prepared for future disruptions. Offering delightful services to leisure travellers in attractive packages will attract more passengers, and airlines should restructure according to new models that combine fuel efficiency, technology, a collaborative network and strategic implications for environmental sustainability. Finally, if airline companies' strategies towards data-driven, action-orientated planning, then the growing demand for aviation in cargo or leisure can be supplied to derive stable and fruitful results.

6.9 Discussion

The outbreak of COVID-19 disrupted many industries and was hardest on the aviation industry. It was also an opportunity to blend in a wide array of technological and BM changes that could be more sustainable and flexible for future disruptions. With heavy build-up and large material costs, airlines saw a steep downturn and realised organisations need to switch their ways and transform towards more cost-efficient, lean airlines. There was a rapid surge in air travel shocks, and the need for extra measures to become sustainable became evident (Morrell & Swan, 2006). Commercial passenger aviation saw a decline in travellers in both the leisure and business sectors, and technological advancements replaced the need for face-to-face meetings. All these attributes combined to create a burden on the sector, leading to job losses that impacted the quality and availability of staff. Aviation is a very delicate and intricate sector, and there is a strong need for a knowledgeable, competent, experienced and motivated workforce that can safeguard travellers worldwide.

Figure 10 Measure taken by aviation industry and future implications



Therefore, aviation must shift from conventional norms and operations to lean management and SAF so that sustainability can be derived. With a sustainable, fuel-efficient and transformed structure, the impact of disruptions can be minimised. Apart from this, the aviation sector, in collaboration with other companies from hospitality, can emerge as a strengthened and integrated system, wherein catastrophic outcomes can be curbed. In the short term, the goals of aviation have been focused on providing precise services to travellers with maximum benefit at lower cost. Furthermore, the long-term aspirations of airline companies towards increased expenditures, acquisitions and the purchase of new highly efficient aircraft that run on green fuel will undoubtedly secure the industry's long-term viability. During the pandemic, it was understood that investments in cost efficiency, technical advancement, strategic partnerships, and innovative and lean BMs are critical in times of crisis.

When the aviation sector allows technology to penetrate deep inside and lead the system automatically, the industry will continuously grow and modify its operations. Today, robotics, paperless operations, global face recognition, the elimination of passports and other lucrative and strategic steps are needed to minimise customer hassles and attract more and more travellers to air travel platforms. Without the involvement of the government, none of these changes and revolutions would be possible. In order to ensure financial stability and support for the aviation industry's fragile performance, the government must provide low-cost financing for long-term investments and aid technological development from its infancy to mature applications.

6.10 Policy Implications

This section presents the various policies and implications that highlight the necessary transformations that can aid the industry. A summary of the main recommendations is presented in **Table 25**.

Table 25 Recommendations for future policies and implications

Policy/ Implication	**Economic Policy**	**Infrastructure-Based Outlook**	**Environmental Policy**	**Long-Term Implications**
Recommendations	- Fuel pricing - Hedging - Operational and maintenance cost reductions	- Retiring old aircraft - New LCCs with longer thinner routes - Robotic and artificial intelligence-based facial recognition tools - A transformed and upgraded infrastructure	- Sustainable fuel alternatives - The usage of green hydrogen technology	- Focus on market expansion - Dominating cargo-based BM - Merger and collaborations - Low-cost financing options

There is an urgent need to develop an integrated aviation system in order to avert future problems. COVID-19 arrived as a reformer, bringing many important realisations to people about the environment and sustainability. Economic policy, the infrastructure-based perspective, environmental policy and the long-term model-based implications are some policy implications that might lead to better results. Economic measures, such as fuel pricing and hedging, should be established as a remedy, and there should be a greater price cap on the amount that may be charged to travellers (Morrell & Swan, 2006).

Furthermore, operating and maintenance expenses should be lowered, leading to the creation of lean systems. Based on the infrastructure perspective, existing aircraft should be slowly phased out, and new low-cost alternatives with longer, thinner route capabilities should be brought into service. To supplement current demand, robotics and artificial intelligence-based face recognition systems should be adopted as a transformed and enhanced infrastructure. Furthermore, environmental policy should emphasise the use of second-generation biofuel alternatives and green hydrogen technologies to enable aviation fuelling (AbouSeada & Hatem, 2022). Finally, strategies that have long-term model-based effects, such as market expansion, dominantly cargo-based BMs, combining and acquiring systems to create a more stable network and low-cost financing options, may result in a sustained global trend with a greater magnitude and a broader spectrum for the future airline industry.

6.11 Chapter Conclusion

The majority of countries think that investing in the aviation industry is in their national interest because of the positive effects it has on GDP, jobs and other industries that may gain from global connectivity. After suffering a precipitous fall in operations due to the broad disruption caused by COVID-19, the aviation sector is now engaged in an intensive recovery effort. Several migrations have previously been completed by airline firms in order to keep the process running smoothly. However, there is an inherent necessity in aviation to adapt the BM. Experts continue to emphasise the importance of technical breakthroughs. The industry must work on methods to improve and automate the process in order to save more money and restore traveller trust.

Furthermore, there were serious worries about the employment situation; a lack of worker motivation and job instability have created a significant gap in aviation. These exacerbated issues must be addressed seriously, and with the help of a comprehensive strategy, aviation can become more sustainable and withstand future transformations in a more coordinated and stable manner.

Managing the storm's aftermath while simultaneously establishing a firm foundation for a long-term position is surely a difficult task. There are serious uncertainties about whether these transient behavioural alterations will survive beyond the pandemic era. However, as many airlines discovered in the aftermath of the 2001–2003 crisis, just surviving the storm does not guarantee recovery success. Scenario analysis can help airlines better prepare for future events and refine their profiles. Long-term performance will be determined by how airlines cope with change, rather than just responding to it.

Chapter 7 Conclusion

This research examined the operational efficiency and productivity of 35 major airlines by benchmarking them using the DEA and bootstrap methods. The STP was employed to investigate the effects of the three tripod components – industry, resources and institutions – and measure their impact on airline efficiency. Due to the COVID-19 outbreak, chapter-6 of the study takes a qualitative approach and uses semi-structured interviews with subject-matter specialists to look at how COVID-19 has affected the findings from the first part.

7.1 Summary of Findings

7.1.1 Relative Differences in Airlines' Optimal Efficiency and Productivity

DEA is a compelling method for benchmarking entities. This method is extremely useful since it makes use of multiple inputs and outputs without specified measurement units. DEA and the Malmquist index provide an overview of the technical, technological and productivity changes over time, thus giving us a longitudinal outline of the performance of our airline sample.

Key Findings:

Airlines operate in a very competitive environment, whether operating under the FSC or LLC. The challenging and competitive nature of the business has led airline BMs to converge into a blurry distinction. Airline efficiency is the ability of organisations to maximise their production by reducing costs. From the DEA assessment, it is derived that many airlines, though performing effectively, still need to focus more on employee number, load factor, and RPK for better efficiency derivation.

Our results reveal that European airlines are the most efficient followed by those in the Asia-Pacific region. Their technical efficiency contributes significantly to the success of most airlines in these two regions. Of the 12 airlines operating in the European region, nine operate with a productivity of more than 100%.

In North and South America, airlines' technological change is the primary contributor to their productivity. On the other hand, technical efficiency is the main contributor to productivity in the Middle East and the Asia-Pacific region.

For African airlines, technical efficiency and technological innovation are low, making the regional aviation industry less productive.

7.1.2 Industry Factors that Influence an Airline's Efficiency and Productivity

The industry factors are the ones wherein business conditions are examined for better information to a large extent about firms' strategy or performance. As airlines are one of the significant contributors to prosperity and economic growth, improving performance requires consideration of factors such as the airline's BM, jet fuel cost, and competition.

Key Findings:

The FY2011–FY2018 reveals that competition is one aspect that tends to pressure airlines to innovate. Yet, as competition is difficult to quantify and constantly varies over time, the results show no significance of this variable on airline efficiency. The complexity of measuring competition in the airline industry is another factor that hampers the accuracy of the results.

Jet fuel costs positively affect technical efficiency; i.e., a rise in the cost of fuel shifts the focus of airlines from innovation activities or productivity to improving efforts and motivates airlines to enhance efficiency by switching to more technically efficient (low fuel-consuming) methods and more efficient aircraft. Therefore, one of the essential components that lead to airline efficiency is jet fuel cost. Fuel costs are a major portion of airline expenses. The survival of an airline is incredibly reliant on how efficiently jet fuel costs are managed. Additionally, a rapid increase in airfares occurs when fuel prices rise. However, there is a slower response in the other direction because airfares have statistically significant asymmetric effects on the demand for air travel.

The airline BM is critical to the airline's performance; the airline's operational level should determine the sort of model to use. Whether operating in a large domestic market or competing on a global scale, FSCs need to find ways to close the gap and use a hybrid approach to keep people from switching to LCCs.

The BM has a direct role in technical efficiency, as the LCC model contributes to controlling airlines' cost structures. A critical element of their success relates to their high labour productivity compared with traditional airlines. Additionally, these airlines typically operate with shorter ground times, translating directly into higher aircraft utilisation rates.

7.1.3 Resource Factors that Influence an Airline's Efficiency and Productivity

Resources are the available internal capabilities of airlines, contributing to their efficiency, strategy and competitive advantage. As in airlines, the resources required for functioning are costly; thus, to tackle the challenges and meet the needs of the dynamic environment, the focus needs to be on these valuable resource factors, including employee numbers, ownership, location (connectivity) and membership in global alliances.

Key Findings:

The formation of alliances is a logical continuation of the development of hub-and-spoke networks. Alliances allow airlines to increase the number of destinations in their network without increasing the number of flights and increase passenger density in their home network by channelling passengers from their alliance partner's home network through its hub and vice versa. Again, because of economies of density, this raises load factors and lowers average costs for all alliance partners.

The rise in employee numbers contributes to improving technical capabilities with the availability of a more skilled workforce; thus, alliances and employees are resources contributing to airlines' efficiency. Larger airlines are more efficient due to economies of scale "cost advantages".

Ownership and location (connectivity) have no significant effect on airlines' technical efficiency. When two BMs are combined, connectivity becomes less important because most LCCs do not have a network with a lot of connections, instead relying heavily on point-to-point service.

Offering better connectivity at the expense of lower network efficiency gives airlines the option to charge premium prices and attract customers who value connectivity. Improved 'network coverage' benefits all airlines up to a saturation point. Beyond the saturation point, all airlines are equally affected by congestion and limited connectivity.

7.1.4 Institutional Factors that Impact the Efficiency and Productivity of an Airline

There exists a dependency between macroenvironmental forces and air transport output. The success of a country in leveraging the air transport sector to achieve its desired economic and social goals will depend on its overall environment, including political and security stability, market efficiency, market size and labour market. Institutional factors are the external influences that govern and exert pressure on enterprise operations. As these characteristics may impact airline efficiency, we analysed destination attractiveness using global indices:

Key Findings:

An examination of FY2011–FY2018 performance of the four institutional variables revealed that only trade openness affects technical efficiency. Trade openness results in the removal of restrictions, increase in competition and the use of less expensive products to provide low-cost services; thus, trade openness reduces existing technical efficiency. When a country opens its economy, either to a large market or to a regional Open Skies agreement, a lot of pressure may be placed on airline operations, forcing them to lower their standards to remain afloat.

Factors such as visa openness indicators, EFW, and TTCI results are not significant; therefore, for this study at least, we can conclude that they do not directly contribute to airline efficiency.

The split between the European region and the rest of the world reveals important differences in the results. The analysis of employment is a contributor to efficiency in Europe compared with the analysis of the rest of the world; this indicates the strong nature of the workforce unions in Europe.

The comparison of the rest of the world's airlines with European airlines indicates that being a member of a global alliance has the same impact on both European and the rest of the world's airlines. However, trade openness and employment are aspects that affect European airlines' technical efficiency, though they have no obvious role in the rest of the world's airlines. In reality, the European region has strong institutional forces and a more diverse environment that play a big part in the efficiency of airlines. This means that airlines operating in Europe have the extra burden of having to cater to their resources and operating environments to derive better efficiency. In other words, there should be more emphasis on institutional-, industrial-, and resource-based factors when operating in the European region. At the same time, for the time being at least, the rest of the world should mainly focus on industrial-and resource-based factors and less on institutional forces.

7.1.5 Use of the Strategy Tripod in Determining Airline Efficiency

Although many researchers have used the STP perspective, few have explored the tripod three legs in the airline industry (Cui, Jiang, and Stening, 2011; Ju, Zhao, and Wang, 2014). Attempting to assess the relationship in a single study empirically is an additional contribution to the STP and airline efficiency. Investigating challenging and complicated businesses should exploit the STP advantage (Peng et al., 2009; Yamakawa, Peng, and Deeds, 2008).

Airlines must efficiently use different resources, institutional, and industry-specific elements depending on how and where they operate. The overall results demonstrates that airline resource repertoires and industry conditions significantly affect airline efficiency more than institutional factors. This finding is not unexpected, given that resources and industrial components account for a considerable proportion of airline operations.

To the best of my knowledge, there has been relatively little research on the empirical examination of airline efficiency utilising the STP and DEA in one study. Strategic choices rely heavily on the interplay between the tripod's three legs to better understand complex business-like airlines. The advantage that the STP has is in the integration of the three legs of the tripod. Previous studies based on the tripod method frequently employ the three legs separately, with little research assessing their impact on one study.

Key Findings:

Theoretical contributions include an examination of how the institutional contexts of a destination may influence airline efficiency in ways other than the usual investigation of industry and resource variables.

There is no one-size-fits-all solution that can be applied to global settings. Research in the global airline industry should note that institutional, industrial and resource forces vary significantly from country to country. We have effectively integrated the three legs of the STP into a single model and examined how these variables interact. Understanding the intricacies of a global airline sample requires a combination of resource-based, industry-based and institutional-based views.

The study provides empirical evidence for STP applications in complicated operational environments, such as the airline industry.

Finally, although employing the STP to investigate complex phenomena is very beneficial, it lacks unified measurements. It is vital to ensure that variable limits are correctly specified while examining global phenomena to prevent widening the study area and yielding weaker findings.

7.1.6 Impact of COVID-19 on the Airline Industry

The international aviation industry has been severely hit – first by the COVID-19 outbreak and second by various national measures adopted across the globe to contain the pandemic. In particular, these circumstances have drastically affected passenger transportation. The pandemic showed that any sector of economic activity should never underestimate the external environment, which is an uncontrollable variable, thus leading companies to demonstrate flexibility and adaptability without losing sight of the focus of efficiency. There are no miracle recipes, but reinventing the BM is a matter of survival for companies. We live in the 'age of experience', when customers continue to be the focus of the business strategy. It is imperative to ensure business continuity through preparation, response and adaptation to recover from these shocks.

Key Findings:

Airline companies have realised that the only way for them to exist in the future is to reinvent their BM and to continually adapt to external shocks. Since each region and country has unique characteristics, no approach or technique can be used universally to tackle the outbreak.

The importance of airline personnel raises the prospect of a talent gap developing in the sector, which might have disastrous effects. Pay adjustments, profitable remuneration, and job stability for cabin crew, pilots, ground employees, and technical support teams may all assist in preventing this problem.

Airlines should collaborate on their planning and create an integrated strategy for both passenger travel and cargo. This guarantees cost-effectiveness, competitive advantage, optimal resource utilisation and defence against potential disruptions.

Fuel efficiency and fuel management are of the utmost importance to airlines. Unfortunately, predicting future fuel prices is notoriously difficult and may even be risky.

In order to ensure the long-term viability of their airlines, governments will constantly keep an eye on them, whether they grant direct or indirect support.

When it comes to global initiatives to safeguard our environment, the aviation industry does not want to fall behind. It places a high priority on finding sustainable and alternative sources of energy.

7.2 Theoretical Implications

This study contributes theoretically and methodologically to the field of operational research and the global airline business. The DEA method is one of the best ways to measure and benchmark entities. Incorporating the DEA and the STP to measure airline efficiency can be further developed using more complicated versions of the DEA. The results of this study substantiated the significance of the STP as a theoretical instrument while researching international corporations.

The research also makes a theoretical contribution to studies examining the influence of all three viewpoints. Indeed, this simultaneous examination expands upon past studies on airline efficiency, enabling us to comprehend the interplay of variables across the three legs of the tripod and to give a holistic perspective on airline efficiency beyond the traditional resource- and industry-based aspects. This investigation is the first to apply the STP to explore airline efficiency; using such a theory may help improve knowledge of how efficiently airlines operate.

The results of this study may be helpful to a wide range of individuals, such as those who make decisions on aviation policy, airline owners, airline management, airport authorities, members of national economic boards, consultants and other strategic planning experts.

7.3 Practical Implications

This study has provided genuine, data-driven information using analytical approaches to assess airline operational efficiency. While DEA has been extensively used to assess airline efficiency, including the STP to analyse the three views simultaneously is a significant achievement. This study provides participants in the airline industry and decision-makers engaged in regulatory activities with enhanced techniques to analyse and compare airline efficiency. An airline may use the facts and options presented in this study to determine if adjustments specific to their airline would be more effective. Similarly, an airline using the FSC, LCC or point-to-point BM could use the model to assess their efficiency before deciding on a business improvement strategy based on the relative efficiencies of their competitors in the same market. Finally, policymakers should evaluate how loosening trade rules might harm airline efficiency. People in charge of airlines should be aware that operating in a regional environment or a free trade zone might distort airline performance.

Airlines link individuals, nations, and cultures, giving them access to the global marketplace. Moreover, restrictions on cross-border travel may effectively prevent the spread of illnesses and save lives. COVID-19 has nonetheless caused severe but inevitable flight interruptions that have had disastrous effects on the aviation industry. Therefore, the results of this research may be utilised to evaluate the success of the lockdown policy from the viewpoint of the aviation industry and as practical evidence to assist governments in developing future pandemic control and risk assessment policies. Both the industry and governments should strategise on how to better support the industry's resilience during times of crisis when travel restrictions are imposed, as well as how to manage the costs of implementing such control measures post-pandemic.

Tourism and mobility are directly impacted by the political, geographic, and management decisions of global health organisations. The current spread of COVID-19 has generated concerns about public health, politics, human rights, geopolitics, and movements that need further investigation. In times of crisis, there is an urgent need to preserve HR in the airline business and work closely with civil aviation authorities to enhance training and currency.

7.4 Recommendations

It must be recognised that aviation is a strategically vital industry that supports several sustainable development goals and, as such, must be an essential element of the development policies established by regions and individual governments. This study focused on exploring the operational efficiency and productivity of the global airline industry. Thus, with the derived outcomes about the aspects influencing performance, the strategies below are suggested for attaining more optimal management of operations.

Technical efficiency is the main contributor impacting the productivity of airlines; thus, efforts such as flight operations optimisation, disruption management, and adaptation of low-cost models should be implemented to derive better efficiency. Technological changes are not the primary factor influencing productivity. In the big data environment, the usage of advanced technologies, whether it is investment in more advanced aircraft and engine technology or revenue management software, is necessary for sustaining competitive advantage.

Resource-based factors have a significant role in influencing technical efficiency; thus, airlines should adopt better fuel management techniques and offer better service delivery by using smaller aircraft more often with higher load factors.

As a strategic alliance or partnership can help airlines improve their strategic position in some markets and regions or make it easier for them to compete, they should look for business opportunities and sign more multilateral or bilateral agreements.

Training highly skilled pilots and technical staff is not easy and requires periodic licencing validation. Therefore, there is a need to encourage young people to join the industry and make it more attractive for them.

The presence of low entry barriers and intense price competition may have a detrimental impact on the technical efficiency of an airline's operations when it is located in an open trade region. The incentives to follow the market may cause performance to drop, so airlines should keep their service standards high and improve their safety operations.

Our global airline sample consists of different airlines operating in different regions worldwide. Some have large domestic markets and Open Skies agreements; thus, the individual country's case-by-case study should yield a more realistic measure of destination attractiveness.

COVID-19 has made the sector vulnerable and has pushed it to its limits, ensuring the industry's survivability against future external shocks. Risk management must be included in the plans of both airlines and governments.

7.5 Limitations

The main limitations of the study are the use of archival data from publicly accessible publications. Due to the availability of data and reporting methods, our ultimate sample size was restricted. Even though the goal of the research was to examine the operational efficiency of global airlines, the study was hampered by a lack of resources and time. The scope of this research has been limited to the 35 leading airlines, and the time frame of performance analysis is FY2011 to FY2018.

The first quantitative part of the research data is limited to the period before the pandemic to exclude any potential global shocks, such as COVID-19, which halted the whole aviation industry, rendering any usefulness of the data ineffective.

DEA is excellent at predicting a DMU's relative efficiency, but it converges slowly to absolute efficiency. In other words, it can identify how well DMUs are doing in comparison to peers but not in comparison to a theoretical maximum.

Statistical hypothesis testing is challenging since the DEA is a non-parametric approach using a selection of inputs and outputs which are subjective by nature. Large data may be computationally intensive since the usual formulation of DEA generates a specific linear program for each DMU.

It is worth mentioning that in the second-stage regression analysis, the Tobit and compound error models rely on a strong assumption of separability, that is, models in which external variables do not change the structure of the production set (Bădin et al., 2012; Bădin et al., 2014). As an illustration, Daraio et al. (2010) provide one of the statistical methods for evaluating the assumption of separability. In our DEA, we assumed that the separability assumption holds. This is a major constraint that must be addressed fully in any future DEA study utilising second-stage contextual variables. The problem of separability is still a contentious issue that requires extensive understanding of econometric research and skills.

The impact of the COVID-19 qualitative study was designed around the results of the first part of the research. It is crucial to be careful about drawing general implications from the study. Furthermore, since the crisis was so recent, the insights obtained at this time may represent a short-term influence. As more data becomes available, future studies might look into how the crisis will affect long-term performance and how it will affect different business strategies.

7.6 Scope for Future Study

Destination attractiveness needs a better and specific individual investigation in a "case study style" rather than a global sample, as this can better judge whether making a destination more attractive directly affects airline operations.

Environmental degradation is the primary concern of the aviation industry. Thus, future studies could build on the multistage DEA model and integrate the environmental aspect into the study to derive an adequate representation of airline efficiency and productivity.

Based on previous research, we believe that DEA and airline efficiency will be investigated in the future in a more complicated problems and data, for example, models dealing with ordinal, negative or interval data.

Analysing airline efficiency using dynamic DEA models and other data prediction approaches is a welcome change from earlier research that predominantly used past periods as sample periods.

Future airline efficiency studies that use the STP will need to look at how particular aspects from all three perspectives might interact with each other and understand their interaction effect. There is also a need to create a framework for delving further into airline operations and determining how incorporating the STP could enhance our knowledge of airline performance.

Supply chain management is accorded a particularly high level of significance within the aviation industry. This is mostly attributable to the inherent complexity of managing supply in the aviation industry. An operation is considered complicated due to a number of factors, including maintenance, spare parts (orders and deliveries), and the provision of onboard catering. As an additional aspect, the control of the reverse flow of supply creates even more complex scenarios. To increase the airline's chances of success and improve its efficiency, academics and practitioners must stress the need for conducting supply chain investigations and how better predictions using AI and transparent data sharing can improve the supply chain in the future of airline operations.

Due to the contagious nature of COVID-19, researchers have already identified a change in travel behaviour in which shared forms of transportation, such as public transportation, are seen as more dangerous than individual modes of travel. It would be interesting to see whether this change in travel behaviour endures after the pandemic is over.

7.7 Final Words

Warren Buffett once said, ‘The worst kind of business is one that develops fast, takes large amounts of capital to drive that growth, and then produces little or no profit. Think airlines. Mr Buffett’s assessment of air travel encapsulates many of the challenges airline owners and management encounter. As an aviator myself, I believe airlines deserve greater recognition and understanding.

Since the Wright brothers' maiden flight in 1903, aviation has continued to excite people worldwide. The disastrous effect of COVID-19 on the airline sector has exposed the need for a healthy and functioning air transportation industry that is both sustainable and environmentally friendly. It is important to realise the crucial role the airline industry plays in our modern world. Air travel's strategic significance cannot be overstated, whether in terms of the economy, society or both. Airline executives, policymakers and governments should all be on high alert for external shocks. Practitioners and academics ought to collaborate to study this important business. Indeed, Mr O'Leary, this is more than a 'glorified bus service'.

Note:

During the process of writing this thesis, the author participated in several courses, webinars, and other events, as well as attempting to produce research articles that are in the process of being submitted to various journals. Please refer to ***Appendices 16 and 17.***

Thank you

References

Abate, M., Christidis, P., & Purwanto, A. J. (2020) “Government support to airlines in the aftermath of the COVID-19 pandemic”. *Journal of air transport management*, 89, 101931.

Abdullah, M. A. & Satar, N. M. (2019) “Efficiency of global airline: An application of the metafrontier DEA model”, *International Journal of Business and Society*, 20(3) pp. 1178–1197.

Abeyratne, R. (1999) “Environmental Impact of Tourism and Air Transport on the Sustainable Development of Small Island Developing States”. *Journal of Air Transportation World Wide*, Vol. 4, No .1-1999.

Abeyratne, R. (2020) “Aviation in the Digital Age”. *Springer International Publishing*.

AbouSeada, N., & Hatem, T. M. (2022) “Climate action: Prospects of green hydrogen in Africa”. *Energy Reports,* 8, 3873-3890*.*

Adam, A., & Tsarsitalidou, S. (2019) “Environmental policy efficiency: measurement and determinants”. *Economics of Governance*, 20, 1-22.

Adrienne, N., Budd, L., & Ison, S. (2020) “Grounded aircraft: An airfield operations perspective of the challenges of resuming flights post COVID”. *Journal of Air Transport Management*, 89, Article 101921. https://doi.org/10.1016/j.jairtraman.2020.101921.

Agarwal, P., Sahai, M., Mishra, V., Bag, M., & Singh, V. (2011) “A review of multi-criteria decision-making techniques for supplier evaluation and selection”. *International journal of industrial engineering computations*, 2(4), 801-810.

Agarwal, S., Yadav, S. S., Singh, S. P. (2002) “Performance Evaluation of Public Sector of UP: An Application of DEA. Vision 2020”: *The Strategic Role of Operational Research*, pp. 509–523.

Aguilera, R. V., & Grøgaard, B. (2019) “The dubious role of institutions in international business: A road forward”. *Journal of International Business Studies*, 50(1), 20-35.

Ahmad, K. & Khan, M. M. (2011) “A Comparative Analysis of Productivity of Airline Industry: Evidence from Selected Asian Airlines”. *International Journal of Business and Social Science*, 2(15) pp. 224–231.

Ahuja, G., & Yayavaram, S. (2011) “Explaining influence rents: The case for an institution-based view of strategy”. *Organization Science*, 22(6), 1631–1652.

AirlineGeeks. (2016) “Airline Geeks. Airline Metrics: Revenue Passenger Kilometres”. Available at: https://airlinegeeks.com/2016/01/17/airline-metrics-revenue-passenger-kilometers/ (Accessed on: 04.12.2022).

Ait Sidhoum, A. (2023) “Measuring farm productivity under production uncertainty”. *Australian Journal of Agricultural and Resource Economics*.

Akbar, Y. H., & Kisilowski, M. (2020) “To bargain or not to bargain: Airlines, legitimacy and nonmarket strategy in a COVID-19 world”. *Journal of air transport management*, 88, 101867.

Alamdari, F., & Fagan, S. (2005) “Impact of the adherence to the original low-cost model on the profitability of low-cost airlines”. *Transport Reviews*, 25(3), 377-392.

Albers, S., & Rundshagen, V. (2020) “European airlines’ strategic responses to the COVID-19 pandemic”. *Journal of air transport management*, 87, 101863.

Algieri, B., Aquino, A., & Succurro, M. (2018) “International competitive advantages in tourism: An eclectic view”. *Tourism management perspectives*, 25, 41-52.

Ali, A. M., & Crain, W. M. (2001) “Political regimes, economic freedom, institutions and growth”. *Journal of Public Finance and Public Choice*, 19 (1), 3-21.

Ali, N. S. Y., Yu, C., & See, K. F. (2021) “Four decades of airline productivity and efficiency studies: A review and bibliometric analysis”. *Journal of Air Transport Management*, 96, 102099.

Allroggen, F., Wittman, M. D., & Malina, R. (2015) “How air transport connects the world–A new metric of air connectivity and its evolution between 1990 and 2012”. *Transportation Research Part E: Logistics and Transportation Review*, 80, 184-201.

Alvesson, M., & Spicer, A. (2019) “Neo-institutional theory and organization studies: a mid-life crisis?”. *Organization Studies*, 40(2), 199-218.

Amankwah-Amoah, J. (2020) “Mayday, Mayday, Mayday! Responding to environmental shocks: Insights on global airlines’ responses to COVID-19”. *Transportation Research Part E: Logistics and Transportation Review*, 143, 102098.

Amara, N., Rhaiem, M., & Halilem, N. (2020) “Assessing the research efficiency of Canadian scholars in the management field: Evidence from the DEA and fsQCA”. *Journal of Business Research*, 115, 296-306.

Amit, R., & Zott, C. (2001) “Value creation in e-business”. *Strategic management journal*, 22(6-7) 493-520.

Andersen, P., & Petersen, N. C. (1993) “A procedure for ranking efficient units in data envelopment analysis”. *Management Science*, 39(10), 1261-1264.

Angrist, J. D., & Pischke, J. S. (2015) “The path from cause to effect: mastering ‘metrics (No. 442)”. *Centre for Economic Performance*, LSE.

Anheier, H. K., Haber, M., & Kayser, M. A. (Eds.). (2018) “Governance indicators: Approaches, progress, promise”. *Oxford University Press*.

Appelbaum, S. H., & Fewster, B. M. (2002) “Global aviation human resource management: contemporary recruitment and selection and diversity and equal opportunity practices”. *Equal Opportunities International*, 21(7), 66–80. https://doi.org/10.1108/02610150210787226

Ariff, M., Cabanda, E., & Sathye, M. (2009) “Privatization and performance: evidence from telecommunications sector”. *Journal of the Operational research Society*, 60(10), 1315-1321.

Artal-Tur, A., Pallardó-López, V. J., & Requena-Silvente, F. (2016) “Examining the impact of visa restrictions on international tourist flows using panel data”. *Estudios de Economía*, 43(2) 265-279.

Arvis, J. F., & Shepherd, B. (2011) “The air connectivity index: measuring integration in the global air transport network”. *World Bank Policy Research Working Paper*, (5722).

Assaf, A. (2011) “A fresh look at the Productivity and Efficiency changes of UK Airlines”. *Applied Economics*, 43(17), 2165-2175.

Assaf, A. G., & Josiassen, A. (2012) “Identifying and ranking the determinants of tourism performance: a global investigation”. *Journal of Travel Research*, 51(4), 388-399.

Assaf, A. G., & Josiassen, A. (2016) “Frontier analysis: A state-of-the-art review and meta-analysis”. *Journal of travel research*, 55(5), 612-627.

Assaf, A., & Matawie, K. M. (2010) “Improving the accuracy of DEA Efficiency Analysis: A Bootstrap application to the Health Care Foodservice Industry”. *Applied Economics*, 42(27), 3547-3558.

ATAG, (2005) “Air Transport Action Group, Geneva, Switzerland”. The Economic and Social Benefits of Air Transport, available at: Home (atag.org) (Accessed on: 09.08.2021).

ATAG, (2008) *“The economic & social benefits of air transport”*. Available at: https://www.atag.org/our-activities/social-and-economic-benefits-of-aviation.html. (Access on: 21.06.2021).

ATAG, (2014) “Aviation Benefits Beyond Borders”. Available at https://www.atag.org. (Access on: 20.06.2021).

ATAG, (2018) “Powering global economic growth, employment, trade links, tourism and support for sustainable development through air transport”. *Aviation Benefits Beyond Borders*, p. 88.

Ater, I. (2012) “Internalization of congestion at US hub airports”. *Journal of Urban Economics*, 72(2-3) 196-209.

Ateş, S. S., Kafali, H., & Çeliktaş, M. (2018) “Analysis of Internal/External Factors Affecting Time Management and The Reasons of Delay in Aviation”. *Journal of Aviation*. Published. https://doi.org/10.30518/jav.480981.

Ateş, S. S., Kafali, H., & Kılıçoğlu, G. C. (2018) "Reducing Operational Fuel Costs of Airlines: A Model for Monitoring and Managing Fuel Consumption Using Unified Modeling Language". *Celal Bayar University Journal of Science*, 14(1), 105-111.

Backx, M., Carney, M., & Gedajlovic, E. (2002) "Public, private and mixed ownership and the performance of international airlines". *Journal of Air Transport Management*, 8(4) 213-220.

Bădin, L., Daraio, C., & Simar, L. (2012) "How to measure the impact of environmental factors in a nonparametric production model". *European Journal of Operational Research*, 223(3), 818-833.

Bădin, L., Daraio, C., & Simar, L. (2014) "Explaining inefficiency in nonparametric production models: the state of the art". *Annals of Operations Research*, 214(1), 5-30.

Bailey, E. E. (2010) "Air-Transportation Deregulation. In Better living through economics". Harvard University Press pp. 188-205.

Bailey, J., & Richardson, L. (2010) "Meaningful measurement: a literature review and Australian and British case studies of arts organizations conducting "artistic self-assessment". *Cultural Trends*, 19(4) 291-306.

Balcombe, K., Davidova, S., & Latruffe, L. (2008) "The use of Bootstrapped Malmquist Indices to reassess productivity change findings: an application to a sample of Polish farms". *Applied Economics*, 40(16), 2055-2061.

Balk, B. M., & Althin, R. (1996) "A new, transitive productivity index". *Journal of Productivity Analysis*, pp. 7, 19–27.

Baltagi, B. H., Griffin, J. M., & Rich, D. P. (1995) "Airline deregulation": The cost pieces of the puzzle. *International Economic Review*, 245-258.

Bams, D., Blanchard, G., Honarvar, I., & Lehnert, T. (2017) "Does oil and gold price uncertainty matter for the stock market?". *Journal of Empirical Finance*, 44, 270-285.

Banalieva, E. R., Eddleston, K. A., & Zellweger, T. M. (2015) “When do family firms have an advantage in transitioning economies? Toward a dynamic institution-based view”. *Strategic Management Journal*, 36(9), 1358–1377.

Banker, R. D., & Johnston, H. H. (1994) “Evaluating the Impacts of Operating Strategies on Efficiency in The US Airline Industry. In Data Envelopment Analysis*”: Theory, Methodology, and Applications* (pp. 97-128). Springer, Dordrecht.

Banker, R. D., & Natarajan, R. (2008) “Evaluating contextual variables affecting productivity using data envelopment analysis”. *Operations research*, 56(1), 48-58.

Banker, R. D., & Natarajan, R. (2011) “Statistical tests based on DEA efficiency scores”. In *Handbook on data envelopment analysis* (pp. 273-295). Springer, Boston, MA.

Banker, R. D., Charnes, A., & Cooper, W. (1984) “Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis”. *Management Science*, 30(9), 1078-1092.

Banker, R., Khosla, I., & Sinha, K. (1998) “Quality and Competition”. *Management Science,* 44(9), 1179-1192. (Retrieved July 6, 2021), from http://www.jstor.org/stable/2634708.

Barbot, C., Costa, A. & Sochirca, E. (2008) “Airlines performance in the new market context: A comparative productivity and efficiency analysis” *Journal of Air Transport Management*, 14, pp. 270–274. DOI: 10.1016/j.jairtraman.2008.05.003.

Barla, P., & Perelman, S. (1989) “Technical efficiency in airlines under-regulated and deregulated environments”. *Annals of public and cooperative economics*, 60(1), 103-124.

Barnes, I. R. (1946) “The economic role of air transportation”. *Law and Contemporary Problems*, 11(3), 431-451.

Barney, J. (1991) “Firm resources and sustained competitive advantage”. *Journal of Management*, 17(1): 99–121. doi:10.1177/014920639101700108.

Barney, J. B. (2001) “Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view”. *Journal of management*, 27(6), 643-650.

Barney, J. (2014) "How marketing scholars might help address issues in resource-based theory". Journal of the Academy of Marketing Science, 42(1), 24-26.

Barney, J. B., & Clark, D. N. (2007) "Resource-based theory: Creating and sustaining competitive advantage". *Oxford University Press on Demand*.

Barney, J. B., & Mackey, A. (2016) "Text and metatext in the resource-based view". *Human Resource Management Journal*, 26(4), 369-378.

Barro, R. J. (1996) "Determinants of economic growth: A cross-country empirical study". (*Cambridge, The MIT Press*).

Barros, C. P. & Peypoch, N. (2009) "An evaluation of European airlines' operational performance", *International Journal of Production Economics*, 122(2), pp. 525–533. doi: 10.1016/j.ijpe.2009.04.016.

Barros, C. P., & Couto, E. (2013) "Productivity analysis of European airlines, 2000–2011". *Journal of Air Transport Management*, 31, 11-13.

Barros, C. P., & Dieke, P. U. (2008) "Measuring the Economic Efficiency of Airports: A Simar–Wilson Methodology Analysis". *Transportation Research Part E: Logistics and Transportation Review*, 44(6), 1039-1051.

Barros, C. P., Liang, Q. Bin and Peypoch, N. (2013) "The technical efficiency of US Airlines", *Transportation Research Part A: Policy and Practice*, 50, pp. 139–148. doi: 10.1016/j.tra.2013.01.019.

Barry, W. S. (2017) "Airline Management*": Business Management in Transport 3* (Vol. 2). Routledge.

Bartels, R. (2015) "Re-interpreting R2, regression through the origin, and weighted least squares". *University Sydney Business school*.

Barth, W., & Staat, M. (2005) "Environmental Variables and Relative Efficiency of Bank Branches: A DEA-Bootstrap Approach". *International Journal of Business Performance Management*, 7(3), 228-240.

Basher, S. A., & Sadorsky, P. (2006) "Oil price risk and emerging stock markets". *Global finance journal*, 17(2), 224-251.

Bauer, P. (2013) "Economic analysis and policy in underdeveloped countries". *Routledge*.

Baum, J. A. C., Cowan, R., & Jonard, N. (2014) "Does evidence of network effects on firm performance in pooled cross-section support prescriptions for network strategy?". *Strategic Management Journal*,35, 652–667.

Beach, W. W., & Miles, M. A. (2006) "Explaining the factors of the index of economic freedom". *2006 Index of Economic Freedom*, 55-76. Available at: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.457.2539&rep=rep1&type=pdf#page=73. (Accessed on: 19.09.2022).

Beamish, P. W. (1987) "Joint ventures in LDCs: Partner selection and performance". *Management International Review*, 23-37.

Beck, A. J., Hodzic, A., Soutis, C., & Wilson, C. W. (2011) "Influence of implementation of composite materials in civil aircraft industry on reduction of environmental pollution and greenhouse effect". *IOP Conference Series: Materials Science and Engineering* (Vol. 26, No. 1, p. 012015). *IOP Publishing*.

Belobaba, P. & Odoni, A. (2009) "Introduction and Overview in The global airline industry" pp. 1–3. DOI: 10.1002/9780470744734.ch4.

Belobaba, P. P., Odoni, A. R. & Barnhart, C. (2016) "The Global Airline Industry", *John Wiley & Sons, Ltd First Edition published in 2009 Registered*. Available at: http://library1.nida.ac.th/termpaper6/sd/2554/19755.pdf.

Belloumi, M. (2014) "The relationship between trade, FDI and economic growth in Tunisia: An application of the autoregressive distributed lag model". *Economic systems*, 38(2), 269-287.

Benarjee, A., & Duflo, E. (2011) "Poor Economics: A Radical Rethinking of the Way to Fight Poverty". *New York: Public Affairs*.

Bendinelli, W. E., Bettini, H. F., & Oliveira, A. V. (2016) "Airline delays, congestion internalization and non-price spillover effects of low-cost carrier entry". *Transportation Research Part A: Policy and Practice*, 85, 39-52.

Bennett, N. J., Whitty, T. S., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., & Allison, E. H. (2018) "Environmental stewardship: a conceptual review and analytical framework". *Environmental management*, 61, 597-614.

Benoit, K. (2011) "Linear regression models with logarithmic transformations". *London School of Economics, London*, 22(1), 23-36.

Berggren, N. (2003) "The benefits of economic freedom: a survey". *The independent review*, 8(2), 193-211.

Berghöfer, B., & Lucey, B. (2014) "Fuel hedging, operational hedging and risk exposure—evidence from the global airline industry". *International Review of Financial Analysis*, 34, 124–139. https://doi.org/10.1016/j.irfa.2014.02.007

Bernard, H. R., Wutich, A., & Ryan, G. W. (2016) "Analyzing qualitative data: Systematic approaches". *SAGE publications*.

Bernardo, V., & Fageda, X. (2017) "The effects of the Morocco-European Union open skies agreement: A difference-in-differences analysis". *Transportation Research Part E*: Logistics and Transportation Review, 98, 24-41.

Bhadra, D. (2009) "Race to the bottom or swimming upstream: performance analysis of US airlines". *Journal of Air Transport Management*, 15(5), 227-235.

Bhattacharyya, S. (2012) "Trade liberalization and institutional development". *Journal of Policy Modeling*, 34(2), 253-269.

Bieger, T., & Wittmer, A. (2006) "Air transport and tourism—Perspectives and challenges for destinations, airlines and governments". *Journal of air transport management*, 12(1), 40-46.

Bilotkach, V., Gitto, S., & Mancuso, P. (2016) "Introduction to special issue" efficiency and productivity in the air transport industry". *Research in Transportation Economics*.

Bisignani, G. (2010) "Annual Report 2010 International Air Transport Association". *Iata*, 1–56.

Bjurek, H. (1996) "The Malmquist Total Factor Productivity Index". *The Scandinavian Journal of Economics*, 98(2), 303. https://doi.org/10.2307/3440861.

Blake, A., Sinclair, M. T., & Sugiyarto, G. (2003) "Quantifying the impact of foot and mouth disease on tourism and the UK economy". Tourism Economics, 9(4), 449–465.

Blanke, J., & Chiesa, T. (2013) "The travel & tourism competitiveness report 2013". In *The World Economic Forum*. Koroni, Switzerland: World Economic Forum.

Boardman, A.E. & Vining, A.R. (1989) "Ownership and performance in competitive environments: a comparison of the performance of private, mixed, and state-owned enterprises", *Journal of Law and Economics,* 32, 1-33.

Boeing Commercial Aircrafts (2008) "Review of Boeing Commercial Airplanes Long-term Airplane Market Forecast Methodology and Airlines' Underlying Requirement for Economic Profits", *public distribution version*.

Bogoch, I., Brady, O., Kraemer, M., German, M., Creatore, M., Kulkarni, M., Brownstein, J., Mekaru, S., Hay, S., Groot, E., & Watts, A. (2016) "Anticipating the international spread of Zika virus from Brazil". *Lancet*, 387, 335–336.

Bogoch, I., Creatore, M. I., Cetron, M. S., Brownstein, J. S., Pesik, N., & Miniota, J. (2015) "Assessment of the potential for international dissemination of Ebola virus via commercial air travel during the 2014 West African outbreak". *Lancet*, 385(9962), 29–35.

Boonekamp, T., Zuidberg, J., & Burghouwt, G. (2018) "Determinants of air travel demand": The role of low-cost carriers, ethnic links and aviation-dependent employment. *Transportation Research Part A: Policy and Practice*, 112, 18-28.

Borenstein, S. (1992) "The evolution of US airline competition". *Journal of Economic perspectives*, 6(2), 45-73.

Borenstein, S., & Rose, N. L. (2007) “How Airlines Market Work... Or Do They?”: *Regulatory Reform in the Airline Industry*. *National Bureau of Economic Research*.

Borenstein, S., & Rose, N. L. (2014) “How Airline Markets Work... or Do They? Regulatory Reform in the Airline Industry”*. University of Chicago Press* pp. 63-136.

Borochin, P., (2020) “The information content of real operating performance measures from the airline industry”. *Journal of Financial Marketing*. (Amsterdam, Netherlands) 50, 100528.

Borkowski, P., Jażdżewska-Gutta, M., & Szmelter-Jarosz, A. (2021) “Lockdown: Everyday mobility changes in response to COVID-19”. *Journal of Transport Geography*, 90, Article 102906. https://doi.org/10.1016/j.jtrangeo.2020.102906

Bourguignon, F., & Darpeix, P. E. (2016) “Air traffic and economic growth: the case of developing countries”.

Box, G. E., & Cox, D. R. (1964) “An analysis of transformations”. *Journal of the Royal Statistical Society Series B*: Statistical Methodology, 26(2), 211–243.

Boyes, W., & M. Melvin, (2014) “Economics”, *Boston: Cengage Learning*.

Boztoprak, H., & Eryilmaz, M. (2021) “The strategy tripod perspective in explaining firms’ export performance”. *Upravlenec*, 12(5).

Breschi, S. & Lissoni, F. (2005) “Cross-firm” Inventors and Social Networks: Localized Knowledge Spillovers Revisited”, *Annales d’Économie et de Statistique* 79/80, 2005.

Brewer, J., & Hunter, A. (2006) “Foundations of multimethod research”: *Synthesizing styles*. Sage.

Brindis, M. A. R., Mejía-Alzate, M. L., & Zapata-Aguirre, S. (2015) “La causalidad entre el crecimiento económico y la expansión del transporte aéreo: un análisis empírico para-Chile”. *Revista de economía del Rosario*, 18(1), 127-144.

Brouthers, L. E., O’Donnell, E., & Hadjimarcou, J. (2005) “Generic product strategies for emerging market exports into Triad nation markets: A mimetic isomorphism approach”. *Journal of Management Studies*, 42(1): 225–245.

Brown, R. S., & Kline, W. A. (2020) "Exogenous shocks and managerial preparedness: A study of US airlines' environmental scanning before the onset of the COVID-19 pandemic". *Journal of Air Transport Management*, 89, 101899.

Brownstein, J. S., Wolfe, C. J., & Mandl, K. D. (2006) "Empirical evidence for the effect of airline travel on inter-regional influenza spread in the United States". *PLoS Medicine*, 3(10), 401.

Brueckner, J. K. (2001) "The economics of international code sharing: an analysis of airline alliances". *International Journal of industrial organization*, 19(10), 1475-1498.

Brueckner, J. K. (2005) "Internalization of airport congestion: A network analysis". International Journal of Industrial Organization, 23(7-8), 599-614.

Brueckner, J. K., & Flores-Fillol, R. (2007) "Airline schedule competition". *Review of Industrial Organization*, 30(3), 161-177.

Brueckner, J. K., & Whalen, W. T. (2000) "The price effects of international airline alliances". *The Journal of Law and Economics*, 43(2), 503-546.

Brueckner, J. K., & Zhang, A. (2010) "Airline emission charges: Effects on airfares, service quality, and aircraft design". *Transportation Research Part B: Methodological*, 44(8-9), 960-971.

Brueckner, J. K., Lee, D., & Singer, E. S. (2013) "Airline competition and domestic US airfares: A comprehensive reappraisal". *Economics of Transportation*, 2(1), 1-17.

Bruning, E. R. (1991) "Market liberalisation and operating efficiency in the international aviation industry". *International Journal of Transport Economics*/Rivista international di economía dei trasporti, 259-274.

Buckley, P., & Casson, M. (1976) "The future of the multinational enterprise". London: *Palgrave Macmillan*.

Buhalis, D. (2000) "Marketing the competitive destination of the future". *Tourism management*, 21(1), 97-116.

Burton, A. L. (2021) "OLS (Linear) Regression". *The Encyclopedia of Research Methods in Criminology and Criminal Justice*, 2, 509-514.

Button, K. (2008a) "Air transportation infrastructure in developing countries": privatization and deregulation. *Aviation Infrastructure Performance: A Study in Comparative Political Economy, Brookings Institution, Washington DC*.

Button, K. (2008b) "The Impacts of Globalisation on International Air Transport Activity". *Global Forum on Transport and Environment in a Globalising World*, pp. 1–40.

Button, K. (Ed.). (2017) "Airline deregulation: international experiences". Routledge.

Button, K., & Ison, S. (2008) "The economics of low-cost airlines: Introduction". *Research in Transportation Economics*, 1(24), 1-4.

Button, K., & Taylor, S. (2000) "International air transportation and economic development". *Journal of air transport management*, 6(4), 209-222.

Button, K., Costa, A., & Cruz, C. (2007) "Ability to Recover Full Costs through Price Discrimination in Deregulated Scheduled Air Transport Markets". Transport Reviews, 27(2), 213–230.

Button, K., Haynes, K., & Stough, R. (1998) "Flying into the future: air transport policy in the European Union". Edward Elgar Publishing.

Cabo, M. *et al.* (2019) "Energy Effectiveness of Jet Fuel Utilization in Brazilian Air Transport", *sustainability*, 12(303), pp. 1–16.

Cai, Y. (2011) "A strategy tripod" perspective on board globalization and MNE firm performance *(Doctoral dissertation, University of Groningen. Faculty of Economics and Business)*.

Calixto, C. V., Garrido, I. L., Vasconcellos, S. L., & Monticelli, J. M. (2013) "Estratégias de internacionalização das empresas calçadistas: análise sob a perspectiva da indústria, capacidades organizacionais e instituições". *Revista Alcance*, 20(4), 513-532.

Camanho, A. S., & Dyson, R. G. (2005) “Cost efficiency, production and value-added models in the analysis of bank branch performance”. *Journal of the Operational Research Society*, 56(5), 483-494.

Camilleri, M. A. (2018) “Aircraft operating costs and profitability”. In *Travel marketing, tourism economics and the airline product* (pp. 191-204). Springer, Cham.

Campbell, J. (2012) “Building an IT economy: South Korean science and technology policy”. *Issues in Technology and Innovation*, 19, 1-9.

Cao, Q., Lv, J., & Zhang, J. (2015) “Productivity efficiency analysis of the airlines in China after deregulation”. *Journal of Air Transport Management*, 42, 135-140.

CAPA. (2021) “Aviation returns to the 1930s Articles from this issue of Airline Leader Aviation strikes and profits slump together” *: CAPA Data*. 1–5.

Capelli, P. (1984) “Competitive Pressures and Labor Relations in the Airline Industry”, *Industrial Relations* 24: 316-338.

Capobianco, H. M. P., & Fernandes, E. (2004) “Capital structure in the world airline industry”. *Transportation Research Part A: Policy and Practice*, 38(6), 421-434.

Card, D. (1998) “Deregulation and Labor Earnings in the Airline Industry” in J. Peoples (ed.), Regulatory Reform and Labor Markets, Kluwer, Boston, pp. 183–229.

Carlos J.C., Sousa M.P., He X. (2014) “The determinants of export performance: A review of the literature 2006-2014”. *International Marketing Review*, vol. 33, no. 5, pp. 626–670. DOI: 10.1108/IMR-10-2015-0212.

Carlucci, F., Cirà, A. & Coccorese, P. (2018) “Measuring and explaining airport efficiency and sustainability: Evidence from Italy”, *Sustainability (Switzerland)*, 10(2), pp. 1–17. doi: 10.3390/su10020400.

Carney, M., & Dostaler, I. (2006) “Airline ownership and control: A corporate governance perspective”. *Journal of Air Transport Management*, 12(2), 63-75.

Carnicky, S., Megyesiova, S., Conkova, M., & Zavadsky, C. (2016) “Productivity development and convergence across the EU Member States”. *Economic annals-XXI*, (162), 13-17.

Casadesus-Masanell, R. & Ricart, J.E. (2010) “From strategy to business models and onto tactics”, *Long Range Planning*, Vol. 43, No. 2, pp.195–215.

Castellan, C. M. (2010) “Quantitative and qualitative research: A view for clarity”. International Journal of Education, 2(2), 1-14. doi:10.5296/ije. v2i2.446

Castrogiovanni, G. J. (1991) “Environmental munihcence; a theoretical assessment”. *Academy of management review*, 16(3), 542-565.

Caves, D. W., Christensen, L. R. & Tretheway, M. W. (1984) “Economies of density versus economies of scale: Why trunk and local service airline costs differ”, *The RAND Journal of Economics*, 15(4), pp. 471–489. doi: 10.4324/9780203985359-16.

Caves, D. W., Christensen, L. R., & Diewert, W. E. (1982) “The economic theory of index numbers and the measurement of input, output, and productivity”. *Econometrica: Journal of the Econometric Society*, 1393-1414.

Chang, D., Lin, M., Wei, L., Xie, L., Zhu, G., Cruz, C. S. D., & Sharma, L. (2020) “Epidemiologic and clinical characteristics of novel coronavirus infections involving 13 patients outside Wuhan”, China. Jama, 323(11), 1092-1093.

Chang, Y. H., & Chang, Y. W. (2009) “Air cargo expansion and economic growth: Finding the empirical link”. *Journal of Air Transport Management*, 15(5), 264-265.

Charnes, A., Cooper, W. W. & Rhodes, E. (1978) “Measuring the efficiency of decision-making units”, *European Journal of Operational Research*, 2(6), pp. 429–444. doi: 10.1016/0377-2217(78)90138-8.

Charnes, A., Cooper, W., Lewin, A. Y., & Seiford, L. M. (1997) “Data envelopment analysis theory, methodology and applications”. *Journal of the Operational Research Society*, 48(3), 332-333.

Cheng, Y., & Choi, J. H. (2022) “Dealing with endogeneity to understand the societal impact of the third sector: Why should we care, and what can we do about It? VOLUNTAS”: *International Journal of Voluntary and Nonprofit Organizations*, 33(6), 1245–1255.

Chen, R., El Ghoul, S., Guedhami, O., & Wang, H. (2017) “Do state and foreign ownership affect investment efficiency? Evidence from privatizations”. *Journal of Corporate Finance*, 42, 408-421.

Chen, Y. & Zhu, J. (2004) “Measuring Information Technology ‘s Indirect Impact”, *Information Technology and Management*, 5, pp. 9–22. Available at: http://link.springer.com/10.1023/B:ITEM.0000008075.43543.97.

Chesbrough, H. (2007) “Business model innovation: it’s not just technology anymore”, Strategy Leadership, Vol. 35, No. 6, pp.12–17.

Cheung, T. K., Wong, C. W., & Zhang, A. (2020) “The evolution of aviation network: Global airport connectivity index 2006–2016”. *Transportation Research Part E: Logistics and Transportation Review*, 133, 101826.

Chèze, B., Chevallier, J., & Gastineau, P. (2011) “Forecasting world and regional air traffic in the mid-term (2025): An econometric analysis of air traffic determinants using dynamic panel-data models”. *In 18th Annual EAERE Conference*.

Chinazzi, M., Davis, J. T., Ajelli, M., Gioannini, C., Litvinova, M., Merler, S., ... & Vespignani, A. (2020) “The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak”. *Science*, 368(6489), 395-400.

Chiou, Y. C., & Chen, Y. H. (2006) “Route-based performance evaluation of Taiwanese domestic airlines using data envelopment analysis”. *Transportation Research Part E*: Logistics and Transportation Review, 42(2), 116-127.

Christensen, H.B., Floyd, E., Liu, L.Y., Maffett, M., (2017) “The real effects of mandated information on social responsibility in financial reports: Evidence from mine safety records”. *Journal of Accounting Economy*. 64 (2–3), 284–304.

Choi, J. H. (2021) “Changes in airport operating procedures and implications for airport strategies post-COVID-19”. *Journal of Air Transport Management*, 94, 102065.

Choi, J. H., Park, Y., Wang, K., & Xia, W. (2020) “Whether low-cost-carrier passengers spend more on duty-free goods at the airport? Evidence from Incheon International Airport”. *Journal of Air Transport Management*, 86, 101834.

Choi, K. (2017) “multi-period efficiency and productivity changes in US domestic airlines”. *Journal of Air Transport Management*, 59, 18-25.

Choo, Y. Y. & Oum, T. H. (2013) “Impacts of low-cost carrier services on efficiency of the major U.S. airports”, *Journal of Air Transport Management*, 33, pp. 60–67. DOI: 10.1016/j.jairtraman.2013.06.010.

Chow, C. K. W. (2010) “Measuring the productivity changes of Chinese airlines: the impact of the entries of non-state-owned carriers”. *Journal of Air Transport Management*, 16(6), 320-324.

Clague, C. K. (1997) “Institutions and economic development: Growth and governance in less-developed and post-socialist countries”. Johns Hopkins University Press.

Coelli, T. (1996) “A guide to DEAP version 2.1: a data envelopment analysis (computer) program”. *Centre for Efficiency and Productivity Analysis, University of New England, Australia*, 96(08), 1-49.

Coelli, T. J., Rao, D. S. P., O’Donnell, C. J., & Battese, G. E. (2005) “An introduction to efficiency and productivity analysis”. *springer science & business media*.

Coelli, T., Perelman, S., & Romano, E. (1999) “Accounting for environmental influences in stochastic frontier models”: with application to international airlines. *Journal of productivity analysis*, 11(3), 251-273.

Cohen, P., West, S. G., & Aiken, L. S. (2014) “Applied multiple regression/correlation analysis for the behavioral sciences”. *Psychology Press*.

Coli, M., Nissi, E. & Rapposelli, A. (2011) “Efficiency evaluation in an airline company: Some empirical results”, *Journal of Applied Sciences*, 11(4), pp. 737–742. doi: 10.3923/jas.2011.737.742.

Cook, W. D., & Seiford, L. M. (2009) “Data Envelopment Analysis (DEA)–Thirty Years On”. *European journal of operational research*, 192(1), 1-17.

Cooper, B. S., Pitman, R. J., Edmunds, W. J., & Gay, N. J. (2006) “Delaying the international spread of pandemic influenza”. *PLoS Medicine*, 3(6), 212.

Cooper, J. C. (1952) “The international air navigation conference”, Paris 1910. *J. Air L. & Com.*, 19, 127.

Cooper, W. W., Seiford, L. M., & Tone, K. (2006) “Introduction to data envelopment analysis and its uses: with DEA-solver software and references”. *Springer Science & Business Media*.

Cooper, W. W., Seiford, L. M., & Tone, K. (2007) “Data Envelopment Analysis”: a comprehensive text with models, applications, references and DEA-solver software (Vol. 2). *New York: Springer.*

Cooper, W. W., Seiford, L. M., & Zhu, J. (Eds.). (2011) “Handbook on Data Envelopment Analysis”. Springer Science and Business Media. New York.

Cordero, J. M., Pedraja-Chaparro, F., Pisaflores, E. C., & Polo, C. (2017) “Efficiency assessment of Portuguese municipalities using a conditional non-parametric approach”. *Journal of Productivity Analysis*, 48(1), 1-24.

Costa, J., Alves, T., Andrade, A. R., & Kalakou, S. (2021) “Assessing efficiency in public service obligations in European air transport using Data Envelopment Analysis”. *Case Studies on Transport Policy*, 9(4), 1783-1809.

Costa, V., & Almeida, C. (2018) “Low-cost carriers and tourism destinations development”. *Case study of Oporto, Portugal. Tourism & Management Studies*, 14(2), 7-15.

Cowen, T., & Tabarrok, A. (2015) “Modern principles of economics”. Macmillan International Higher Education.

Cracolici, M. F., & Nijkamp, P. (2009) "The attractiveness and competitiveness of tourist destinations: A study of Southern Italian regions". *Tourism management*, 30(3), 336-344.

Creswell, J. W. (2021) "A concise introduction to mixed methods research". *SAGE publications*.

Creswell, J. W., & Poth, C. N. (2016) "Qualitative inquiry and research design: Choosing among five approaches". Sage publications.

Cronin, B., & Alexander, A. (2019) "Responding to the demographic and skill shifts in the mobility workforce". In *Empowering the New Mobility Workforce* (pp. 125-148). Elsevier.

Crotts, J. C. (2004) "The effect of cultural distance on overseas travel behaviours". *Journal of Travel Research*, 43(1), 83-88.

Cuadros, A., Orts, V., & Alguacil, M. (2004) "Openness and growth: Re-examining foreign direct investment, trade and output linkages in Latin America". *Journal of Development Studies*, 40(4), 167-192.

Cui, Q., & Li, Y. (2017) "Airline efficiency measures using a Dynamic Epsilon-Based Measure model". *Transportation Research Part A: Policy and Practice*, 100, 121-134.

Cui, Q., & Li, Y. (2020) "A Cross Efficiency Distinguishing Method to Explore the Cooperation Degree in Dynamic Airline Environmental Efficiency". *Transport Policy*, 99, 31-43.

Cui, Q., & Yu, L. T. (2021) "A Review of Data Envelopment Analysis in Airline Efficiency: State of the Art and Prospects". *Journal of Advanced Transportation*.

Cui, L., Jiang, F., & Stening, B. (2011) "The entry-mode decision of Chinese outward FDI: Firm resources, industry conditions, and institutional forces". *Thunderbird International Business Review*, 53(4), 483-499.

Cyert, R. M., & J. G. March. (1963) "A Behavioral Theory of the Firm". 2nd ed. *Prentice Hall*, Englewood Cliffs, NJ.

Czaika, M., & De Haas, H. (2013) "The effectiveness of immigration policies". *Population and Development Review*, 39(3), 487-508.

Czaika, M., & Neumayer, E. (2017) "Visa restrictions and economic globalization". *Applied Geography*, 84, 75-82.

Czaika, M., de Haas, H., & Villares-Varela, M. (2018) "The global evolution of travel visa regimes". *Population and Development Review*, 44(3), 589.

Czerny, A. I., Fu, X., Lei, Z., & Oum, T. H. (2021) "Post pandemic aviation market recovery: Experience and lessons from China". *Journal of Air Transport Management*, 90, 101971.

Da Silva, A. V., Costa, M. A., Lopes, A. L. M., & do Carmo, G. M. (2019) "A close look at second stage data envelopment analysis using compound error models and the Tobit model". *Socio-Economic Planning Sciences*, 65, 111-126.

da Silveira Pereira, D., & de Mello, J. C. C. S. (2021) "Efficiency evaluation of Brazilian airlines operations considering the Covid-19 outbreak". *Journal of Air Transport Management*, 91, 101976.

Daft, J., & Albers, S. (2015) "An empirical analysis of airline business model convergence". *Journal of Air Transport Management*, 46, 3-11.

Daley, B. (2009) "Is air transport an effective tool for sustainable development?". *Sustainable Development*, 17(4), 210-219.

Daoud, J. I. (2017) "Multicollinearity and regression analysis". In Journal of Physics: Conference Series (Vol. 949, No. 1, p. 012009). IOP Publishing.

Daraio, C., & Simar, L. (2005) "Introducing environmental variables in non-parametric frontier models: a probabilistic approach". *Journal of Productivity Analysis*, 24, 93-121.

Daraio, C., & Simar, L. (2007) "Conditional non-parametric frontier models for convex and nonconvex technologies: a unifying approach". *Journal of Productivity Analysis*, 28, 13-32.

Daraio, C., Simar, L., & Wilson, P. W. (2010) "Testing whether two-stage estimation is meaningful in non-parametric models of production". *ISBA discuss. Pap. Google Sch*.

Daraio, C., Simar, L., & Wilson, P. W. (2018) "Central limit theorems for conditional efficiency measures and tests of the 'separability' condition in non-parametric, two-stage models of production". *The Econometrics Journal*, 21(2), 170-191.

Das, T. K., & Teng, B. S. (2000) "A resource-based theory of strategic alliances". *Journal of management*, 26(1), 31-61.

Davis, D., & Gift, T. (2014) "The positive effects of the Schengen Agreement on European trade". *The World Economy*, 37(11), 1541-1557.

De Haan, J., Lundström, S., & Sturm, J. E. (2006) "Market-oriented institutions and policies and economic growth: A critical survey". *Journal of economic surveys*, 20(2), 157-191.

De Leon, P. M. (1992) "Cabotage in air transport regulation". *Martinus Nijhoff Publishers*.

De Soto, H. (1989) The other path: "The invisible revolution in the third world".

De Waal, A. (2013) "Strategic Performance Management: A managerial and behavioural approach". Macmillan International Higher Education.

Debbage, K. G. (1991) "Spatial behaviour in a Bahamian resort". *Annals of Tourism Research*, 18(2), 251-268.

Debbage, K. G., & Alkaabi, K. (2016) "Market power and vertical (dis) integration? Airline networks and destination development in the United States and Dubai". In *Aviation and Tourism* (pp. 177-194). Routledge.

Deeds, D. L., & Hill, C. W. (1996) "Strategic alliances and the rate of new product development: An empirical study of entrepreneurial biotechnology firms". *Journal of business venturing*, 11(1), 41-55.

Denzin, N. K., & Lincoln, Y. (2007) "The landscape of qualitative research". SAGE Publications. 2455 Teller Road, Thousand Oaks, CA 91320.

Derudder, B., & Witlox, F. (2016) "Global cities and air transport". In *The geographies of air transport* (pp. 119-140). Routledge.

Dess, G. G., & Beard, D. W. (1984) “Dimensions of organizational task environments”. *Administrative science quarterly*, 52-73.

DiMaggio, P. & W. Powell. (1991) “Introduction” In W. Powell and P. DiMaggio (eds.), “The New Institutionalism in Organizational Analysis”. *Chicago*: University of Chicago Press.

DiMaggio, P. Powell, W. (1983) “The iron cage revisited: institutional isomorphism and collective rationality in organizational fields”. *American Sociological Review*, 48(2):147-160. http://dx.doi.org/10.2307/2095101.

Ding, Z., Liu, Z., Zhang, Y., & Long, R. (2017) “The contagion effect of international crude oil price fluctuations on Chinese stock market investor sentiment”. *Applied energy*, 187, 27-36.

Dismuke, C., & Lindrooth, R. (2006) *“Ordinary least squares”. Methods and Designs for Outcomes Research*, 93, 93-104.

Distexhe, V., & Perelman, S. (1994) “Technical efficiency and productivity growth in an era of deregulation: the case of airlines”. *Swiss Journal of Economics and Statistics*, 130(4), 669–689.

Doganis, R. (2005) “Airline business in the 21st century”. Routledge.

Doganova, L., & Eyquem-Renault, M. (2009) “What do business models do? Innovation devices in technology entrepreneurship”. *Research policy*, 38(10), 1559-1570.

Douglas, I., & Tan, D. (2017) “Global airline alliances and profitability: A difference-in-difference analysis”. *Transportation Research Part A: Policy and Practice*, 103, 432-443.

Draper, N. R., & Smith, H. (1998) “Applied regression analysis” (Vol. 326). John Wiley & Sons.

Dresner, M., Flicop, S., & Windle, R. (1995) “Trans-Atlantic airline alliances: a preliminary evaluation”. In *Journal of the Transportation Research Forum* (Vol. 35, No. 1).

Dube, K., Nhamo, G., & Chikodzi, D. (2021) “COVID-19 pandemic and prospects for recovery of the global aviation industry”. *Journal of Air Transport Management*, 92, 102022.

Duke, J. & Torres, V. (2005) “Multifactor productivity change in the air transportation industry”, *Monthly Labor Review*, pp. 32–45.

Duman, Y. S. & Kasman, A. (2017) "The Role of International Trade and Urbanization on Environmental Technical Efficiency in EU Member and Candidate Countries", *Ege Academic Review*, pp. 481–492. DOI: 10.21121/eab.2017431297.

Dunning, J. (2000) "The eclectic paradigm as an envelope for economic and business theories of MNE activity". *International Business Review*, 9(1):163-190. http://dx.doi.org/10.1016/S0969-5931(99)00035-9

Dunning, J. H. (2006) "Comment on ''Dragon multinationals: New players in 21st century globalization''. *Asia Pacific Journal of Management*, 23(2): 139–141.

Dunning, J. H., & Lundan, S. M. (2008) "Institutions and the OLI paradigm of the multinational enterprise". *Asia Pacific Journal of Management*, 25(4), 573-593.

Duppati, G., Scrimgeour, F., & Stevenson, R. (2016) "Corporate governance in the airline industry-Evidence from the Asia-Pacific Region". *Corp. Ownership. Control*, 13, 329-335.

Dutta, P., Jain, A., & Gupta, A. (2020) "Performance analysis of non-banking finance companies using two-stage data envelopment analysis". *Annals of Operations Research*, pp. 295, 91–116.

Duval, D. T. (2013) "Critical issues in air transport and tourism". *Tourism Geographies*, 15(3), 494-510.

Duval, D. T., & Koo, T. T. (2012) "The politics and geographies of international air transport". In *The Routledge handbook of tourism geographies* (pp. 222-228). Routledge.

Duygun, M., Prior, D., Shaban, M., & Tortosa-Ausina, E. (2016) "Disentangling the European airlines' efficiency puzzle: a network data envelopment analysis approach". *Omega (United Kingdom)*, 60, 2–14. https://doi.org/10.1016/j.omega.2015.06.004.

Duygun, M., Shaban, M., Sickles, R. C., & Weyman-Jones, T. (2013) "Efficiency and productivity change in the European airlines industry in the post liberalization era". *Online: http://rsickles. blogs. rice. edu/files/2014/03/Dugan-et-al.-2013. Pdf.*

Dyson, R. G., Allen, R., Camanho, A. S., Podinovski, V. V., Sarrico, C. S., & Shale, E. A. (2001) "Pitfalls and protocols in DEA". *European Journal of operational research*, *132*(2), 245-259.

Easton, S. T., & Walker, M. A. (1997) "Income, growth, and economic freedom". *The American Economic Review*, 87(2), 328-332.

Ebrahimi, A., Davoodabadi, M., & Pashazadeh, H. (2014) "Regulation and Efficiency & Productivity Considerations in Water & Wastewater Industry: Case of Iran". *Procedia - Social and Behavioral Sciences*, 109(21), 281–289. https://doi.org/10.1016/j.sbspro.2013.12.458.

EC. (2020) "Evaluation of the Single European Sky (SES) performance and charging schemes". http://ec.europa.eu/smart-regulation/roadmaps/docs/2016_move_015_evaluation_single_european_sky_performance_en.pdf. (Accessed on: 17.06. 2021).

EFI. (2020) "Index of Economic Freedom: Promoting Economic Opportunity and Prosperity by Country", (*heritage.org*) (Accessed date 27.07.2021).

Efron, B. (1981) "Censored data and the bootstrap". *Journal of the American Statistical Association*, 76(374), 312-319.

Efron, B., & Tibshirani, R. (1985) "The bootstrap method for assessing statistical accuracy". *Behaviormetrika*, 12(17), 1-35.

Efron, B., & Tibshirani, R. J. (1994) "An introduction to the bootstrap". *CRC press*.

Ejem, E. A., Ekeugo, C. U., Dike, D. N., Chukwu, O., Igboanusi, C. C. and Erumaka, O (2017) "Analysis of Determinants of Airlines Productivity in Nigeria Domestic Network". *Global Journal of Engineering Science and Research Management*, 4(12). DOI: 10.5281/zenodo.1098664.

Elango, S. Lahiri (2014*)* "Do market-supporting institutional characteristics explain firm performance? Evidence from emerging markets". *Thunderbird International Business Review*, 56 (2014), pp. 145-155.

Eller, R. de A. G., & Moreira, M. (2014) "The main cost-related factors in airlines management".

Journal of Transport Literature, 8(1), 8–23. https://doi.org/10.1590/s2238-10312014000100002.

Elwakil, O. S., Windle, R. J., & Dresner, M. E. (2013) "Transborder demand leakage and the US–Canadian air passenger market". *Transportation Research Part E*: Logistics and Transportation Review, 57, 45-57.

Emrouznejad, A., & Podinovski, V. (Eds.). (2004) "Data envelopment analysis and performance management (Vol. 421)". *Birmingham: Aston Business School, Aston University*.

Emrouznejad, A., & Thanassoulis, E. (1996) "An Extensive Bibliography of Data Envelopment Analysis (DEA)".

Emrouznejad, A., & Thanassoulis, E. (2014) "Introduction to Performance Improvement Management Software (PIM-DEA)". *In Handbook of research on strategic performance management and measurement using data envelopment analysis (pp. 256-275). IGI Global.*

Emrouznejad, A., & Yang, G. L. (2018) "A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016". *Socio-economic planning sciences*, 61, 4-8.

Emrouznejad, A., Parker, B. R., & Tavares, G. (2008) "Evaluation of research in efficiency and productivity: A survey and analysis of the first 30 years of scholarly literature in DEA". *Socio-economic planning sciences*, 42(3), 151-157.

Emrouznejad, A., Yang, G. L., Khoveyni, M., & Michali, M. (2022) "Data envelopment analysis: Recent developments and challenges". *The Palgrave Handbook of Operations Research*, 307-350.

Encaoua, D. (1991) "Liberalising European airlines: cost and factor productivity evidence". *International Journal of Industrial Organization*, 9(1), 109–124.

Enright, M. J., & Newton, J. (2004) "Tourism destination competitiveness: a quantitative approach". *Tourism management*, 25(6), 777-788.

Enright, M. J., & Newton, J. (2005) "Determinants of tourism destination competitiveness in Asia Pacific: Comprehensiveness and universality". *Journal of travel research*, 43(4), 339-350.

FAA. (2022) "Federal Aviation Administration Strategic Plan FY 2019-2022" Available at: https://www.faa.gov/sites/faa.gov/files/about/plans_reports/FAA_Strategic_Plan_Final_FY2019-2022.pdf (Accessed on: 24.01.2022).

Fadok, D. S. (1995) "John Boyd and John Warden": Air Power's Quest for Strategic Paralysis. *AIR UNIV MAXWELL AFB AL SCHOOL OF ADVANCED AIRPOWER STUDIES.*

Fageda, X., Flores-Fillol, R., & Theilen, B. (2019) "Hybrid cooperation agreements in networks: The case of the airline industry". *International Journal of Industrial Organization*, 62, 194-227.

Fallon, J. (2004) "Market structure, regulation and performance in the airline industry". In *Paper of Anu/Necg Conference on The Performance of Air Transport Markets* (Vol. 24).

Farantos, G. I. (2015) "The Data Envelopment Analysis Method and the influence of a phenomenon in organizational Efficiency: A literature review and the Data Envelopment Contrast Analysis new application", *Data Envelopment Analysis and Decision Science*, 2015(2), pp. 101–117. doi: 10.5899/2015/dea-00098.

Färe, R., & Grosskopf, S. (1985) "A nonparametric cost approach to scale efficiency". *The Scandinavian Journal of Economics*, 594-604.

Färe, R., & Grosskopf, S. (1996) "Productivity and Intermediate Products: A Frontier Approach". *Economics Letters*, 50(1), 65-70.

Fare, R., Grosskopf, S., & Lovell, C. K. (1994) "Production frontiers". *Cambridge university press.*

Färe, R., Grosskopf, S., Lindgren, B., & Roos, P. (1992) "Productivity Changes in Swedish Pharmacies 1980–1989: A Non-Parametric Malmquist Approach". *Journal of Productivity Analysis*, 3(1), 85-101.

Färe, R., Grosskopf, S., Lindgren, B., & Roos, P. (1994) "Productivity developments in Swedish hospitals: a Malmquist output index approach". *In Data envelopment analysis: Theory, methodology, and applications (pp. 253-272). Springer, Dordrecht*.

Färe, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994) "Productivity growth, technical progress and efficiency change in Industrialized countries”. *The American Economic Review*, *84*(1), 66–83. https://doi.org/10.1111/j.1467-8268.2004.00089.x.

Farrell, M. J. (1957) “The Measurement of Productive Efficiency”. *Journal of the Royal Statistical Society: Series A (General)*, 120(3), 253-281.

Feigenbaum, S., & Hafer, R. W. (2011) “Principles of Macroeconomics”*: The Way We Live*. Macmillan.

Ferguson, N. M., Cummings, D. A., Fraser, C., Cajka, J. C., Cooley, P. C., & Burke, D. S. (2006) “Strategies for mitigating an influenza pandemic”. Nature, 442(7101), 448–452.

Fethi, M. D., Jackson, P. M., & Weyman-Jones, T. G. (2000) “Measuring the efficiency of European airlines: an application of DEA and Tobit Analysis”.

Fielt, E. (2013) “Conceptualizing business models: Definitions, frameworks and classifications”. Journal of business models, 1(1), 85-105.

Florida, R. (2021) “The Rise of the Creative Class Publisher”: *Basic Books*. New York.

Forsyth, P. (2001) “Total factor productivity in Australian domestic aviation”. *Transport policy*, 8(3), 201–207.

Forsyth, P. (2006) “Martin Kunz memorial lecture. Tourism benefits and aviation policy”. *Journal of Air Transport Management*, 12(1), 3-13.

Forsyth, P. (2016) “Tourism and aviation policy: exploring the links”. In *Aviation and tourism* (pp. 103-112). *Routledge.*

Forsyth, P., Guiomard, C., & Niemeier, H. M. (2020) “Covid− 19, the collapse in passenger demand and airport charges”. *Journal of air transport management*, 89, 101932.

Fox, J., & Weisberg, S. (2018) “Time-series regression and generalized least squares: an appendix”. *An R Companion to Applied Regression*, 1–8. http://tinyurl.com/carbook.

Fox, S. J. (2014) “The Evolution of Aviation in Times of War and Peace: Blood, Tears, And Salvation”. *International Journal on World Peace*, 31(4).

Fox, S. J. (2017) “Borderless skies! Sovereign dominance, regionalism: lessons from Europe”. *International Journal on World Peace*, 34(4), 19-52.

Fox, S. J., & Ismail, R. (2017) “The Skies the Limit!” *European Journal of Comparative Law and Governance*, *4*(4), 387–422. https://doi.org/10.1163/22134514-00404002

Francis, G., Humphreys, I., Ison, S. & Aicken, M. (2006) “Where next for low-cost airlines? A spatial and temporal comparative study”, *Journal of Transport Geography*, Vol. 14, No. 2, pp.83–94.

Franke, M. (2004) “Competition between network carriers and low-cost carriers – retreat battle or breakthrough to a new level of efficiency?”, *Journal of Air Transport Management*, Vol. 10, pp.15–21.

Fried, H. O., Lovell, C. K., & Schmidt, S. S. (Eds.). (2008) “The measurement of productive efficiency and productivity growth”. *Oxford University Press*.

Fu, X., Lei, Z., Wang, K., & Yan, J. (2015) “Low-cost carrier competition and route entry in an emerging but regulated aviation market–the case of China”. *Transportation Research Part A*: Policy and Practice, 79, 3-16.

Gabriel, P. I (2017) “Index of Economic Freedom and Transport Development in Romania”. Annals of the Constantin Brâncuşi” University of Târgu Jiu, Economy Series, Issue 4/2017.

Gaggero, A. A., & Bartolini, D. (2012) “The determinants of airline alliances”. *Journal of Transport Economics and Policy (JTEP)*, 46(3), 399-414.

GAO. (2014) Government Accountability Office “Impact of Fuel Price Increases on the Aviation Industry”, available at: https://www.gao.gov/assets/gao-14-331.pdf (Accessed on: 23.11.2022).

Gao G.Y., Murray J.Y., Kotabe M., Lu J. (2010) “A strategy tripod” perspective on export behaviours: Evidence from domestic and foreign firms based in an emerging economy”.

Journal of International Business Studies, vol. 41, no. 3, pp. 377–396. DOI: 10.1057/jibs.2009.27.

Garcés-Ayerbe, C., Rivera-Torres, P., & Murillo-Luna, J. L. (2012) "Stakeholder pressure and environmental proactivity: Moderating effect of competitive advantage expectations". *Management Decision*.

Garrido E., Gomez J., Maicas J.P., Orcos R. (2014) "The institution-based view of strategy: How to measure it". *BRQ Business Research Quarterly*, vol. 17, no. 2, pp. 82–101. DOI: 10.1016/j.brq.2013.11.001.

Garrow, L., & Lurkin, V. (2021) "How COVID-19 is impacting and reshaping the airline industry". *J Revenue Pricing Manag*, 20, 3–9. https://doi.org/10.1057/s41272-020-00271-1

Gattoufi, S., Oral, M., & Reisman, A. (2004) "Data Envelopment Analysis Literature: A Bibliography Update (1951–2001)". *Journal of Socio-Economic Planning Sciences*, *38*(2-3), 159-229.

Gbosi, A. N. (2003) "Fundamentals of international economics and finance". *Abakaliki, Nigeria: SE Pack Publishers*.

George, G., Merrill, R. K., & Schillebeeckx, S. J. (2021) "Digital sustainability and entrepreneurship: How digital innovations are helping tackle climate change and sustainable development". *Entrepreneurship Theory and Practice*, 45(5), 999-1027.

Gerede, E. (2010) "The Evolution of Turkish Air Transport Industry: Significant Developments and the Impacts of 1983 Liberalisation". *Yönetim ve Ekonomi*, 17(2), 63-91.

Gertler, M. S. (2003) "Tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there)". *Journal of economic geography*, 3(1), 75-99.

Gertler, Z. J. (1982) "Nationality of airlines: A hidden force in the international air regulation equation". *Journal of Air Law and Commerce*, 48, 51.

Ghaderi, Z., Saboori, B., & Khoshkam, M. (2017) "Does security matter in tourism demand?". *Current Issues in Tourism*, 20(6), 552-565.

Gilbert, M., Pullano, G., Pinotti, F., Valdano, E., Poletto, C., Boëlle, P. Y., & Colizza, V. (2020) “Preparedness and vulnerability of African countries against importations of COVID-19: a modelling study”. *The Lancet*, 395(10227), 871-877.

Gillen, D. (2006) “Airline business models and networks: Regulation, competition and evolution in aviation markets”. *Review of Network economics*, 5(4).

Gillen, D. W., Oum, T. H. & Tretheway, M. W. (1987) “Airline Cost and Performance: Implications for Public and Industry Policies”, *Canadian Public Policy / Analyse de Politiques*, 13(2), p. 253. doi: 10.2307/3550657.

Gillen, D., & Gados, A. (2008) “Airlines within airlines: Assessing the vulnerabilities of mixing business models”. *Research in Transportation Economics*, 24(1), 25-35.

Gittell, J. H., Von Nordenflycht, A., & Kochan, T. A. (2004) “Mutual gains or zero sum? Labor relations and firm performance in the airline industry”. *Ilr Review*, 57(2), 163-180.

Gittell, J. H., von Nordenflycht, A., Kochan, T. A., McKersie, R., & Bamber, G. J. (2009) “Labor relations and human resource management in the airline industry”. *The Global Airline Industry*, 275.

Gittens, A., Hocquard, S., Juniac, A. de, Liu, F., & Fanning, E. (2019) “Aviation Benefits Report”. In *Convention on International Civil Aviation*. https://www.icao.int/sustainability/Documents/AVIATION-BENEFITS-2019-web.pdf

Given, L. M. (2016) ”100 questions (and answers) about qualitative research”. *SAGE publications, Thousand Oaks.*

Goh, K., & Uncles, M. (2003) “The benefits of airline global alliances: an empirical assessment of the perceptions of business travelers”. *Transportation Research Part A: Policy and Practice*, 37(6), 479-497.

Gök, U. (2012) “Evaluating Turkish Airports Efficiencies Using Data Envelopment Analysis”.

Goksen, Y., Dogan, O. & Ozkarabacak, B. (2015) “A Data Envelopment Analysis application for measuring efficiency of University Departments", *Procedia Economics and Finance*, 19, pp. 226–237.

Goldsmith, A. A. (1997) "Economic rights and government in developing countries: Cross-national evidence on growth and development". *Studies in Comparative International Development*, 32(2), 29-44.

Good, D. H., Röller, L. H., & Sickles, R. C. (1995) "Airline Efficiency Differences Between Europe and the US: Implications for The Pace of EC Integration and Domestic Regulation". *European journal of operational research*, 80(3), 508-518.

Good, D. H., Nadiri, M. I., Röller, L. H., & Sickles, R. C. (1993) "Efficiency and productivity growth comparisons of European and US air carriers: a first look at the data". *Journal of Productivity Analysis*, 4(1-2), 115-125.

Gorica, K., Gumeni, A., & Ndregjoni, Z. (2015) "Using OLS for testing EKC environmental Kuznets curve hypothesis in Albania–measuring the relationship between the environmental quality and economic growth".

Gössling, S. (2020) "Risks, resilience, and pathways to sustainable aviation: A COVID-19 perspective". *Journal of Air Transport Management*, 89, 101933.

Graham, A., Kremarik, F., & Kruse, W. (2020) "Attitudes of ageing passengers to air travel since the coronavirus pandemic". *Journal of air transport management*, 87, 101865.

Grais, R. F., Ellis, J. H., & Glass, G. E. (2003) "Assessing the impact of airline travel on the geographic spread of pandemic influenza". *European Journal of Epidemiology*, 18, 1065–1072.

Greene, W. (2004) "Fixed effects and bias due to the incidental parameters problem in the Tobit model". *Econometric reviews*, 23(2), 125–147.

Greene, W. H. (2008) "The econometric approach to efficiency analysis". *The measurement of productive efficiency and productivity growth*, 1(1), 92-250.

Greenspan, A. (2008) "The age of turbulence: Adventures in a new world". *Penguin*.

Greer, M. (2009) “Is it the labour unions’ fault? Dissecting the causes of the impaired technical efficiencies of the legacy carriers in the United States”. *Transportation Research Part A: Policy and Practice*, 43(9-10), 779-789.

Greer, M. R. (2006) “Are the discount airlines actually more efficient than the legacy carriers? A data envelopment analysis”, *International Journal of Transport Economics*, 33(1), pp. 37–55.

Greer, M. R. (2008) “Nothing Focuses the Mind on Productivity Quite Like the Fear of Liquidation: Changes in Airline Productivity in The United States, 2000–2004”. *Transportation Research Part A: Policy and Practice*, 42(2), 414-426.

Grek, S. (2009) “Governing by numbers: The PISA ‘effect ‘in Europe”. *Journal of education policy*, 24(1), 23-37.

Grewal, J., Riedl, E.J., Serafeim, G., (2019) “Market reaction to mandatory non-financial disclosure”. *Management Science*. 65 (7), 3061–3084. https://doi.org/10.1287/mnsc.2018.3099.

Griffis, V. W., & Stedinger, J. R. (2007) “The use of GLS regression in regional hydrologic analyses”. *Journal of Hydrology*, 344(1–2), 82–95. https://doi.org/10.1016/j.jhydrol.2007.06.023

Gu, X., Nagarajan, N. J., Sarak, A., & Srinivasan, D. (2023) “US airline responses to mandated disclosure of non-financial performance”. *Journal of Contemporary Accounting & Economics*, 100394.

Gudmundsson, S. V., & Rhoades, D. L. (2001) “Airline alliance survival analysis: typology, strategy and duration”. *Transport Policy*, 8(3), 209-218.

Gudmundsson, S. V., Cattaneo, M., & Redondi, R. (2021) “Forecasting temporal world recovery in air transport markets in the presence of large economic shocks: The case of COVID-19”. *Journal of Air Transport Management*, 91, 102007.

Gwartney, J. D., Lawson, R., & Block, W. (1996) “Economic freedom of the world”, *1975-1995*. *Fraser Inst.*

Gwartney, J. D., Stroup, R. L., Sobel, R. S., & Macpherson, D. A. (2021) “Economics: private & public choice”. *Cengage Learning*.

Gwartney, J., & Fike, R. (2015) “Public Choice Versus the Benevolent Omniscient Planner Model of Government”: Evidence from Principles Textbooks. *Forthcoming in the Journal of Economic Education*.

Gwartney, J., & Lawson, R. (2003) “The concept and measurement of economic freedom”. *European Journal of Political Economy*, 19(3), 405-430.

Gwartney, J., Lawson, R., & Hall, J. (2010) “Economic Freedom of the World 2012”. Annual Report. Fraser Institute. *[2012] URL: http://www. freetheworld. com/datasets_efw. html*.

Hakim, M. M., & Merkert, R. (2019) “Econometric evidence on the determinants of air transport in South Asian countries”. *Transport Policy*, 83, 120-126.

Hall, C. M., Scott, D., & Gössling, S. (2020) “Pandemics, transformations and tourism: Be careful what you wish for”. *Tourism Geographies*, 1–22. https://doi: 10.1080/14616688.2020.175913

Hall, J. C., & Lawson, R. A. (2014) “Economic freedom of the world: An accounting of the literature”. *Contemporary Economic Policy*, 32(1), 1-19.

Hallowell, R. (1996) “Southwest Airlines: A case study linking employee needs satisfaction and organizational capabilities to competitive advantage”. *Human Resource Management,* 35(4), 513-534.

Halpern, N., & Bråthen, S. (2011) “Impact of airports on regional accessibility and social development”. *Journal of Transport Geography*, 19(6), 1145-1154.

Hansman, J., McConnachie, D., Wollersheim, C., Elke, M., Hansen, M., Chan, N., Crépin, M., Li, T., Peterson, E., & Trani, A. (2014) “The Impact of Oil Prices on the Air Transportation Industry Final”. *In National Centre of Excellence for Aviation Operations Research*.

Hanson, J. R. (2000) “Prosperity and economic freedom: A virtuous cycle”. *The Independent Review*, 4(4), 525-531.

Hawawini, G., Subramanian, V., & Verdin, P. (2003) “Is performance driven by industry-or firm-specific factors? A new look at the evidence”. *Strategic management journal*, 24(1), 1-16.

Haynes, W. (2017) “Pursuit of the red passport: Perceptions of global citizenship among low-paid global workers”. *Journal of Contemporary Issues in Education*, 12(1).

Hayton, D. W. (2014) “An Account of Denmark, With Francogallia and Some Considerations for the Promoting of Agriculture and Employing the Poor by Robert Molesworth”. *The Scriblerian and the Kit-Cats*, 46(2), 186-188.

He, X., Rizov, M., & Zhang, X. (2022) “Workforce size adjustment as a strategic response to exchange rate shocks A strategy-tripod application to Chinese firms”. *Journal of Business Research*, 138, 203-213.

Heckelman, J. C. (2000) “Economic freedom and economic growth: A short-run causal investigation”. *Journal of Applied Economics*, 3(1), 71-91.

Held, D., McGrew, A., Goldblatt, D., & Perraton, J. (2000) “Global transformations: Politics, economics and culture”. *In Politics at the Edge* (pp. 14-28). Palgrave Macmillan, London.

Hensher, D. A., Wei, E., Beck, M., & Balbontin, C. (2021) “The impact of COVID-19 on cost outlays for car and public transport commuting-The case of the Greater Sydney Metropolitan Area after three months of restrictions”. *Transport Policy*, 101, 71-80.

Herdman. (2007) “Full-Service Airlines: Adopting New Business Strategies in The Crowded Sky”. Downloaded at http://www.aapairlines.org/resource_centre/SP_AAPA-HerdmanLCACongressSingapore-24Jan2007.pdf, (Accesses on 12.03.2019).

Heyne, P. T., Boettke, P. J., & Prychitko, D. L. (1994) “The economic way of thinking”. Prentice Hall.

Hingtgen, N., Kline, C., Fernandes, L., & McGehee, N. G. (2015) “Cuba in transition: Tourism industry perceptions of entrepreneurial change”. *Tourism Management*, 50, 184-193.

Hirsch, B.T. & Macpherson, D.A. (2000) “Earnings, Rents and Competition in the Airline Labor Market”, *Journal of Labor Economics*, Vol. 18, No. 1, pp. 125–155.

Hitt, M. A., Hoskisson, R. E., & Kim, H. (1997) “International diversification: Effects on innovation and firm performance in product-diversified firms”. *Academy of Management journal*, 40(4), 767-798.

Hitt, M. A., Li, D., & Xu, K. (2015) “International strategy: From local to global and beyond”. *Journal of World Business.*

Hoechle, D. (2007) “Robust Standard Errors for Panel Regressions with Cross-Sectional Dependence”. *The stata journal*, 7(3), 281-312.

Hofer, C., Kali, R., & Mendez, F. (2018) “Socio-economic mobility and air passenger demand in the US”. *Transportation Research Part A*: Policy and Practice, 112, 85-94.

Hoffmann, J., & Kumar, S. (2013) “Globalization–the maritime nexus”. *In The handbook of maritime economics and business* (pp. 65-94). Informa Law from Routledge.

Hong, S., & Zhang, A. (2010) “An efficiency study of airlines and air cargo/passenger divisions: a DEA approach”. *World Review of Intermodal Transportation Research*, 3(1-2), 137-149.

Honma, S., & Hu, J. L. (2008) “Total-factor energy efficiency of regions in Japan”. *Energy Policy*, 36(2), 821-833.

Hoskisson, R. E., Wan, W. P., Yiu, D., & Hitt, M. A. (1999) “Theory and research in strategic management: Swings of a pendulum”. *Journal of Management*, 25(3), 417-456.

Hoskisson, M. Wright, I. Filatotchev, M.W. Peng (2013) “Emerging multinationals from mid-range economies: The influence of institutions and factor markets”. *Journal of Management Studies*, 50 (2013), pp. 1295-1321.

Hou, M., Wang, K., & Yang, H. (2021) “Hub airport slot Re-allocation and subsidy policy to speed up air traffic recovery amid COVID-19 pandemic---case on the Chinese airline market”. *Journal of Air Transport Management*, 93, 102047.

Hovhannisyan, N., & Keller, W. (2015) “International business travel: an engine of innovation?”. *Journal of Economic Growth*, 20(1), 75-104.

Hsiao, C. Y., & Hansen, M. (2011) “A passenger demand model for air transportation in a hub-and-spoke network”. *Transportation Research Part E*: Logistics and Transportation Review, 47(6), 1112-1125.

Hsu, C. (2017) “How fuel price shocks affect airline stock returns: an empirical study of major US carriers”. *The International Journal of Business and Finance Research*, 11(2), 51-59.

Hu, J. L., Li, Y. & Tung, H. J. (2017) “Operational efficiency of ASEAN airlines: based on DEA and bootstrapping approaches”, *Management Decision*, 55(5), pp. 957–986. doi: 10.1108/MD-07-2016-0489.

Hu, X. (2013) “Economic benefits associated with the visa waiver program–A difference-in-difference approach”. *Global Journal of Business Research*, 7(1), 81-89.

Huang, B. N., Hwang, M. J., & Peng, H. P. (2005) “The asymmetry of the impact of oil price shocks on economic activities: an application of the multivariate threshold model”. *Energy Economics*, 27(3), 455-476.

Huang, C. C., Hsu, C. C., & Collar, E. (2021) “An Evaluation of the Operational Performance and Profitability of the US Airlines”. *International Journal of Global Business and Competitiveness*, 16(2), 73-85.

Hufnagel, L., Brockmann, D., & Geisel, T. (2004) “Forecast and control of epidemics in a globalized world”. *Proceedings of the national academy of sciences*, 101(42), 15124-15129.

Hunter, L. (2006) “Low-Cost Airlines: Business Model and Employment Relations”. *European Management Journal*, 24(5), 315-321.

Hussain, M. E., & Haque, M. (2016) “Impact of economic freedom on the growth rate: A panel data analysis”. *Economies*, 4(2), 5.

Hutt, M. D., Stafford, E. R., Walker, B. A., & Reingen, P. H. (2000) “Case study: defining the social network of a strategic alliance”. *MIT Sloan Management Review*, 41(2), 51.

Hyett, N., Kenny, A., & Dickson-Swift, V. (2014) “Methodology or method? A critical review of qualitative case study reports”. *International Journal of Qualitative Studies on Health and Well-being*, 9. doi:10.3402/qhw. v9.23606

Iacus, S. M., Natale, F., Santamaria, C., Spyratos, S., & Vespe, M. (2020) “Estimating and projecting air passenger traffic during the COVID-19 coronavirus outbreak and its socio-economic impact”. *Safety Science*, *129*, 104791.

IATA, (2008) “Airline Handbook”. *Air Transport Association,* available at: https://www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/iataannualreport2009.pdf. (Accessed on: 25.07.2021).

IATA, (2014) “Annual Review 2014”. *International Air Transport Association Annual Review* 2014 available at: https://www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/iata-annual-review-2014.pdf. (Access on: 24.07.2021).

IATA, (2015) “Economic performance of the airline industry”. URL: https://www. iata. org/whatwedo/Documents/economics/IATA-Economic-Performance-of-the-Industry-end-year-2014-report. pdf. (Access on: 24.07.2021).

IATA, (2016) “Economic Performance of the Airline Industry”. Available at: www.iata.org/economics.

IATA, (2018) “Economic Performance of the Airline Industry”. Available at https://www.iata.org/en/iata-repository/publications/economic-reports/airline-industry-economic-performance---2018-mid-year---report/(Accessed on 12.11.2020).

IATA, (2018a) “Future of Airline Industry 2035”. https://www.iata.org/en/policy/future-of-airlines-2035/.(Accessed on 16.06.2020).

IATA, (2019) “Fuel Fact Sheet. Iata, December 2019”, https://www.iata.org/pressroom/facts_figures/fact_sheets/Documents/fact-sheet-fuel.pdf ICAO, (2019) “*Aviation and Data Analysis Seminar, Connectivity and Competition”, Bangkok, December* 10-13, 2019.

IATA, (2020) “Air connectivity: Measuring the connections that drive economic growth”.

IATA, (2020a) “COVID-19. Fourth Impact Assessment”. *International Air Transport Association*. Available online: https://www.iata. org/en/iata-repository/publications/economic-reports/covid-fourth-impact-assessment/. (Accessed on 13.04.2022).

IATA, (2020a) “Air Connectivity Measuring the connections that drive economic growth”.

IATA. (2020b) “Economic Performance of the Airline Industry”. Available at: https://www.iata.org/en/iata-repository/publications/economic-reports/airline-industry-economic-performance---november-2020---report/.(Accessed on 20.11.2020).

IATA, (2020b) “Recovery delayed as international travel remains locked down”. Available at https://www.iata.org/en/pressroom/pr/2020-07-28-02/. (Accessed on 07.07.2022).

IATA, (2020c) “Deep losses continue into 2021”, Available at https://www.iata.org/en/pressroom/pr/2020-11-24-01/. (Accessed on 24.11.2021).

IATA Economics, (2021) “Outlook for the global airline industry”. In *IATA Economics* (Issue April). https://www.iata.org/whatwedo/Documents/economics/Industry-Outlook-Presentation-September2011.pdf

ICAO, (2020) “International Civil Aviation Organization” available at: https://www.icao.int/pages/copyright.aspx (Accessed on: 27.07.2021).

ICAO, (2021) “Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis”. *International Civil Aviation Organization (ICAO), Montréal, Canada*, *May*, 125.

Ignatiev, A. A. (2015) “Development of the tourism industry in the North of Russia based on the environment features”. *Mediterranean Journal of Social Sciences*, 6(5 S4), 387.

ILO, (2013) "Civil aviation and its changing world of work". Available at: https://www.ilo.org/sector/Resources/publications/WCMS_201282/lang--en/index.htm. (Access on: 04.08.2021).

Inglada, V., Rey, B., Rodríguez-Alvarez, A., & Coto-Millan, P. (2006) "Liberalisation and efficiency in international air transport". *Transportation Research Part A: Policy and Practice*, 40(2), 95-105.

Ingram, P., & Silverman, B. (2002) "Introduction. In P. Ingram and B. Silverman (Eds)", *The new institutionalism in strategic management*: 1–30. Amsterdam: Elsevier.

InterVistas/IATA, (2019) "Transforming Intra-African Air Connectivity: The Economic Benefits of Implementing the Yamoussoukro Decision".

Irwin, M. D., & Kasarda, J. D. (1991) "Air passenger linkages and employment growth in US metropolitan areas". *American Sociological Review*, 524-537.

ISU, (2014) "Air transport as a driver of sustainable development in Latin America and the Caribbean: challenges and policy proposals". https://repositorio.cepal.org/handle/11362/43412?locale-attribute=en. (Accessed date 13.04.2020).

Iatrou, K., & Alamdari, F. (2005) "The empirical analysis of the impact of alliances on airline operations". *Journal of Air Transport Management*, 11(3), 127-134.

Jain, R. K. & Natarajan, R. (2015) "A DEA study of airlines in India", *Asia Pacific Management Review*.

Jiménez, J. L., Valido, J., & Pellicer, A. A. (2023) "Evaluating the effect of air transport resident subsidies on non-resident tourists' expenditure". *Journal of Air Transport Management*, 106, 102319.

Jarvis, D., Stoeckl, N., & Liu, H. B. (2016) "The impact of economic, social and environmental factors on trip satisfaction and the likelihood of visitors returning". *Tourism Management*, 52, 1-18.

Jeon, C. (2011) “Review: ICAO A History of the International Civil Aviation Organization”. *International Journal: Canada’s Journal of Global Policy Analysis*, *66*(1), 239–241. https://doi.org/10.1177/002070201106600121.

Ji, X., & Chen, G. Q. (2006) “Exergy analysis of energy utilization in the transportation sector in China”. *Energy policy*, 34(14), 1709-1719.

Johnson, P. (2002) “Domestic Air Transport”. *The Structure of British Industry*, 281.

Jones, C. M., & Kaul, G. (1996) “Oil and the stock markets”. *The journal of Finance*, 51(2), 463-491.

Joo, S. J., & Fowler, K. L. (2014) “Exploring comparative efficiency and determinants of efficiency for major world airlines”. *Benchmarking*: *An International Journal*.

Jorens, Y., Gillis, D., Valcke, L., & Joyce De Coninck. (2015) “Atypical employment in Aviation Sector”. *European Social Dialogue, European Commission*. https://biofuels-news.com/news/oneworld-agrees-saf-deal-over-seven-years-beginning-in-2024/. (Accesses on 11.10.2022)

Ju M., Zhao H., Wang T. (2014) “The boundary conditions of export relational governance: A “strategy tripod” perspective”. *Journal of International Marketing*, vol. 22, no. 2, pp. 89–106. https://doi.org/10.1509/jim.13.0114.

Kafouros, M., Wang, C., Piperopoulos, P., & Zhang, M. (2015) “Academic collaborations and firm innovation performance in China: The role of region-specific institutions”. *Research Policy*, 44(3), 803–817.

Kafouros, M. Aliyev (2016) “Institutions and foreign subsidiary growth in transition economies: The role of intangible assets and capabilities”. *Journal of Management Studies*, 53 (2016), pp. 580-607.

Kahn, A. E. (2003) “Lessons from deregulation: telecommunications and airlines after the crunch”. *Brookings Institution Press*.

Kao, C. & Hwang, S.-N. (2008) “Efficiency decomposition in two-stage data envelopment analysis:

An application to non-life insurance companies in Taiwan”*, European Journal of Operational Research*, 185, pp. 418–429. doi: 10.1016/j.ejor.2006.11.041.

Karaman, A. S. (2016) “The pernicious impact of visa restrictions on inbound tourism: The case of Turkey”. *Turkish Studies*, 17(3), 502-524.

Kasarda, J. D., & Sullivan, D. L. (2006) “Air cargo, liberalisation, and economic development”. *Annals of Air and Space Law*, 31, 167-93.

Kaufmann, R. Hooghiemstra, M.K. Feeney (2018) “Formal institutions, informal institutions, and red tape: A comparative study”. *Public Administration*, 96 (2018), pp. 386-403.

Kazemi, M. & Bagherieh-mashhadi, A. (2014) “A Comparative Analysis of Airlines Efficiency: Evidence from Middle East and North Africa”, in *Advances in Business-Related Scientific Research Conference*.

Keho, Y. (2017) “The impact of trade openness on economic growth: The case of Cote d’Ivoire”. *Cogent Economics & Finance*, 5(1), 1332820.

Kekezi, O., & Klaesson, J. (2020) “Agglomeration and innovation of knowledge-intensive business services”. *Industry and Innovation*, 27(5), 538-561.

Kellert, S. H., Longino, H. E., & Waters, C. K. (Eds.). (2006) “Scientific pluralism”, (Vol. 19). *University of Minnesota Press.*

Kelly, P. (2012) “An Account of Denmark with Francogallia and Some Considerations for the Promoting of Agriculture and Employing the Poor”.

Kemeny, T. (2011) “Are international technology gaps growing or shrinking in the age of globalization?”. *Journal of Economic Geography*, 11(1), 1-35.

Kennan, J. (2013) “Open borders”. *Review of Economic Dynamics*, 16(2), L1-L13.

Kennan, J. (2017) “Open borders in the European Union and beyond: migration flows and labour market implications (No. w23048)”. *National Bureau of Economic Research*.

Keshavarz, M. (2018) “The design politics of the passport: Materiality, immobility, and dissent”. *Bloomsbury Publishing*.

Keynes, J. M. (1920) “The economic consequences of the peace”. *Penguin, New York.*

Khan, K., Su, C. W., Umar, M., & Yue, X. G. (2021) “Do crude oil price bubbles occur?”. *Resources Policy*, 71, 101936.

Khanna, T., & Palepu, K. (2004) “Globalization and convergence in corporate governance: Evidence from Infosys and the Indian software industry”. *Journal of International Business Studies*, 35(6): 484–507.

Khanna, T., Palepu, K., & Bullock, R. (2010) “Vencendo em Mercados Emergentes”. *Harvard Business Review*, 88(6), 80-85.

Kim, E. H., & Singal, V. (1993) “Mergers and market power: Evidence from the airline industry”. *The American Economic Review*, 549-569.

Kim, J. H. (2019) “Multicollinearity and misleading statistical results”, *Korean Journal of Anaesthesiology*, 72(6), pp. 558–569.

Kim, Y. R., & Liu, A. (2021) “Social distancing, trust and post-COVID-19 recovery”. Tourism Management, 1–9 104416

Kim, R.E. Hoskisson (2015) “A resource environment view of competitive advantage. Emerging Economies and Multinational Enterprises”. *Advances in International Management*, 28 (2015), pp. 95-140

Kim, R.E. Hoskisson, S.-H. Lee (2015) “Why strategic factor markets matter: New multinationals’ geographic diversification and firm profitability”. *Strategic Management Journal*, 36 (2015), pp. 518-536.

Kirisci, K. (2005) “A friendlier Schengen Visa System as a tool of soft power: the experience of Turkey”. *Eur. J. Migration & L.*, 7, 343-367.

Klees, S. (2016) “Inferences from regression analysis: Are they valid”. *Real World Economics Review*, 74(1), 85-97.

Kogut, B. (2003) “Globalization and context”. Keynote Address at the First Annual Conference on Emerging *Research Frontiers in International Business*, Duke University

Koo, T. T., Lim, C., & Dobruszkes, F. (2017) “Causality in direct air services and tourism demand”. *Annals of Tourism Research*, 67, 67-77.

Kotler P & Gertner D (2002) “Country as brand, products, and beyond: A place marketing and brand management perspective”. *Journal of Brand Management* 9(4/5): 249–261.

Kottas, A. T. & Madas, M. A. (2018) “Comparative efficiency analysis of major international airlines using Data Envelopment Analysis: Exploring effects of alliance membership and other operational efficiency determinants”, *Journal of Air Transport Management*, 70, pp. 1–17. doi: 10.1016/j.jairtraman.2018.04.014.

Krasnokutskiy, P. A., Kulchittskij, A. V., Perova, T. V., Bystrova, N. V., & Khizhnaya, A. V. (2016) “The main trends and prospects of development of international tourism”. *International Journal of Economics and Financial Issues*, 6(8S).

Kristjanpoller, W. D., & Concha, D. (2016) “Impact of fuel price fluctuations on airline stock returns”. *Applied Energy*, 178, 496-504.

Krueger, A. B., & Anderson, D. A. (2014) “Explorations in economics”. *BFW/Worth Publishers*.

Krugman, P. (1994) “Competitiveness: a dangerous obsession”. *Foreign Affairs.*, 73, 28.

Krull, E., Smith, P., & Ge, G. L. (2012) “The internationalization of engineering consulting from a strategy tripod perspective”. *The Service Industries Journal*, 32(7), 1097-1119.

Kulendran, N., & Wilson, K. (2000) “Is there a relationship between international trade and international travel?”. *Applied Economics*, 32(8), 1001-1009.

Kumar, S., & Chong, I. (2018) “Correlation analysis to identify the effective data in machine learning: Prediction of depressive disorder and emotion states”. *International Journal of*

Environmental Research and Public Health, 15(12). https://doi.org/10.3390/ijerph15122907

Kuo, H. I., Chen, C. C., Tseng, W. C., Ju, L. F., & Huang, B. W. (2008) "Assessing impacts of SARS and Avian Flu on international tourism demand to Asia". *Tourism Management*, 29(5), 917-928.

Kutner, M. H., Kutner, M. H., Nachtsheim, C., & Neter, J. (2004) "Student solutions manual for use with applied linear regression models". *McGraw-Hill/Irwin*.

Kuzminykh, N., & Zufan, P. (2014) "Airline alliances and their influence on firm performance". *Procedia Economics and Finance*, 12, 329-333.

Kweh, Q. L., Kuo, K. C., Wang, W. K., & Liu, H. M. (2015) "Board Independence, Family Control, and Performance in Taiwanese Listed Semiconductor Companies". *Hitotsubashi Journal of Economics*, 93-115.

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (1999) "Corporate ownership around the world". *Journal of Finance*, 54(2): 471–517.

Latif, Z., Latif, S., Ximei, L., Pathan, Z. H., Salam, S., & Jianqiu, Z. (2018) "The dynamics of ICT, foreign direct investment, globalization and economic growth: Panel estimation robust to heterogeneity and cross-sectional dependence". *Telematics and Informatics*, 35(2), 318-328.

Lau, H., Khosrawipour, V., Kocbach, P., Mikolajczyk, A., Schubert, J., Bania, J., & Khosrawipour, T. (2020) "The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China". *Journal of Travel Medicine*, 27(3), Article taaa037.

Lawson, R. A., & Roychoudhury, S. (2016) "Do travel visa requirements impede tourist travel?". *Journal of Economics and Finance*, 40(4), 817-828.

Lawton, T., Rajwani, T., & Doh, J. (2013) "The antecedents of political capabilities: A study of ownership, cross-border activity and organization at legacy airlines in a deregulatory context". *International Business Review*, 22(1), 228-242.

Leamer, E. E. (1998) "Let's Take the Con Out of Econometrics", American Economic Review, 73 (1), March, 31-43. *International Library of Comparative Public Policy*, 6, 534-546.

Lee Rodgers, J., & Nicewander, W. A. (1988) “Thirteen ways to look at the correlation coefficient”. *The American Statistician*, 42(1), 59-66.

Lee, B. L., & Worthington, A. C. (2014) “Technical Efficiency of Mainstream Airlines and Low-Cost Carriers: New Evidence Using Bootstrap Data Envelopment Analysis Truncated Regression”. *Journal of Air Transport Management*, 38, 15-20.

Lee, C. F., Huang, H. I., & Chen, W. C. (2010) “The determinants of honeymoon destination choice—The case of Taiwan”. *Journal of Travel & Tourism Marketing*, 27(7), 676-693.

Lee, K. B., Peng, M. W., & Lee, K. (2008) “From diversification premium to diversification discount during institutional transitions”. *Journal of World Business*, 43(1), 47–65.

Lenaerts, B., Allroggen, F., & Malina, R. (2021) “The economic impact of aviation: A review on the role of market access”. *Journal of Air Transport Management*, 91, 102000.

Levine, M.E. (1987) “Airline Competition in Deregulated Markets: Theory, Firm Strategy, and Public Policy”. *Yale Journal on Regulation*, Vol. 4, pp. 393–495.

Lewis, W. (1954) “Economic development with unlimited supplies of labour”. *The Manchester School,* 22(2), 139–191. https://doi.org/10.1111/j.1467-9957.1954.tb00021.x.

Li, Y., & Cui, Q. (2018) “Airline efficiency with optimal employee allocation: an input-shared network range adjusted measure”. *Journal of Air Transport Management*, 73, 150-162.

Li, Y., & Cui, Q. (2021) “Analysing the role of competition and cooperation in airline environmental efficiency through two dynamic environmental cross-efficiency models”. *International Journal of Sustainable Transportation*, 15(11), 850-864.

Li, Y., Wang, Y. Z., & Cui, Q. (2015) “Evaluating Airline Efficiency: An Application of Virtual Frontier Network SBM”. *Transportation Research Part E: Logistics and Transportation Review*, 81, 1-17.

Lim, S. H., & Hong, Y. (2014) “Fuel hedging and airline operating costs”. *Journal of air transport management*, 36, 33-40.

Lin, B. (2013) “The Effects of Joining a Strategic Alliance Group on Airline Efficiency, Productivity and Profitability”.

Lin, E. T. J. (2008) “Route-based performance evaluation of Taiwanese domestic airlines using data envelopment analysis: A comment”, *Transportation Research Part E: Logistics and Transportation Review*, 44(5), pp. 894–899. doi: 10.1016/j.tre.2007.01.004.

Linden, E. (2021) “Pandemics and environmental shocks: What aviation managers should learn from COVID-19 for long-term planning”. *Journal of Air Transport Management*, 90, 101944.

Ling, Y. H., Kokkiang, T., Gharleghi, B., & Fah, B. C. Y. (2018) “Productivity and efficiency modeling amongst ASEAN-5 airline industries”. *International Journal of Advanced and Applied Sciences*, 5(8), 47-57.

Lisciandra, M., Milani, R., & Millemaci, E. (2022) “A corruption risk indicator for public procurement”. *European Journal of Political Economy*, 73, 102141

Liu, A., Vici, L., Ramos, V., Giannoni, S., & Blake, A. (2021) “Visitor arrivals forecasts amid COVID-19: A perspective from the Europe team”. *Annals of Tourism Research*, 88, Article 103182.

Liu, J. S., Lu, L. Y., Lu, W. M., & Lin, B. J. (2013) “Data Envelopment Analysis 1978–2010: A Citation-Based Literature Survey”. *Omega*, 41(1), 3-15.

Lohmann, G. & Koo, T.T. (2013) “The airline business model spectrum”, Journal of Air Transport Management, Vol. 31, pp.7–9.

Lothgren, M., & Tambour, M. (1999) “Bootstrapping the Data Envelopment Analysis Malmquist Productivity Index”. *Applied Economics*, 31(4), 417-425.

Loudon, G. F. (2004) “Financial risk exposures in the airline industry: Evidence from Australia and New Zealand”. *Australian Journal of Management*, 29(2), 295-316.

Low, J. M., & Yang, K. K. (2019) “Understanding the operating landscape of the global airline industry: A DEA integrated alternating conditional expectation approach”. *Journal of Airline and Airport Management*, 9(2), 27.

Low, J.M., & Lee, B.K. (2014) "Effects of Internal Resources on Airline Competitiveness". *Journal of Air Transport Management*, 36, 23-32. https://doi.org/10.1016/j.jairtraman.2013.12.001.

Lozano, S., & Gutiérrez, E. (2011) "A multiobjective approach to fleet, fuel and operating cost efficiency of European airlines". *Computers & Industrial Engineering*, 61(3), 473-481.

Lu, G., Ding, X. D., Peng, D. X., & Chuang, H. H. C. (2018) "Addressing endogeneity in operations management research: Recent developments, joint problems, and directions for future research". *Journal of Operations Management*, pp. 64, 53–64.

Lu, W. M., Wang, W. K., Hung, S. W., & Lu, E. T. (2012) "The Effects of Corporate Governance on Airline Performance: Production and Marketing Efficiency Perspectives". *Transportation Research Part E: Logistics and Transportation Review*, 48(2), 529-544.

Lucas Jr, R. E. (1988) "On the mechanics of economic development". *Journal of monetary economics*, 22(1), 3-42.

Luenberger, D. G. (1992) "Benefit functions and duality". *Journal of Mathematical Economics*, 21(5), 461-481.

Luo, X. S., Imai, N., & Dorigatti, I. (2020) "Quantifying the risk of Zika virus spread in Asia during the 2015-16 epidemic in Latin America and the Caribbean: A modeling study". *Travel Medicine and Infectious Disease,* 33. https://doi.org/10.1016/j.tmaid.2020.101562.

Luo, X., & Chung, C. N. (2005) "Keeping it all in the family: The role of particularistic ties in business group performance during institutional transition". *Administrative Science Quarterly*, 50(2), 404–439.

MacFarland, T. W., & Yates, J. M. (2016) "Spearman's rank-difference coefficient of correlation". In *Introduction to nonparametric statistics for the Biological Sciences using R* (pp. 249-297). Springer, Cham.

Macilree, J., & Duval, D. T. (2020) "Aeropolitics in a post-COVID-19 world". *Journal of Air Transport Management*, 88, 101864.

Mackenzie, D. (2010) “ICAO: a history of the international civil aviation organization”. *University of Toronto Press.*

Maclennan[1], M. L. F., & Oliva, F. L. (2016) “Strategy Tripod empirical instrumentalization: analysis of weaknesses and opportunities”. *Revista de Negócios*, 21(2), 38-50.

MacMillan, M. (2007) “Paris 1919: Six months that changed the world”. *Random House*.

Madhok, A., (1997) “The Organization of Economic Activity: Transaction Costs, Firm Capabilities, and the Nature of Governance”. *Organization Science*, 7(5), pp. 577-590.

Magdalina, A., & Bouzaima, M. (2021) “An empirical investigation of European airline business models: Classification and hybridization”. *Journal of Air Transport Management*, 93, 102059

Magretta, J. (2002) “Why business models matter”, *Harvard Business Review*, Vol. 80, No. 5, pp.86–92.

Mahlberg, B., & Url, T. (2010) “Single Market effects on productivity in the German insurance industry”. *Journal of Banking & Finance*, 34(7), 1540-1548.

Mahmoudi, R., Emrouznejad, A., Shetab-Boushehri, S. N., & Hejazi, S. R. (2020) “The Origins, Development and Future Directions of Data Envelopment Analysis Approach in Transportation Systems”. *Socio-Economic Planning Sciences*, 69, 100672.

Mahoney, J. T. (2005) “Economic foundations of strategy”. *Thousand Oaks*, CA: Sage.

Mahoney, J.R. Pandian (1992) “The resource-based view within the conversation of strategic management”. *Strategic Management Journal*, 13 (1992), pp. 363-380.

Mak, B., & Go, F. (1995) “Matching global competition: Cooperation among Asian airlines”. *Tourism Management*, 16(1), 61-65.

Malhotra, R. (2012) “Benchmarking the Operating Efficiency of US Airlines”. In Applications of Management Science. *Emerald Group Publishing Limited*.

Malik, A. (2018) “Strategic human resource management and employment relations”. *Springer Nature Singapore Pte Ltd. 2018.*

Malik, M., Efendi, S., & Zarlis, M. (2018) *"Data Envelopment Analysis (DEA) Model in Operation Management Data Envelopment Analysis (DEA) Model". 4th International Conference on Operational Research (InteriOR) Series: Materials Science and Engineering*, *300*. https://doi.org/10.1088/1757-899X/300/1/012008

Malmquist, S. (1953) "Index numbers and indifference surfaces". *Trabajos de estadística*, 4(2), 209-242.

Manning, W. G. (1998) "The logged dependent variable, heteroscedasticity, and the retransformation problem". *Journal of Health Economics*, 17(3), 283–295.

Mariz, F. B., Almeida, M. R., & Aloise, D. (2018) "A Review of Dynamic Data Envelopment Analysis: State of The Art and Applications". *International Transactions in Operational Research*, 25(2), 469-505.

Marrocu, E., & Paci, R. (2012) "Education or creativity: what matters most for economic performance?". *Economic geography*, 88(4), 369-401.

Martin L.Á.G., Madhok A., Sánche Á.M. (2014) "The evolution of strategic management research: Recent trends and current directions". *BRQ Business Research Quarterly*, vol. 17, no. 2, pp. 69–76. https://doi.org/10.1016/j.brq.2014.03.001.

Mason, K. J., & Morrison, W. G. (2008) "Towards a means of consistently comparing airline business models with an application to the 'low-cost airline sector". *Research in Transportation Economics*, 24(1), 75-84.

Mathews, J. (2006) "Dragon multinationals: "New players in 21st century globalization". *Asia Pacific Journal of Management,* 23(1): 5–27.

Mattos, B., & Fregnani, J. A. G. (2016) "Effects of the airline deregulation act on aeronautical industry". *International Journal Advance Innovation Thoughts Ideas*, 3(161), 2277-1891.

Matwin, S., Kouznetsov, A., Inkpen, D., Frunza, O., & O'Blenis, P. (2010) "A new algorithm for reducing the workload of experts in performing systematic reviews". *Journal of the American Medical Informatics Association*, 17(4), 446-453.

McConnachie, D., Wollersheim, C., & Hansman, R. J. (2013) “The impact of fuel price on airline fuel efficiency and operations”. In *2013 Aviation Technology, Integration, and Operations Conference* (p. 4291).

McDonald, J. (2009) “Using least squares and tobit in second stage DEA efficiency analyses”. *European journal of operational research*, 197(2), 792-798.

McGrath, R.G. (2010) “Business models: a discovery driven approach”, *Long Range Planning*, Vol. 43, Nos. 2–3, pp.247–261.

McKibbin, W., & Fernando, R. (2021) “The global macroeconomic impacts of COVID-19: Seven scenarios”. *Asian Economic Papers*, 20(2), 1-30.

Mckinsey, (2021) “Back to the future? Airline sector poised for change post-COVID-19”. April 2, 2021 | Article available at The Future of the Airline Industry After COVID-19 | McKinsey. (Accesses on 21. 04. 2022).

McLean, A., May, R., Pattison, J., & Weiss, R. (2005) “SARS: A case study in emerging infections”. *OUP Oxford Publishing.UK.*

Mechling Jr, G. W. (1991) “Deregulation and the capacity, productivity and technical efficiency of equipment of former trunk airlines”. *Journal of Transport Economics and Policy*, 51-61.

Medina-Muñoz, D. R., & Medina-Muñoz, R. D. (2014) “The attractiveness of wellness destinations: An importance–performance–satisfaction approach”. *International Journal of Tourism Research*, 16(6), 521-533.

Melas, D., & Melasova, K. (2020) “The early impact of COVID-19 pandemic on the aviation industry”. *Acta Avionica*, 22(1), 38-44.

Menguc, B., Auh, S., & Ozanne, L. (2010) “The interactive effect of internal and external factors on a proactive environmental strategy and its influence on a firm’s performance”. *Journal of Business Ethics*, 94(2), 279-298.

Merkert, R. & Hensher, D. A. (2011) “The impact of strategic management and fleet planning on airline efficiency - a random effects tobit model based on dea efficiency scores”, *Transportation Research Part A: Policy and Practice*, 45(7), pp. 686–695. doi: 10.1016/j.tra.2011.04.015.

Merkert, R., & Pearson, J. (2015) “A non-parametric efficiency measure incorporating perceived airline service levels and profitability”. *Journal of Transport Economics and Policy (JTEP)*, 49(2), 261-275.

Merkert, R., & Williams, G. (2013) “Determinants of European PSO airline efficiency–Evidence from a semi-parametric approach”. Journal of Air Transport Management, 29, 11-16.

Meyer, K. E., & Peng, M. W. (2005) “Probing theoretically into Central and Eastern Europe: Transactions, resources, and institutions”. *Journal of International Business Studies*, 36(6): 600–621.

Meyer, K. E., & Peng, M. W. (2016) “Theoretical foundations of emerging economy business research”. *Journal of International Business Studies*, 47(1), 3–22.

Meyer, S. Estrin, S.K. Bhaumik, M.W. Peng (2009) “Institutions, resources, and entry strategies in emerging economics”. *Strategic Management Journal*, 30 (2009), pp. 61-80.

Micskei, Z., Madeira, H., Avritzer, A., Majzik, I., Vieira, M., & Antunes, N. (2012) “Robustness testing techniques and tools”. Resilience Assessment and Evaluation of Computing Systems. *Springer*, 323, 339.

Miller, J. I., & Ratti, R. A. (2009) “Crude oil and stock markets: Stability, instability, and bubbles”. *Energy economics*, 31(4), 559-568.

Miller, T., & A.B. Kim. (2016) “2016 Index of Economic Freedom”. Washington, DC and New York: *The Heritage Foundation and Dow Jones & Company, Inc*.

Miller, J. (1996) “The resource-based view of the firm in two environments: The Hollywood film studios from 1936–1965”. *Academy of Management Journal*, 39 (1996), pp. 519-543.

Millward, R., & Parker, D.M. (1983) “Public and private enterprise: comparative behaviour and relative efficiency”, in Millward *et al*. (eds.), Public Sector Economics, Longman

Min, H. and Joo, S. (2016) “A comparative performance analysis of airline strategic alliances using data envelopment analysis”, *Journal of Air Transport Management*, 52, pp. 99–110. DOI: 10.1016/j.jairtraman.2015.12.003.

Miyoshi, C., & Fukui, H. (2018) “Measuring the rebound effects in air transport: The impact of jet fuel prices and air carriers’ fuel efficiency improvement of the European airlines”. *Transportation Research Part A: Policy and Practice*, 112, 71-84.

Molesworth, R. (2012) “An Account of Denmark”. *Liberty Fund*.

Mollick, A. V., & Amin, M. R. (2021) “Occupancy, oil prices, and stock returns: Evidence from the US airline industry”. *Journal of Air Transport Management*, 91, 102015.

Montalbano, P. (2011) “Trade openness and developing countries’ vulnerability: Concepts, misconceptions, and directions for research”. *World Development*, 39(9), 1489-1502.

Montemari, M., & Chiucchi, M. S. (2017) “Enabling intellectual capital measurement through business model mapping: The Nexus case”. *In The Routledge companion to intellectual capital (pp.* 266-283*). Routledge.*

Moradi-Motlagh, A., & Emrouznejad, A. (2022) “The origins and development of statistical approaches in non-parametric frontier models: A survey of the first two decades of scholarly literature (1998–2020)”. *Annals of Operations Research*, 318(1), 713-741.

Morgenthau, H. J., Thompson, K. W., & Clinton, W. D. (1985) “Politics among nations: The struggle for power and peace”.

Morrell, P. S., & Taneja, N. K. (1979) “Airline productivity redefined: an analysis of US and European carriers”. *Transportation*, 8(1), 37-49.

Morrell, P., & Swan, W. (2006) “Airline jet fuel hedging: Theory and practice”. *Transport Reviews*, 26(6), 713-730.

Morris, M., Schindehutte, M., & Allen, J. (2005) “The entrepreneur’s business model: toward a unified perspective”. *Journal of business research*, 58(6), 726-735.

Morrish, S. C., & Hamilton, R. T. (2002) “Airline alliances—who benefits?”. *Journal of air transport management*, 8(6), 401-407.

Morrison, S., & Winston, C. (2010) “The economic effects of airline deregulation”. *Brookings Institution Press.*

Mrazova, M. (2013) “Advanced composite materials of the future in aerospace industry”. *Incas bulletin*, 5(3), 139.

MS, (2022). [Mobility Score]. “Arton Capital Passport’s Global Mobility Score”, available at: The Passport Index - Arton Capital. (Accessed on 20.11.2020).

Mueller, F. (2015) “Estimating own-price elasticities of air travel demand: The case of Norway”. (*Master's thesis*, Høgskolen i Molde-Vitenskapelig høgskole i logistikk).

Mugun, W. (2019) “Effect of Financial Indicators on Financial Performance”. *2*, 88–102.

Munir, K. A. (2019) “Challenging institutional theory’s critical credentials”. *Organization Theory*, 1(1), 2631787719887975.

Muthusamy, A. & Kalpana, G. (2018) “Operational and Productivity Efficiency of international airlines in India”*, International Journal of Research Culture Society*, 2(1), pp. 35–40.

Nair, S. K. S., Palacios Fernández, M., & Ruiz López, F. (2011) “The analysis of airline business models in the development of possible future business options”. *World Journal of Management*, 3(1), 48-59.

Narandaran, Y. Y., Hamid, B. A., & Habibullah, M. S. (2016) “Financial risk exposures of the airlines industry: evidence from Cathay pacific airways and China airlines”. *International Journal of Business and Society*, 17(2), 221-244.

Narayan, P. K., & Sharma, S. S. (2011) “New evidence on oil price and firm returns”. *Journal of Banking & Finance,* 35(12), 3253-3262.

Narayan, P. K., & Sharma, S. S. (2014) “Firm return volatility and economic gains: the role of oil prices”. *Economic Modelling*, 38, 142-151.

Narula, R. (2006) “Globalization, new ecologies, new zoologies, and the purported death of the eclectic paradigm”. *Asia Pacific Journal of Management*, 23(2): 143–151.

Nazmfar, H. (2012) “An analysis of urban system with emphasis on entropy model (Case study: the cities of East Azerbaijan Province)”. *Indian Journal of Science and Technology*, 5(9), 3340-3344.

Nazmfar, H. (2017) “Urban development predictions direction of using a combination GIS and Bayesian the probabilistic model (case study: Ardabil)”. *Human Geography Research*, 49(2), 357-370.

Nazmfar, H., Eshghei, A., Alavi, S., & Pourmoradian, S. (2019) “Analysis of travel and tourism competitiveness index in middle-east countries”. *Asia Pacific Journal of Tourism Research*, 24(6), 501-513.

Nelson, F. D. (1990) “Logit, probit and tobit”. *In Econometrics (pp. 136–144)*. London: Palgrave Macmillan UK.

Nelson, R., & Winter, S., (1982) “An evolutionary theory of economic change”. *Belknap Press of Harvard University Press: Cambridge, MA.*

Nenonen. S. & Storbacka. K. (2010) “Business model design: conceptualizing networked valueco-creation”, *International Journal of Quality and Service Sciences*, Vol. 2, No. 1, pp.43–59.

Neumayer, E. & Plumper, T. (2017) “Robustness Tests for Quantitative Research”. doi: 10.1017/9781108233590.

Neumayer, E. (2006) “Unequal access to foreign spaces: how states use visa restrictions to regulate mobility in a globalized world”. *Transactions of the Institute of British Geographers*, 31(1), 72-84.

Neumayer, E. (2010) “Visa restrictions and bilateral travel”. *The professional geographer*, 62(2), 171-181.

Neumayer, E. (2011) “On the detrimental impact of visa restrictions on bilateral trade and foreign direct investment”. *Applied geography*, 31(3), 901-907.

Ng, C. K., & Seabright, P. (2001) “Competition, privatization and productive efficiency: Evidence from the airline industry”. *The Economic Journal*, 111(473), 591-619.

Ngo V.D., Janssen F., Leonidou L.C., Christodoulides P. (2016) “Domestic institutional attributes as drivers of export performance in an emerging and transition economy”. *Journal of Business Research*, vol. 69, no. 8, pp. 2911–2922. DOI: 10.1016/j.jbusres.2015.12.060.

Nguyen T.V., Le N.T.B., Bryant S.E. (2013) “Sub-national institutions, firm strategies, and firm performance: A multilevel study of private manufacturing firms in Vietnam”. *Journal of World Business*, vol. 48, no. 1, pp. 68–76. DOI: 10.1016/j.jwb.2012.06.008.

Nielsen, C., & Montemari, M. (2012) “The role of human resources in business model performance: the case of network-based companies”. *Journal of Human Resource Costing & Accounting.*

Nielsen, C., Roslender, R., & Bukh, P. N. (2009) “Intellectual Capital Reporting: Can a strategy perspective solve accounting problems? In Knowledge Ecology in Global Business”: *Managing Intellectual Capital (pp.* 174-191*). IGI global*.

Niskanen, W. A. (1971) “Bureaucracy and Representative Government”. *Aldine--Atherton. Chicago.*

Nitsch, V. (2019) “Passport, please! Travels, travails and trade”. *Applied Economics Letters*, 26(15), 1274-1278.

Nolen, A., & Talbert, T. (2011) “Qualitative assertions as prescriptive statements”. *Educational Psychology Review*, 23(2), 263-271.

North, D. C. (1990) “Institutions, Institutional Change and Economic Performance (Political Economy of Institutions and Decisions) (59262nd ed.)”. *Cambridge University Press.*

North, D. C. (1991) “Institutions”. *Journal of economic perspectives*, *5*(1), 97-112.

Nye, J. S. (2003) “The paradox of American power: Why the world’s only superpower can’t go it alone”. *Oxford University Press*.

Nye, J. S. (2021) “Soft power: the evolution of a concept”. *Journal of Political Power*, 14(1), 196-208.

Nyshadham, E. A. & Rao, V. K. (2000) “Assessing efficiency of European airports: A Total Factor Productivity Approach”, *Public Works Management & Policy*, 5(2), pp. 106–114. doi: 10.1177/1087724X0052004.

O’Connell, J. F. (2011) “The rise of the Arabian Gulf carriers: An insight into the business model of Emirates Airline”. *Journal of Air Transport Management*, 17(6), 339-346.

O’Connell, J. F. (2018) “The global airline industry”. In *The Routledge companion to air transport management* (pp. 11-28). Routledge.

O’Connell, J. F. (2019) “The role of different airline business models. In A. Graham, & F. Dobruszkes (Eds.)”. *Air transport: A tourism perspective*. Elsevier

O’Connell, J. F., & Bueno, O. E. (2018) “A study into the hub performance Emirates, Etihad Airways and Qatar Airways and their competitive position against the major European hubbing airlines”. *Journal of Air Transport Management*, 69, 257-268.

O’Connor, K., & Fuellhart, K. (2012) “Cities and air services”: the influence of the airline industry. *Journal of Transport Geography*, 22, 46-52.

O’Neal, T., Min, H., Cherobini, D., & Joo, S. J. (2020) “Benchmarking aircraft maintenance performances using data envelopment analysis”. *International Journal of Quality & Reliability Management*.

Oliver, C. (1991) “Strategic responses to institutional processes”. *Academy of management review*, *16*(1), 145-179. 20(4), pp. 285–292. doi: 10.1016/j.apmrv.2015.03.004.

Oliver, C. (1997) “Sustainable Competitive Advantage: Combining Institutional and Resource-Based Views.” *Strategic Management Journal* 18, 679–713.

Omrani, H., & Soltanzadeh, E. (2016) “Dynamic DEA models with network structure: An application for Iranian airlines”. *Journal of Air Transport Management*, 57, 52-61.

Osterwalder, A., & Pigneur, Y. (2010) “Business model generation”: a handbook for visionaries, game-changers, and challengers (Vol. 1). *John Wiley & Sons*.

Othman, P., & Rosli, M. M. (2011) “The impact of tourism on small business performance: Empirical evidence from Malaysian islands”. *International Journal of Business and Social Science*, *2*(1).

Ouellette, P., Petit, P., Tessier-Parent, L. P., & Vigeant, S. (2010) “Introducing regulation in the measurement of efficiency, with an application to the Canadian air carrier’s industry”. *European Journal of Operational Research*, 200(1), 216-226.

Oum, T. H., & Yu, C. (1995) “A Productivity Comparison of The World’s Major Airlines”. *Journal of Air Transport Management*, 2(3-4), 181-195.

Oum, T. H., & Yu, C. (2012) “Winning airlines: Productivity and cost competitiveness of the world’s major airlines”. Springer Science & Business Media.

Oum, T. H., Fu, X. & Yu, C. (2005) “New evidences on airline efficiency and yields: A comparative analysis of major North American air carriers and its implications”, *Transport Policy*, 12(2), pp. 153–164. doi: 10.1016/j.tranpol.2005.01.002.

Oum, T. H., Fu, X., & Yu, C. (2005) “New evidences on airline efficiency and yields: a comparative analysis of major North American air carriers and its implications”. *Transport policy*, 12(2), 153–164.

Oum, T. H., Park, J. H., & Zhang, A. (2000) “Globalization and strategic alliances: The case of the airline industry”.

Oum, T. H., Zhang, A. & Fu, X. (2010) “Air transport liberalisation and its impacts on airline competition and air passenger traffic". *Transportation Journal*, 49(4), pp. 24–41. DOI: 10.2307/40904912.

Özcan, İ. Ç. (2013*)* "Air passenger traffic and local employment: Evidence from Turkey". *European Journal of Transport and Infrastructure Research*, 13(4).

Oztig, L. I., & Askin, O. E. (2020) "Human mobility and coronavirus disease 2019 (COVID-19): A negative binomial regression analysis". *Public Health*, 185, 364–367.

Paço, C. L., & Pérez, J. M. C. (2013) "The use of DEA (Data Envelopment Analysis) methodology to evaluate the impact of ICT on productivity in the hotel sector". *International Interdisciplinary Review of Tourism*.

Page, S. J., & Hardyman, R. (1996) "Place marketing and town centre management: A new tool for urban revitalization". *Cities*, 13(3), 153-164.

Pal, S., Dutta, N., & Roy, S. (2011) "Media freedom, socio-political stability and economic growth". *Unpublished Research*.

Papatheodorou, A. (2002) "Civil aviation regimes and leisure tourism in Europe". *Journal of Air Transport Management*, 8(6), 381-388.

Parast, M. M. & Fini, E. H. (2010) "The Effect of Productivity and Quality on Profitability in US airline industry", *Managing Service Quality*, 20(5), pp. 458–474.

Park, J. H. (1997) "The effects of airline alliances on markets and economic welfare". *Transportation Research Part E: Logistics and Transportation Review*, 33(3), 181-195.

Park, J. H., & Zhang, A. (2000) "An empirical analysis of global airline alliances: cases in North Atlantic markets". *Review of industrial organization*, 16(4), 367-384.

Patel, B. (2008*)* "A Flight Plan Towards Financial Stability-The History and Future of Foreign Ownership Restrictions in the United States Aviation Industry". *J. Air L. & Com.*, 73, 487.

Pearce, B. (2007) "Investing in air transport connectivity to boost national productivity and economic growth". *The travel & tourism competitiveness report 2007: Furthering the process of economic development*.

Pearce, B. (2012) "The state of air transport markets and the airline industry after the great recession". *Journal of Air Transport Management*, 21, 3-9. https://doi.org/10.1016/j.jairtraman.2011.12.011.

Pearson, J., Pitfield, D., & Ryley, T. (2015) "Intangible resources of competitive advantage: Analysis of 49 Asian airlines across three business models". *Journal of Air Transport Management,* 47, 179-189.

Peeters, P., & Landré, M. (2012) "The emerging global tourism geography—An environmental sustainability perspective". *Sustainability*, 4(1), 42-71.

Peng M.W. (2002) "Towards an institution-based view of business strategy". *Asia Pacific Journal of Management*, vol. 19, pp. 251–267. https://doi.org/10.1023/A:1016291702714.

Peng M.W. (2009) "Global Strategy". (2nd ed.) Cincinnati, OH*: South–Western Cengage Learning*.

Peng M.W., Sun W., Vlas C., Minichilli A., Corbetta G. (2018) "An institution-based view of large family firms: A recap and overview". *Entrepreneurship Theory and Practice*, vol. 42, no. 2, pp. 187–205. DOI: 10.1177/1042258717749234.

Peng, C., Zhu, H., Jia, X., & You, W. (2017) "Stock price synchronicity to oil shocks across quantiles: Evidence from Chinese oil firms". *Economic Modelling*, 61, 248-259.

Peng, M. W. (2003) "Institutional transitions and strategic choices". *Academy of Management Review*, 28(2): 275–296.

Peng, M. W., Sun, S. L., Pinkham, B., & Chen, H. (2009) "The institution-based view as a third leg for a strategy tripod". *Academy of management perspectives*, 23(3), 63-81.

Peng, M. W., Wang, D. Y., & Jiang, Y. (2008) "An institution-based view of international business strategy: A focus on emerging economies". *Journal of international business studies*, 39(5), 920-936.

Peng, M.W. (2000) “Controlling the Foreign Agent: How Governments Deal with Multinationals in a Transition Economy.” *Management International Review* 40(2), 141–165.

Peng, M.W. & P. Heath. (1996) “The Growth of the Firm in Planned Economies in Transition: Institutions, Organizations, and Strategic Choice.” *Academy of Management Review* 21(2), 492–528.

Penrose, E. (1995) “The theory of the growth of the firm”. https://doi.org/10.1093/0198289774.001.

Petersen, E., Wasserman, S., Lee, S. S., Unyeong, G. O., Holmes, A. H., Al-Abri, S., Tambyah, P. (2020) “COVID-19—We urgently need to start developing an exit strategy”. *International Journal of Infectious Diseases*., 233–239. https://doi.org/10.1016/j.ijid.2020.04.035.

Phan, D. H. B., Sharma, S. S., & Narayan, P. K. (2015) “Oil price and stock returns of consumers and producers of crude oil”*. Journal of International Financial Markets, Institutions and Money*, 34, 245-262.

Pinho, B. A. (2017) “The global airline industry: an assessment of the impact of low-cost carriers on the technical efficiency of full-service airlines”.

Pires, H. M., & Fernandes, E. (2012) “Malmquist financial efficiency analysis for airlines”. *Transportation Research Part E: Logistics and Transportation Review*, 48(5), 1049-1055.

Pointon, C., & Matthews, K. (2016) “Dynamic Efficiency in The English and Welsh Water and Sewerage Industry”. *Omega*, 58, 86-96.

Porter, M. E. (1980) “Competitive strategy: techniques for analysing industries and competitors”: New York: Free Press.

Porter, M. E. (1985a) “Technology and competitive advantage”. *Journal of Business Strategy*, 5(3), 60–78. https://doi.org/10.1108/eb039075

Porter, M. E. (1985b) “Competitive Advantage: Creating and Sustaining Superior Performance”. New York: Free Press.

Porter, M. E. (1990) “The competitive advantage of nations”. *Competitive Intelligence Review*, 1(1), 14-14.

Porter, M. E. (2008) “The five competitive forces that shape strategy”. *Harvard business review*, 86(1), 78.

Porter, M. E. (2011) “Competitive advantage of nations: creating and sustaining superior performance”. *Simon and Schuster*.

Prabhakar, A. C., Azam, M., Bakhtyar, B., & Ibrahim, Y. (2015) “Foreign direct investment, trade and economic growth: A new paradigm of the BRICS”. *Modern Applied Science*, 9(12), 32-42.

Prideaux, B. (2005) “Factors affecting bilateral tourism flows”. *Annals of Tourism Research*, 32(3), 780-801.

Priem, R. L., & Butler, J. E. (2001) “Is the resource-based “view” a useful perspective for strategic management research?” *Academy of management review*, 26(1), 22-40.

Prince, J. T., & Simon, D. H. (2017) “The impact of mergers on quality provision: Evidence from the airline industry”. *The Journal of Industrial Economics*, 65(2), 336-362.

PWC. (2013) Price Waterhouse Coopers “Air connectivity: Why it matters and how to support growth”. Available at pwc-air-connectivity.pdf. (Accessed on 21.03.22).

Qin, P. (2018) “The Revenue and Cost of the Airline Company”. *Research in Economics and Management*, *3*(2), 134. https://doi.org/10.22158/rem.v3n2p134.

Qin, X., & Du, D. (2018) “Measuring universities' R&D performance in China's provinces: A multistage efficiency and effectiveness perspective”. *Technology Analysis & Strategic Management*, 30(12), 1392–1408.

Qiu, R. T., Park, J., Li, S., & Song, H. (2020) "Social costs of tourism during the COVID-19 pandemic". *Annals of Tourism Research*, 84, Article 102994.

Qiu, R. T., Wu, D. C., Dropsy, V., Petit, S., Pratt, S., & Ohe, Y. (2021) "Visitor arrivals forecasts amid COVID-19: A perspective from the Asia and Pacific team". *Annals of Tourism Research,* 88, Article 103155

Rai, A. (2013) "Measurement of efficiency in the airline industry using data envelopment analysis", *Investment Management and Financial Innovations*, 10(1), pp. 38–45.

Rajasalu, T. (2003) "Indicators of economic freedom and economic structure as determinants of growth and convergence in enlarging EU and priorities for Estonia". *Essays in Estonian Transformation Economics*. Tallinn, 7-32.

Ramamurti, R.& Singh, J.V. (2009) "Emerging Multinational in Emerging Markets". Cambridge, *Cambridge University Press*, 420 p. http://dx.doi.org/10.1017/CBO9780511576485.

Ray, S. C. (2004) "Data envelopment analysis: Theory and techniques for economics and operations research", *Cambridge University Press*. doi: 10.1017/CBO9780511606731.

Ray, S. C., & Desli, E. (1997) "Productivity growth, technical progress, and efficiency change in industrialized countries: comment". *The American Economic Review*, 87(5), 1033-1039.

Razavi, A., Erondu, N. A., & Okereke, E. (2020) "The Global Health Security Index: what value does it add"? *BMJ Global Health*, 5(4), e002477.

Redondi, R., Birolini, S., Morlotti, C., & Paleari, S. (2021) "Connectivity measures and passengers' behaviour: Comparing conventional connectivity models to predict itinerary market shares". *Journal of Air Transport Management*, 90, 101958.

Rhoades, D.L. (2006) "Growth, customer service and profitability Southwest style", Managing Service Quality: *An International Journal*, Vol. 16, No. 5, pp.538–547.

Ricart, J. E., Enright, M. J., Ghemawat, P., Hart, S. L., & Khanna, T. (2004) "New frontiers in international strategy". *Journal of International Business Studies*, 35(3): 175–200.

Richard, O. (2003) “Flight frequency and mergers in airline markets”. *International Journal of Industrial Organization*, 21(6), 907-922.

Ridderstaat, J., Croes, R., & Nijkamp, P. (2014) “Tourism and long-run economic growth in Aruba”. *International Journal of Tourism Research*, 16(5), 472-487.

Rittenberg, L., & Tregarthen, T. (2009) “Principles of Microeconomics”. *Flat World Knowledge*.

Rodrik, D. (2006). “Goodbye Washington consensus, hello Washington confusion? A review of the World Bank’s economic growth in the 1990s: learning from a decade of reform”. *Journal of Economic literature*, 44(4), 973-987.

Roh, Y., Heo, G. and Whang, S. E. (2018) “A survey on data collection for machine learning: A big data - AI integration perspective”, *arXiv*, pp. 1–20. DOI: 10.1109/tkde.2019.2946162.

Rose, A. (2005) “Which international institutions promote international trade?”. *Review of International Economics*, 13(4), 682-698.

Rose, N. L. (2012) “After airline deregulation and Alfred E. Kahn”. *American Economic Review*, 102(3), 376-80.

Rosselló, J., Santana-Gallego, M., & Awan, W. (2017) “Infectious disease risk and international tourism demand”. *Health Policy and Planning*, 32(4), 538–548.

Roth, K., & Kostova, T. (2003) “Organizational coping with institutional upheaval in transition economies”. *Journal of World Business*, 38(4): 314–330.

Rumelt, R. P. (1991) “How much does industry matter?”. *Strategic management journal*, 12(3), 167-185.

Rupp, N. G., & Liu, A. N. (2018) “Product quality choices and competition”. *Journal of Transport Economics and Policy (JTEP)*, 52(4), 367-390.

Russell, B., Richards, A., & Kruger, B. (1994) “Transportation and Economic Development-A Summary of Key Issues Being Explored on Transportation Options and Economic Development”-Wisconsin TransLinks 21.

Russell, R. (2018) “Theoretical productivity indices. In E. Grifell-Tatjé, C. Lovell, & R. Sickles (Eds.), The oxford handbook on productivity analysis (pp. 153–182)”. New York: *Oxford University Press*

Sabadie, J. A., & Johansen, J. (2010) “How do national economic competitiveness indices view human capital?”. *European Journal of Education*, 45(2), 236-258.

Saha, S., & Yap, G. (2014*)* “The moderation effects of political instability and terrorism on tourism development: A cross-country panel analysis”. *Journal of Travel Research*, 53(4), 509-521.

Saha, S., Su, J. J., & Campbell, N. (2017) “Does political and economic freedom matter for inbound tourism? A cross-national panel data estimation”. *Journal of Travel research*, 56(2), 221-234.

Saini, A. P. (2018) “Evaluation of Airline Efficiency and Environmental Impacts Using Data Envelopment Analysis”.

Salari, M., Milne, J., Delcea, C., Kattan, L., & Cotfa, L. A. (2020) “Social distancing in airplane seat assignments”*. Journal of Air Transport Management*, 89, Article 101915.

Saranga, H., & Nagpal, R. (2016) “Drivers of operational efficiency and its impact on market performance in the Indian Airline industry”. *Journal of Air Transport Management*, 53, 165-176.

Sarstedt, M. & Mooi, E. (2014) “Regression Analysis”, in *A Concise Guide to Market Research*, pp. 193–233. DOI: 10.1007/978-3-642-53965-7.

Satish G. (2006) Travel Wire News “Australia targets the Gulf region with simplified visa norms”, eTurboNews, 11 June. Daily travel industry email newsletter published *by eTurboNews*, Haileiwa, HI. Available at www.travelwirenews.com/cgi-cript/csArticles/articles/000087/008765.htm (Accessed 20.07.2019).

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., ... & Jinks, C. (2018) “Saturation in qualitative research: exploring its conceptualization and operationalization”. *Quality & quantity*, *52*(4), 1893-1907.

Saunders, M. N. K., Lewis, P., Thornhill, A., & Bristow, A. (2015) “Understanding research philosophies and approaches”: *Research methods for business students*.

Saunders, M., Lewis, P. H. I. L. I. P., & Thornhill, A. D. R. I. A. N. (2007) “Research methods”. *Business Students 4th edition Pearson Education Limited, England*.

Saville, A. D., & White, L. (2015) “Ensuring that Africa keeps rising: The economic integration imperative”. *South African Journal of International Affairs*, 22(1), 1-21.

Schefczyk, M. (1993) “Operational performance of airlines: an extension of traditional measurement paradigms”. *Strategic Management Journal*, 14(4), 301-317.

Scheiwiller, S., & Zizka, L. (2021) “Strategic responses by European airlines to the Covid-19 pandemic: A soft landing or a turbulent ride?”. *Journal of air transport management*, 95, 102103.

Scheraga, C. A. (2004a) “Operational Efficiency Versus Financial Mobility in The Global Airline Industry: A Data Envelopment and Tobit Analysis”. *Transportation Research Part A: Policy and Practice*, 38(5), 383-404.

Scheraga, C. A. (2004b) “The relationship between operational efficiency and customer service: A global study of thirty-eight large international airlines”*, Transportation Journal*, 43(3), pp. 48–58.

Schneider, F. (2013) “Size and development of the shadow economy of 31 European and 5 other OECD countries from 2003 to 2013: a further decline”.

Scott, W. R. (2008) “Institutions and organizations: Ideas and interests”. *Thousand Oaks, CA: Sage Publications, Inc*

Scott, W. R. (2013) “Institutions and Organizations (4th ed)”. *Thousand Oaks, CA: Sage Publications.*

Scott, W.R. (1995) “Institutions and Organizations”. *Thousand Oaks, CA: Sage*.

Scotti, D., & Dresner, M. (2015) “The impact of baggage fees on passenger demand on US air routes”. *Transport Policy*, 43, 4-10.

Scully, G. W. (1988) “The institutional framework and economic development”. *Journal of Political Economy*, 96(3), 652-662.

Scully, G. W. (2014) “Constitutional environments and economic growth”. *Princeton University Press.*

Seiford, L. M. (1996) “Data Envelopment Analysis: The Evolution of The State of The Art (1978–1995)”. *Journal of productivity analysis*, 7(2), 99-137.

Seiford, L. M. (1997) “A Bibliography for Data Envelopment Analysis (1978-1996)”. *Annals of Operations Research*, 73, 393-438.

Sengupta, J. K. (1992) “Measuring Efficiency by A Fuzzy Statistical Approach”. *Fuzzy Sets and Systems*, 46(1), 73-80.

Sengupta, J. K. (1999) “A dynamic efficiency model using data envelopment analysis”, *International Journal of Production Economics*, 62(3), pp. 209–218. doi: 10.1016/S0925-5273(98)00244-8.

Senthilnathan, S. (2019) “Usefulness of Correlation Analysis”. *SSRN Electronic Journal*, *July*. https://doi.org/10.2139/ssrn.3416918

Seo, G. H. (2020 “A Content Analysis of International Airline Alliances Mission Statements”. *Business Systems Research: International journal of the Society for Advancing Innovation and Research in Economy*, 11(1), 89-105.

Seufert, J. H., Arjomandi, A., & Dakpo, K. H. (2017) “Evaluating airline operational performance: A Luenberger-Hicks-Moorsteen productivity indicator”. *Transportation Research Part E: Logistics and Transportation Review*, 104, 52-68.

Severin, B., & Nancy, L. (2008) “How Airline Markets Work... or Do They? Regulatory Reform in the Airline Industry”.

Secilmis, N., & Koc, A. (2016) “Economic factors affecting aviation demand: Practice of EU countries”. *Актуальні проблеми економіки*, (5), 412-420.

Shafer, S. M., Smith, H. J., & Linder, J. C. (2005) “The power of business models”. *Business horizons*, 48(3), 199-207.

Shahverdi, R. & Ebrahimnejad, A. (2014) “DEA and Malmquist productivity indices for measuring group performance in two periods”, *International Journal of Industrial and Systems Engineering*, 16(3), pp. 382–395. doi: 10.1504/IJISE.2014.060135.

Sharma, S. K. (2020) “DESCRIPTIVE STATISTICS”. Scientific Methods Used in Research and Writing, 9.

Shen, Y., Hermans, E., Ruan, D., Vanhoof, K., Brijs, T., & Wets, G. (2010) “A DEA-based Malmquist productivity index approach in assessing road safety performance”. In *Computational Intelligence: Foundations and Applications* (pp. 923-928).

Shevlyakov, G. L., & Vilchevski, N. O. (2011) “Robustness in data analysis”. De Gruyter.

Shirazi, F., & Mohammadi, E. (2019) “Evaluating efficiency of airlines: A new robust DEA approach with undesirable output”. *Research in Transportation Business & Management*, p. 33, 100467.

Siegel, J. (2007) “Contingent political capital and international alliances: Evidence from South Korea”. *Administrative Science Quarterly*, 52(4), 621–666.

Sileshi, G. W. & Anglong, K. (2015) “The relative standard error as an easy index for checking the reliability of regression coefficients”, (August). DOI: 10.13140/RG.2.1.2123.6968.

Simar, L., & Wilson, P. W. (1998) “Sensitivity Analysis of Efficiency Scores: How to Bootstrap in Non-Parametric Frontier Models”. *Management Science*, 44(1), 49-61.

Simar, L., & Wilson, P. W. (1999a) “Estimating and Bootstrapping Malmquist Indices”. *European journal of operational research*, 115(3), 459-471.

Simar, L., & Wilson, P. W. (1999b) “Of course, we can bootstrap DEA scores! But does it mean anything? Logic trumps wishful thinking”. *Journal of productivity Analysis*, 93-97.

Simar, L., & Wilson, P. W. (2000) “A general methodology for bootstrapping in non-parametric frontier models”. *Journal of applied statistics*, 27(6), 779-802.

Simar, L., & Wilson, P. W. (2002) “non-parametric tests of returns to scale”. *European Journal of Operational Research*, 139(1), 115-132.

Simar, L., & Wilson, P. W. (2007) “Estimation and inference in two-stage, semi-parametric models of production processes”. *Journal of econometrics*, 136(1), 31-64.

Simar, L., & Wilson, P. W. (2011a) “Two-stage DEA: caveat emptor”. *Journal of Productivity Analysis*, 36(2), 205-218.

Simar, L., & Wilson, P. W. (2011b) “Performance of the bootstrap for DEA estimators and iterating the principle”. In *Handbook on data envelopment analysis* (pp. 241-271). *Springer, Boston, MA.*

Simar, L., & Wilson, P. W. (2011c) “Inference by the m out of n bootstrap in nonparametric frontier models”. *Journal of Productivity Analysis*, 36(1), 33-53.

Simar, L., Vanhems, A., & Van Keilegom, I. (2016) “Unobserved heterogeneity and endogeneity in non-parametric frontier estimation”. *Journal of Econometrics*, 190(2), 360-373.

Simon, M. K., & Goes, J. (2011) “Dissertation and scholarly research: Recipes for success”. *Seattle, WA: Dissertation Success, LLC*

Singh, J., Sharma, S. K., & Srivastava, R. (2018) “Managing fuel efficiency in the aviation sector: Challenges, accomplishments and opportunities”. *FIIB Business Review*, 7(4), 244-251.

Singh, P. K., & Thaker, K. (2020) “Profit efficiency and determinants of Indian banks; A truncated bootstrap and data envelopment analysis”. *Cogent Economics & Finance*, 8(1), 1724242.

Sisman, Z. (2017) *“Using Data Envelopment Analysis and Malmquist Total Factor Productivity Index for Agriculture of Turkish Regions”. In Istanbul Sehir University*.

Şişman, Z. (2017) “Using data envelopment analysis and malmquist total factor productivity index for agriculture of Turkish regions”. (Master’s thesis, Fen Bilimleri Enstitüsü).

Sjögren, S. (2016) “Modeling airline efficiency–a comparison of international airlines using data envelopment analysis”. In Airline Efficiency. *Emerald Group Publishing Limited*.

Sofield, T. H. (2006) “Border tourism and border communities: An overview”. *Tourism Geographies*, 8(2), 102-121.

Soiferman, L. K. (2010) “Compare and Contrast Inductive and Deductive Research Approaches”. *Online Submission*.

Song, H., Gartner, W. C., & Tasci, A. D. (2012) “Visa restrictions and their adverse economic and marketing implications–Evidence from China”. *Tourism Management*, 33(2), 397-412.

Sorouri Ghare-Aghaj, S., Sadeghian, R., Tavakkoli-Moghaddam, R., & Makoei, A. (2019) “Multi-Objective Modeling for Airlines Cooperation by Game Theory and Sustainable Development Approaches”. *International Journal of Transportation Engineering*, 6(4), 367-380.

Spence, M. (1978) “Job market signalling. In Uncertainty in economics”. *Academic Press*.pp.281-306.

Staat, M. (2006) “Efficiency of Hospitals in Germany: A DEA-Bootstrap Approach”. *Applied Economics*, 38(19), 2255-2263.

Statistica. (2021) “Passenger load factor of commercial airlines worldwide from 2005 to 2022”. https://www-statista-com.zorac.aub.aau.dk/statistics/658830/passenger-load-factor-of-commercial-airlines-worldwide/

Storper, M., & Venables, A. J. (2004) “Buzz: face-to-face contact and the urban economy”. *Journal of economic geography*, 4(4), 351-370.

Su Z., Peng M., & Xie E. (2016) “A strategy tripod perspective on knowledge creation capability”. *British Journal of Management*, vol. 27, issue 1, pp. 58–76. https://doi.org/10.1111/1467-8551.12097.

Suau-Sanchez, P., Voltes-Dorta, A., & Cugueró-Escofet, N. (2020) “An early assessment of the impact of COVID-19 on air transport: Just another crisis or the end of aviation as we know it?”. *Journal of Transport Geography*, 86, 102749.

Suk, M., & Kim, W. (2021) "COVID-19 and the airline industry: crisis management and resilience". *Tourism Review*.

Sun, S., Lu, H., Tsui, K. L., & Wang, S. (2019) "Nonlinear vector auto-regression neural network for forecasting air passenger flow". *Journal of Air Transport Management*, 78, 54-62.

Sun, X., Wandelt, S., & Zhang, A. (2020) "How did COVID-19 impact air transportation? A first peek through the lens of complex networks". *Journal of Air Transport Management*, 89, 101928.

Sun, X., Wandelt, S., Zheng, C., & Zhang, A. (2021) "COVID-19 pandemic and air transportation: Successfully navigating the paper hurricane". *Journal of Air Transport Management*, 94, 102062.

Sureiman, O. & Mangera, C. M. (2020) "F - Test of Overall Significance in Regression Analysis Simplified", *Journal of the Practice of Cardiovascular Sciences*. DOI: 10.4103/jpcs.

Susilawati, S. & Faisal, A. (2021) "Business Strategy, Environmental Uncertainty and Management Accounting Systems and Their Influence on Firm Performance". I*RE Journals Volume 5 Issue 5, pp. 37-48*

Szabo, S., Mako, S., Tobisova, A., Hanak, P., & Pilat, M. (2018) "Effect of the load factor on the ticket price". *Transport problems*, 13.

Taleb, M., Khalid, R., Emrouznejad, A., & Ramli, R. (2023) "Environmental efficiency under weak disposability: an improved super efficiency data envelopment analysis model with application for assessment of port operations considering NetZero". *Environment, Development and Sustainability*, 25(7), 6627-6656.

Tallman, S. B., & Shenkar, O. (1990) "International cooperative venture strategies: Outward investment and small firms from NICs". *MIR: Management International Review*, 299-315.

Tallman, S., & Li, J. (1996) "Effects of international diversity and product diversity on the performance of multinational firms". *Academy of Management journal*, 39(1), 179-196.

Tan, Y., Wanke, P., Antunes, J., & Emrouznejad, A. (2021) "Unveiling endogeneity between competition and efficiency in Chinese banks: A two-stage network DEA and regression analysis". *Annals of Operations Research*, 306(1-2), 131-171.

Tandon, D., Tandon, K., & Malhotra, N. (2014) "An evaluation of the technical, pure technical and scale efficiencies in the Indian banking industry using data envelope analysis". *Global Business Review*, 15(3), 545-563.

Tang, R. W., & Buckley, P. J. (2020) "Host country risk and foreign ownership strategy: Meta-analysis and theory on the moderating role of home country institutions". *International Business Review*, 29(4), 101666.

Tang, S., Tang, B., Bragazzi, N. L., Xia, F., Li, T., He, S., ... & Wu, J. (2020) "Stochastic discrete epidemic modeling of COVID-19 transmission in the Province of Shaanxi incorporating public health intervention and case importation". *medRxiv*.

Tatem, A. J., Rogers, D. J., & Hay, S. I. (2006) "Global transport networks and infectious disease spread". *Advances in Parasitology,* 62, 293–343.

Tavassoli, M., Faramarzi, G. R. & Saen, R. F. (2014) "Efficiency and effectiveness in airline performance using a SBM-NDEA model in the presence of shared input", *Journal of Air Transport Management*, 34, pp. 146–153. doi: 10.1016/j.jairtraman.2013.09.001.

Taylor, S. (2020) "Air transport 2035: Four possible post-COVID-19 scenarios for aviation". [WWW document]. APEX | airline passenger experience. https://apex.aero/ 2020/05/04/air-transport-2035-webinar-results.

Taylor, T., Greenlaw, S. A., Dodge, E. R., Gamez, C., Jauregui, A., Keenan, D., ... & Sonenshine, R. (2014) "Principles of microeconomics". OpenStax College, Rice University.

Teece, D. J. (2010) "Business models, business strategy and innovation". *Long range planning*, 43(2-3), 172-194.

Teece, D., Pisano, G., & Shuen, A., (1997) "Dynamic capabilities and strategic management". *Strategic Management Journal* 18(7), pp. 509–533.

Thams, A., Zech, N., Rempel, D., & Ayia-Koi, A. (2020) “An initial assessment of economic impacts and operational challenges for the tourism and hospitality industry due to COVID-19 (No. 2/2020)”. *IUBH Discussion Papers-Tourismus and Hospitality*, 17, 7366.

The Economist Intelligence Unit. (2019) “Middle East and Africa economy: Turbulent times ahead for Gulf aviation sector”, Demanding More - *The Economist Intelligence Unit* (EIU) .

Thomas, J., & Catling, B. (2014) “Reaching new heights together: How airlines can maximize the value of joint ventures”. *LEK Executive Insights*, 16(4), 1-5.

Thomas, N. (2012) “UK visa system attacked as tourists stay away during Olympics”. *The Telegraph*, *11*.

Thompson, P. W., & Thompson, A. G. (1994) “Talking about rates conceptually, Part I: A teacher's struggle”. *Journal for research in mathematics education*, 25(3), 279-303.

Tian, H., Sun, Z., Faria, N. R., Yang, J., Cazelles, B., Huang, S., Xu, B., Yang, Q., Pybus, O. G., & Xu, B. (2017) “Increasing airline travel may facilitate co-circulation of multiple dengue virus serotypes in Asia”. *Tropical Disease*, 11, 1–15.

Timothy, D. J. (2002) “Tourism and political boundaries”, (Vol. 8). *Routledge*.

Timothy, D. J., & Teye, V. B. (2004) “Political boundaries and regional cooperation in tourism”. *A companion to tourism*, 584.

Tinbergen, J. (1962) “Shaping the World Economy: Suggestions for an International Economic Policy” (*New York: Twentieth Century Fund*).

Tirado, J. S., & Mavlutova, I. (2023) “The Impact of Strategic Management Accounting on The Financial Performance of Low-Cost Airlines”. *Wseas Transactions on Environment and Development*, 19, 786-797.

Tobin, J. (1958) “Estimation of relationships for limited dependent variables”. *Econometrica: Journal of the Econometric Society*, 24-36.

Tolcha, T. D., Njoya, E. T., Bråthen, S., & Holmgren, J. (2021) "Effects of African aviation liberalisation on economic freedom, air connectivity and related economic consequences". *Transport Policy*, 110, 204-214.

Tolkin, J. (2010) "Airline Bankruptcy: The Determining Factors Leading to an Airline's Decline".

Tone, K. (2004) "Malmquist Productivity Index Efficiency Change over Time". *In Handbook on Data Envelopment Analysis. International Series in Operations Research & Management Science (Vol. 71, pp. 203–227). Springer, Boston, MA.*

Tone, K., & Tsutsui, M. (2010) "Dynamic DEA: A Slacks-Based Measure Approach". *Omega*, 38(3-4), 145-156.

Tone, K., & Tsutsui, M. (2014) "Dynamic DEA with Network Structure: A Slacks-Based Measure Approach". *Omega*, 42(1), 124-131.

Tortosa-Ausina, E., Armero, C., Conesa, D., & Grifell-Tatjé, E. (2012) "Bootstrapping profit change: An application to Spanish banks". *Computers & operations research*, 39(8), 1857-1871.

Tortosa-Ausina, E., Grifell-Tatjé, E., Armero, C., & Conesa, D. (2008) "Sensitivity Analysis of Efficiency and Malmquist Productivity Indices: An Application to Spanish Savings Banks". *European Journal of Operational Research*, 184(3), 1062-1084.

Tran, D. V. (2019) "A study on the impact of economic freedom on economic growth in ASEAN countries". *Business and Economic Horizons*, 15(3), 423-449.

Tranfield, D., Denyer, D., & Smart, P. (2003) "Towards a methodology for developing evidence-informed management knowledge by means of systematic review". *British journal of management*, 14(3), 207-222.

Tsui, W. H. K., & Fung, M. K. Y. (2016) "Causality between business travel and trade volumes: Empirical evidence from Hong Kong". *Tourism Management*, 52, 395-404.

TTCI, (2019) "The Travel & Tourism Competitiveness Report 2019" | World Economic Forum (weforum.org) (Accessed date 20.04.2021).

Tuncer, N., & Le, T. (2014) “Effect of air travel on the spread of an avian influenza pandemic to the United States”. *International Journal of Critical Infrastructure Protection*, 7(1), 27–47. https://doi.org/10.1016/j.ijcip.2014.02.001.

UNCTAD, (2007) “Transport Newsletter No. 36”. *Geneva: UNCTAD*.

UNWTO, (2013) “United nations world trade organizations” available at: https://www.unwto.org/archive/global/publication/unwto-annual-report-2013

(Access date 07.01.2019).

UNTWO, (2020) “Impact assessment of the COVID-19 outbreak on international tourism”. Available at https://www.unwto.org/impact-assessment-of-the-covid-19- outbreak-on-international-tourism (Accessed: 16.11.2021).

Urquhart, C. (2013) “Grounded Theory for Qualitative Research: A Practical Guide”. *Sage, Thousand Oaks*

Vaidya, R., Herten-Crabb, A., Spenser, J., Moon, S., & Lillywhite, L. (2020) “Travel restrictions and infectious disease outbreaks”. *Journal of Travel Medicine*, 27(3), 1–10. https://doi.org/10.1093/jtm/taaa050.

Van De Vijver, E., Derudder, B., & Witlox, F. (2014) “Exploring causality in trade and air passenger travel relationships: the case of Asia-Pacific, 1980–2010”. *Journal of Transport Geography*, 34, 142-150.

Vasigh, B., Fleming, K., & Humphreys, B. (2015) “Foundations of airline finance: methodology and practice”. *Routledge.* https://doi.org/10.4324/9781315813769

Vasigh, B., Fleming, K., & Tacker, T. (2018) *“Introduction to air transport economics”: from theory to applications. Routledge.*

Vasileiou, K., Barnett, J., Thorpe, S., & Young, T. (2018) “Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period”. *BMC medical research methodology*, 18(1), 1-18.

Vidar Gudmundsson, S., & Hoon Oum, T. (2002) “Globalized air transport services: policy and economic issues”. *Transportation Research Part E: Logistics and Transportation Review*, 38(3-4), 151-153.

Wacziarg, R., & Welch, K. H. (2008) “Trade liberalization and growth: New evidence”. *The World Bank Economic Review*, 22(2), 187-231.

Wadud, Z. (2015) “Imperfect reversibility of air transport demand: Effects of airfare, fuel prices and price transmission”. *Transportation Research Part A*: Policy and Practice, 72, 16-26.

Walt S.M., (2006) “Taming American Power: The Global Response to US Primacy”. New York: W.W. Norton.

Waltz, K. (1979) “Addison-Wesley Series in Political Science”. *Theory of International Politics*.

Wan, W. P., & Hoskisson, R. E. (2003) “Home country environments, corporate diversification strategies, and firm performance”. *Academy of Management Journal*, 46(1), 27-45.

Wan, W.P. (2005) “Country resource environment, firm capabilities, and corporate diversification strategies”. *Journal of Management Studies*, 42 (2005), pp. 161-182.

Wang, C. N., Tsai, T. T., Hsu, H. P., & Nguyen, L. H. (2019) “Performance evaluation of major Asian airline companies using DEA window model and grey theory”. *Sustainability*, 11(9), 2701.

Wang, K., Zhang, A., & Zhang, Y. (2018) “Key determinants of airline pricing and air travel demand in China and India: Policy, ownership, and LCC competition”. *Transport Policy*, 63, 80-89.

Wang, L., Zhou, Z., Yang, Y., & Wu, J. (2020) “Green efficiency evaluation and improvement of Chinese ports: A cross-efficiency model”. *Transportation Research Part D*: Transport and Environment, 88, 102590.

Wang, S., & Gao, Y. (2021) “A literature review and citation analyses of air travel demand studies published between 2010 and 2020”. *Journal of Air Transport Management*, 97, 102135.

Wang, W. K., Lu, W. M., & Tsai, C. J. (2011) “The relationship between airline performance and corporate governance amongst US Listed companies”. *Journal of Air Transport Management*, 17(2), 148-152.

Wanke, P., Azad, M. A. K., Barros, C. P., & Hassan, M. K. (2016) “Predicting efficiency in Islamic banks: An integrated multicriteria decision making (MCDM) approach”. *Journal of International Financial Markets, Institutions and Money*, 45, 126-141.

Wanke, P., Barros, C. P., & Faria, J. R. (2015) “Financial Distress Drivers in Brazilian Banks: A Dynamic Slacks Approach”. *European Journal of Operational Research*, 240(1), 258-268.

Wanke, P., Barros, C. P., & Nwaogbe, O. R. (2016) “Assessing productive efficiency in Nigerian airports using Fuzzy-DEA”. *Transport Policy*, 49, 9-19.

Warnock-Smith, D., & O’Connell, J. F. (2011) “The impact of air policy on incoming tourist traffic: the contrasting cases of the Caribbean Community and the Middle-East”. *Journal of Transport Geography*, 19(2), 265-274.

Weede, E., & Kämpf, S. (2002) “The impact of intelligence and institutional improvements on economic growth”. *Kyklos*, 55(3), 361-380.

Weeks, D. K., Kishtainy, N., Abbot, G., Farndon, J., Kennedy, F., Meadway, J., & Christopher Wallace, M. (2021) “660 The Economics Book (Big Ideas Simply Explained)”.

Wen, Z., Gu, H., & Kavanaugh, R. (2005) “The impacts of SARS on the consumer behaviour of Chinese domestic tourists”. *Current Issues in Tourism*, 8(1), 22–38.

Wernerfelt, B. (1984) “A resource-based view of the firm”. *Strategic management journal*, 5(2), 171-180.

Wilder-Smith, A., Paton, N. I., & Goh, K. T. (2003) “Low risk of transmission of severe acute respiratory syndrome on airplanes: The Singapore experience”. *Tropical Medicine and International Health,* 8(11), 1035–1037.

Williams. G. (2002) “Airline Competition: Deregulation’s Mixed Legacy”. *Ashgate, Aldershot*, England, 2002.

Williamson, C. R., & Mathers, R. L. (2011) “Economic freedom, culture, and growth”. *Public Choice*, 148(3-4), 313-335.

Williamson, O. (1985) “The Economic Institutions of Capitalism”. *New York: Free Press*

Williamson, O. E. (1981) "The economics of organization: the transaction cost approach". *American journal of sociology*, 548-577.

Williamson, O. E. (2000) "The new institutional economics: Taking stock, looking ahead". *Journal of Economic Literature*, 38(3): 595–613.

Wilson, P. W. (2008) "FEAR: A software package for frontier efficiency analysis with R". *Socio-economic planning sciences*, 42(4), 247-254.

Wilson, P. W. (2010) "FEAR 1.15 user's guide". *South Carolina: Clemson University*.

Wilson, P. W. (2013) "Package ' FEAR ', Frontier Efficiency Analysis with R".

Wiltshire, J., & Jaimurzina, A. (2017) "Air transport as a driver of sustainable development in Latin America and the Caribbean": *challenges and policy proposals*.

Winchester, N., McConnachie, D., Wollersheim, C., & Waitz, I. A. (2013) "Economic and emissions impacts of renewable fuel goals for aviation in the US". *Transportation Research Part A*: *Policy and Practice*, 58, 116-128.

Winters, L. A., & Masters, A. (2013) "Openness and growth: still an open question?". *Journal of International Development*, 25(8), 1061-1070.

Wittmer, A., Bieger, T., & Müller, R. (Eds.) (2011) *"*Aviation systems: management of the integrated aviation value chain (p. 236)". *Heidelberg: Springer*.

WNS, (2018) "Top Trends for the Global Airline Industry". Available at: https://www.wns.com/insights/articles/articledetail/579/top-trends-for-the-global-airline-industry.(Accessed date 30.06.2021).

Wong, I. A., & Yang, F. X. (2020) "A quarantined lodging stay: The buffering effect of service quality". *International Journal of Hospitality Management*, 91, 102655. https://doi.org/10.1016/j.ijhm.2020.102655

Wooldridge, J. M. (2015) "Introductory econometrics: A modern approach". *Cengage learning*.

World Bank, (2008) "The World Bank World Development Indicators", Online, 2008. Available at www.worldbank.org/data/wdi/home.html.

World Bank, (2011) "The Air Connectivity Index: Measuring Integration in the Global Air Transport Network". Available at: The air connectivity index: measuring integration in the global air transport network (worldbank.org). (Accessed date 16.04.2021).

Worthington, A. C. (1999) "Malmquist Indices of Productivity Change in Australian Financial Services". *Journal of International Financial Markets, Institutions and Money*, 9(3), 303–320. https://doi.org/10.1504/GBER.2009.025380

WTTC, (2020) World Travel & Tourism Council "*Available at: World Travel & Tourism Council (WTTC)" | Travel & Tourism Representative Council* . (Accessed date 12.07.2021).

Wu, W. W., Lan, L. W., & Lee, Y. T. (2012) "Critiquing the World Economic Forum's concept of destination competitiveness": A further analysis. *Tourism Management Perspectives*, 4, 198-206.

Wu, W. Y., & Liao, Y. K. (2014) "A balanced scorecard envelopment approach to assess airlines' performance". *Industrial Management and Data Systems*, 114(1), 123–143. https://doi.org/10.1108/IMDS-03-2013-0135

Wu, W., & Davis, O. A. (1999) "The two freedoms, economic growth and development: An empirical study". *Public choice*, 100(1), 39-64.

Xu, Y., Park, Y. S., Park, J. D., & Cho, W. (2021) "Evaluating the environmental efficiency of the US airline industry using a directional distance function DEA approach". *Journal of Management Analytics*, 8(1), 1-18.

Yamakawa, Y., Peng, M. W., & Deeds, D. L. (2008) "What drives new ventures to internationalize from emerging to developed economies?". *Entrepreneurship theory and practice*, 32(1), 59-82.

Yang, C. & Wang, T. P. (2016) "Productivity comparison of European airlines: bootstrapping Malmquist indices", *Applied Economics*, 48(52), pp. 5106–5116. doi:

10.1080/00036846.2016.1170937.

Yang, Y., Zhang, H., & Chen, X. (2020) “Coronavirus pandemic and tourism: Dynamic stochastic general equilibrium modeling of infectious disease outbreak”. *Annals of Tourism Research*, 83, Article 102913.

Yang, Z. (2006) “A two-stage DEA model to evaluate the overall performance of Canadian life and health insurance companies”, *Mathematical and Computer Modelling*, 43(7–8), pp. 910–919. doi: 10.1016/j.mcm.2005.12.011.

Yaşar M., Paul C.J.M.& Ward M.R. (2011) “Property rights institutions and firm performance: A cross-country analysis”. *World Development*, vol. 39, no. 4, pp. 648–661.

Yasar, M., Lisner, D., & Rejesus, R. M. (2012) “Bilateral trade impacts of temporary foreign visitor policy”. *Review of world economics*, 148(3), 501-521.

Yu, C. (2016) “Airline productivity and efficiency: concept, measurement, and applications. In Airline Efficiency*”. Emerald Group Publishing Limited*.

Yu, H., Zhang, Y., Zhang, A., Wang, K., & Cui, Q. (2019) “A comparative study of airline efficiency in China and India: a dynamic network DEA approach”. *Research in Transportation Economics,* 76, 100746.

Yu, M. M., & Chen, L. H. (2017) “DEA In the Transport Sector. Advances In DEA Theory and Applications: With Extensions to Forecasting Models”, 192.

Yu, M. M., Chang, Y. C., & Chen, L. H. (2016) “Measurement of airlines’ capacity utilization and cost gap: Evidence from low-cost carriers”*. Journal of Air Transport Management*, 53, 186-198.

Yuen, A. C. L., Zhang, A., & Cheung, W. (2013) “Foreign Participation and Competition: A Way to Improve the Container Port Efficiency in China?”. *Transportation Research Part A: Policy and Practice*, 49, 220-231.

Yun, X., & Yoon, S. M. (2019) “Impact of oil price change on airline’s stock price and volatility: Evidence from China and South Korea”. *Energy Economics*, 78, 668-679.

Zervopoulos, P. D., Triantis, K., Sklavos, S., & Kanas, A. (2023) "An alternative Bayesian data envelopment analysis approach for correcting bias of efficiency estimators". *Journal of the Operational Research Society*, 74(4), 1021-1041.

Zhang, J., Fang, H., Wang, H., Jia, M., Wu, J., & Fang, S. (2017) "Energy efficiency of airlines and its influencing factors: A comparison between China and the United States". *Resources, Conservation and Recycling*, 125, 1-8.

Zhang, K. E., Hou, Y., & Li, G. (2020) "Threat of infectious disease during an outbreak: Influence on tourists' emotional responses to disadvantaged price inequality". *Annals of Tourism Research,* 84, Article 102993.

Zhang, L., Yang, H., Wang, K., Bian, L., & Zhang, X. (2021) "The impact of COVID-19 on airline passenger travel behaviour: An exploratory analysis on the Chinese aviation market". *Journal of Air Transport Management*, 95, 102084.

Zhang, L., Yang, H., Wang, K., Zhan, Y., & Bian, L. (2020) "Measuring imported case risk of COVID-19 from inbound international flights---A case study on China". *Journal of Air Transport Management*, 89, 101918.

Zhang, M., Li, H., Zhou, M., & Mu, H. (2011) "Decomposition analysis of energy consumption in Chinese transportation sector". *Applied Energy*, 88(6), 2279-2285.

Zhang, N., Jia, W., Wang, P., Dung, C. H., Zhao, P., Leung, K., ... & Li, Y. (2021) "Changes in local travel behaviour before and during the COVID-19 pandemic in Hong Kong". Cities, 112, 103139.

Zhang, X., Zheng, Y., & Wang, S. (2019) "A demand forecasting method based on stochastic frontier analysis and model average: An application in air travel demand forecasting". *Journal of Systems Science and Complexity*, pp. 32, 615–633.

Zhang, Y., Zhang, A., & Wang, J. (2020) "Exploring the roles of high-speed train, air and coach services in the spread of COVID-19 in China". *Transport Policy*, 94, 34-42.

Zhu, C., Wu, J., Liu, M., Wang, L., Li, D., & Kouvelas, A. (2021) “Recovery preparedness of global air transport influenced by COVID-19 pandemic: Policy intervention analysis”. *Transport Policy*, 106, 54-63.

Zhu, H., Ma, X., Sauerwald, S., & Peng, M. W. (2019) “Home country institutions behind cross-border acquisition performance”. *Journal of Management*, 45(4), 1315-1342.

Zhu, J. (2011) “Airlines Performance Via Two-Stage Network DEA Approach”. *Journal of CENTRUM Cathedra: The Business and Economics Research Journal*, 4(2), 260-269.

Zhu, J. (2014) “Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopment Analysis with Spreadsheets (Vol. 213)”. *Springer.*

Zhu, Y., Yang, F., Gong, B., & Zeng, W. (2023) “Assessing the efficiency of innovation entities in China: evidence from a nonhomogeneous data envelopment analysis and Tobit”. *Electronic Commerce Research*, 23(1), 175-205.

Zollenkop, M. (2008) “Changing business models and their impact on product development. In Operations Excellence”. *Palgrave Macmillan, London pp.*9-23*.*

Zott, C., Amit, R., & Massa, L. (2011) “The business model: recent developments and future research”. *Journal of management*, 37(4), 1019-1042.

Zou, B., Elke, M., Hansen, M., & Kafle, N. (2014) “Evaluating air carrier fuel efficiency in the US airline industry”. *Transportation Research Part A*: Policy and Practice, 59, 306-330.

Zou, L., & Chen, X. (2017) “The effect of code-sharing alliances on airline profitability”. *Journal of Air Transport Management*, 58, 50-57.

Zuidberg, J. (2014) “Identifying airline cost economies: an econometric analysis of the factors affecting aircraft operating costs”. *Journal of Air Transport Management*, 40, 86–95.

Appendixes

Appendix 1 DEA-Solver Projection 2011

Model = BCC-I Workbook Name = C:\Users\hamad\Desktop\Japan Correction DEA SOLVER\Japan Corrected data 2011.xlsx

				No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	British Airways Plc	0.9555	20	273	260.843	-4.453	13885	13266.7	-4.453	38761	37034.9	-4.453	0.799	0.799	0	14246	14246	0	117525	117525	0
2	Cathay Pacific	1	1	164	164	0	12083	12083	0	23015	23015	0	0.804	0.804	0	12697	12697	0	105000	105000	0
3	Emirates Airline	1	1	169	169	0	16433	16433	0	42422	42421.8	0	0.8	0.80001	0.001	16925	16925	0	126273	126273	0
4	Etihad Airline	1	1	82	82	0	4750	4750	0	23650	23650	0	0.78	0.78	0	4800	4800	0	74800	74800	0
5	Qatar Airways	1	1	112	112	0	6780.82	6780.82	0	24293	24293	0	0.77	0.77	0	6809	6809	0	92300	92300	0
6	Singapore Airline	1	1	100	100	0	10636.8	10636.8	0	22514	22514	0	0.757	0.757	0	10845.6	10845.6	0	93400	93400	0
7	Ethiopian Airlines	1	1	51	51	0	1195	1195	0	6286	6286	0	0.72	0.72	0	1337	1337	0	16175	16175	0
8	Turkish Airlines	0.8554	29	179	153.117	-14.46	6749	5773.1	-14.46	15737	13461.4	-14.46	0.73	0.81885	12.171	6749	6749	0	58933	58933	0
9	Air Canada	0.8061	34	331	199.342	-39.776	8689	7004.6	-19.385	23700	19105.7	-19.385	0.82	0.82	0	8825	8825	0	54223	65817.8	21.384
10	Thai Airways	0.8955	25	89	79.6997	-10.45	6674	5976.58	-10.45	25848	17056.9	-34.011	0.7	0.73392	4.846	6413	6413	0	55267	55267	0
11	KLM	1	1	204	204	0	7602	7602	0	37169	37169	0	0.84	0.84	0	11130	11130	0	63823	63823	0
12	RyanAir	1	1	272	272	0	3891	3891	0	7032	7032	0	0.83	0.83	0	4536	4536	0	72062	72062	0
13	EasyJet	1	1	197	197	0	3938	3938	0	8288	8288	0	0.87	0.87	0	4556	4556	0	61347	61347	0
14	Delta Airlines	1	1	550	550	0	33140	33140	0	78392	78391.9	0	0.82	0.82001	0.001	35115	35115	0	192767	192767	0
15	Qantas	0.94	21	283	266.025	-5.998	12397	11653.4	-5.998	33169	31179.4	-5.998	0.8	0.80358	0.448	12957	12957	0	106759	106759	0
16	South Africa Airways	0.9106	22	61	55.5478	-8.938	1879	1711.05	-8.938	10057	9158.09	-8.938	0.7	0.73646	5.209	1966	1966	0	22661	22661	0
17	SAS Airline	0.853	30	147	125.394	-14.698	5300	4521.02	-14.698	13479	11497.9	-14.698	0.75	0.78606	4.808	5500	5500	0	30668	41321.9	34.74
18	Lufthansa	1	1	636	635.998	0	38030	38029.9	0	116400	116397	-0.002	0.78	0.78001	0.002	38996	38996	0	202670	202671	0.001
19	United Airways	1	1	1253	1252.96	-0.003	35288	35288	0	88000	87999.9	0	0.82	0.82001	0.001	37110	37110	0	207531	207531	0
20	Alitalia	0.8299	33	152	126.139	-17.014	4837	4014.05	-17.014	12600	10456.3	-17.014	0.73	0.78704	7.813	4877	4877	0	32600	39823.6	22.158
21	Finair	0.8313	32	65	54.0334	-16.872	3096	2573.65	-16.872	7467	6207.19	-16.872	0.73	0.74909	2.615	2821	2821	0	22000	22000	0
22	Aer lingus	1	1	43	43	0	1548	1548	0	3491	3491	0	0.76	0.76	0	1610	1610	0	14051	14051	0
23	Jet Blue	0.8839	27	169	149.384	-11.607	4182	3696.6	-11.607	11532	10193.5	-11.607	0.82	0.82	0	4504	4504	0	30698	42956.5	39.933
24	West Jet Airlines	0.9633	19	98	58.0772	-40.738	2138	2059.62	-3.666	7141	6879.2	-3.666	0.83	0.83	0	2333	2333	0	16890	16890	0
25	LATAM Airlines	1	1	150	150	0	4078	4078	0	51606	51606	0	0.76	0.76	0	5585	5585	0	98700	98700	0
26	Korea Air	1	1	140	140	0	10206	10206	0	15623	15623	0	0.77	0.77	0	11805	11805	0	65000	65000	0
27	Southwest	0.8708	28	698	310.834	-55.468	14965	13030.9	-12.924	45392	39525.5	-12.924	0.81	0.82829	2.258	15658	15658	0	97582	97582	0
28	China Easternairways	0.8422	31	377	317.526	-15.776	11893	10016.8	-15.776	66200	51150.3	-22.734	0.79	0.8	1.266	12360	12360	0	100895	100895	0
29	Japan Airlines	0.8999	24	216	194.384	-10.007	8499	7648.48	-10.007	30087	27076.1	-10.007	0.7	0.81966	17.094	10240	10240	0	52578	64384.3	22.455
30	Iberia	0.8876	26	84	74.5601	-11.238	6345	5631.95	-11.238	19811	11097.1	-43.985	0.8	0.8	0	6051	6051	0	4870	41821.9	75.8766
31	Alaska	0.9095	23	165	138.247	-16.214	3869	3518.9	-9.049	11840	10768.6	-9.049	0.85	0.85	0	4318	4318	0	25032	41491.9	65.756
32	Hawaiian Airlines	1	1	37	37	0	1630	1630	0	4314	4314	0	0.84	0.84	0	1650	1650	0	10139	10139	0
33	Kenya Air	1	1	31	31	0	1004	1004	0	4355	4355	0	0.69	0.69	0	1077	1077	0	8896	8896	0
34	Air China	1	1	432	431.999	0	15204	15204	0	24474	24474	0	0.81	0.81001	0.001	16237	16237	0	123488	123488	0
35	Aerofiot	0.7804	35	236	130.202	-44.83	4989	3893.51	-21.958	28400	22163.9	-21.958	0.77	0.77311	0.404	5377	5377	0	46077	46077	0

			No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
Average	0.9404	13.6286	235.6	209.038	-9.6726	9366.39	8955.1	-5.9569	28072.7	26152.4	-7.7646	0.7814	0.7936	1.6839	9943.3	9943.3	0	71533.7	74589.4	27.5769
Max	1	35	1253	1252.96	0	38030	38029.9	0	116400	116397	0	0.87	0.87	17.094	38996	38996	0	207531	207531	758.766
Min	0.7804	1	31	31	-55.468	1004	1004	-21.958	3491	3491	-43.985	0.69	0.69	0	1077	1077	0	4870	8896	0
St Dev	0.0714	13.6319	240.699	228.208	14.5225	9205.73	9252.07	7.1383	25659	25390.2	10.8306	0.0474	0.0393	3.7954	9589.8	9589.8	0	53973.3	51792.8	128.072

Appendix 2 DEA-Solver Projection 2012

Model = BCC-I   Workbook Name = C:\Users\hamad\Desktop\Japan Correction DEA SOLVER\Japan Corrected data 2012.xlsx

				No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	British Air	0.9869	21	278	274.347	-1.314	14171	13984.8	-1.314	38592	34659.5	-10.19	0.813	0.813	0	15027	15027	0	117348	117348	0
2	Cathay P	1	1	176	176	0	12706	12706	0	23844	23844	0	0.801	0.801	0	12822	12822	0	110000	110000	0
3	Emirates .	1	1	197	197	0	19096	19096	0	47678	47678	0	0.797	0.797	0	19867	19867	0	146134	146134	0
4	Etihad Air	1	1	86	86	0	6000	6000	0	24100	24100	0	0.78	0.78	0	6100	6100	0	76900	76900	0
5	Qatar Air	1	1	120	120	0	6813	6813	0	32000	32000	0	0.75	0.75	0	7612	7612	0	94300	94300	0
6	Singapore	1	1	101	101	0	10854.4	10854.4	0	23189	23189	0	0.736	0.736	0	11021.5	11021.5	0	93765	93765	0
7	Ethiopian	1	1	48	48	0	1599	1599	0	6559	6559	0	0.72	0.72	0	1826	1826	0	18424	18424	0
8	Turkish A	0.9412	26	200	188.243	-5.878	8585	8080.33	-5.878	15857	14924.9	-5.878	0.77	0.7943	3.155	8585	8585	0	74410	74410	0
9	Air Canad	0.9204	30	351	263.312	-24.982	8870	8164.23	-7.957	24000	22090.4	-7.957	0.83	0.83	0	9206	9206	0	55646	82878.6	48.939
10	Thai Airw	0.9787	22	95	92.9764	-2.13	6812	6666.9	-2.13	25412	18141.5	-28.61	0.77	0.77	0	7152	7152	0	60679	60679	0
11	KLM	1	1	203	203	0	10706	10706	0	35787	35786.9	0	0.86	0.86	0	11841	11841	0	86281	86281	0
12	RyanAir	1	1	294	294	0	4633	4633	0	8063	8063	0	0.82	0.82	0	5487	5487	0	75814	75814	0
13	Easy Jet	1	1	214	214	0	4668	4668	0	8446	8446	0	0.89	0.89	0	5087	5087	0	65227	65227	0
14	Delta Airli	1	1	568	568	0	34495	34495	0	73561	73561	0	0.84	0.84001	0.001	36670	36670	0	192974	192974	0
15	Qantas	0.9341	27	308	287.7	-6.591	13449	12562.6	-6.591	33584	31370.5	-6.591	0.8	0.8	0	13679	13679	0	111692	111692	0
16	South Afri	0.8843	33	59	52.1725	-11.572	2190	1936.57	-11.572	11044	8121.74	-26.46	0.72	0.72268	0.372	2079	2187.52	5.22	23217	23217	0
17	SAS Airlir	0.8534	34	145	123.742	-14.661	5080	4335.23	-14.661	13591	11598.4	-14.661	0.77	0.77	0	4972	4972	0	33451	37653.2	12.562
18	Lufthansa	1	1	627	626.999	0	39652	39652	0	117000	116999	-0.001	0.79	0.79001	0.001	41291	41291	0	205015	205016	0
19	United Air	1	1	1253	1252.94	-0.005	37113	37112.8	0	84600	84599.3	-0.001	0.83	0.83001	0.001	37152	37152	0	205485	205485	0
20	Alitalia	0.819	35	124	101.56	-18.097	4693	3843.71	-18.097	13273	10871	-18.097	0.75	0.75	0	4401	4401	0	32200	33235.4	3.216
21	Finair	0.9295	29	60	55.7708	-7.049	3105	2886.14	-7.049	6784	6305.82	-7.049	0.78	0.78	0	3061	3061	0	24000	24000	0
22	Aer lingus	1	1	44	44	0	1655	1655	0	3566	3566	0	0.78	0.78	0	1741	1741	0	14523	14523	0
23	Jet Blue	0.9526	23	180	171.472	-4.738	4606	4387.77	-4.738	12035	11464.8	-4.738	0.84	0.84	0	4982	4982	0	33563	35007	4.302
24	West Jet.	1	1	100	99.9993	-0.001	2318	2317.99	0	7742	7741.98	0	0.82	0.82	0	2604	2604	0	18262	18263	0.005
25	LATAM A	0.9136	31	327	298.737	-8.643	13130	11995.2	-8.643	53599	30886.6	-42.375	0.79	0.79	0	13222	13222	0	105000	105000	0
26	Korea Air	1	1	146	146	0	10434	10434	0	20508	20508	0	0.76	0.76	0	11695	11695	0	69000	69000	0
27	Southwes	0.9455	24	694	294.302	-57.593	16465	15567.9	-5.448	45861	42467.9	-7.399	0.8	0.8	0	17088	17088	0	102874	102874	0
28	China Ea	0.9328	28	428	396.037	-7.468	12411	11577.5	-6.716	66207	20041.1	-69.73	0.8	0.80022	0.028	12787	12787	0	109112	109112	0
29	Japan Air	1	1	216	216	0	8870	8870	0	30882	30882	0	0.67	0.67	0	10530	10530	0	57545	57545	0
30	Iberia	0.9451	25	84	79.3872	-5.491	6742	5824.59	-13.607	19811	16092.7	-18.769	0.81	0.81	0	6051	6051	0	49614	49614	0
31	Alaska	1	1	172	171.999	0	4125	4124.99	0	11955	11954.7	-0.002	0.86	0.86	0	4657	4657	0	27007	27009.5	0.009
32	Hawaiian	1	1	45	45	0	1832	1832	0	4906	4906	0	0.83	0.83	0	1962	1962	0	12195	12195	0
33	Kenya Air	1	1	34	34	0	1203	1203	0	4834	4834	0	0.72	0.72	0	1218	1218	0	9943	9943	0
34	Air China	1	1	461	461	0	15283	15283	0	25269	25269	0	0.8	0.8	0	16638	16638	0	129773	129773	0
35	Aeroflot	0.9113	32	233	212.333	-8.87	7780	7089.91	-8.87	28800	23328.7	-18.998	0.78	0.78	0	8138	8138	0	74617	74617	0

			No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
Average	0.9671	12.5714	247.743	228.487	-5.2881	10347	10084.5	-3.522	28655.4	25824.3	-8.2145	0.7908	0.7915	0.1017	10807.2	10810.3	0.1491	77599.7	78568.8	1.9724
Max	1	35	1253	1252.94	0	39652	39652	0	117000	116999	0	0.89	0.89	3.155	41291	41291	5.22	205485	205485	48.939
Min	0.819	1	34	34	-57.593	1203	1203	-18.097	3566	3566	-69.73	0.67	0.67	0	1218	1218	0	9943	9943	0
St Dev	0.0478	13.857	242.151	228.649	10.893	9545.15	9574.94	5.0736	25195.4	24054.6	14.7952	0.0456	0.0453	0.535	9877.1	9874.29	0.8823	53277.6	52984.7	8.481

Appendix 3 DEA-Solver Projection 2013

Model = BCC-I   Workbook Name = C:\Users\hamad\Desktop\Japan Correction DEA SOLVER\Japan Corrected data 2013.xlsx

				No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	British Air	1	1	279	279	0	14136	14136	0	39868	39868	0	0.81	0.81001	0.001	15419	15419	0	126436	126436	0
2	Cathay P:	1	1	181	181	0	12612	12612	0	24572	24572	0	0.822	0.822	0	12965	12965	0	110600	110600	0
3	Emirates .	1	1	217	217	0	21297	21297	0	52516	52516	0	0.794	0.794	0	22455	22455	0	160446	160446	0
4	Etihad Air	1	1	95	95	0	7500	7500	0	24206	24206	0	0.77	0.77	0	7600	7600	0	79400	79400	0
5	Qatar Air	1	1	134	134	0	8369	8369	0	34650	34650	0	0.74	0.74	0	8394	8394	0	105000	105000	0
6	Singapore	1	1	102	102	0	10912	10912	0	23716	23716	0	0.696	0.696	0	11128.1	11128.1	0	95064	95064	0
7	Ethiopian	1	1	58	58	0	1929	1929	0	7000	7000	0	0.72	0.72	0	2079	2079	0	24726	24726	0
8	Turkish A	0.9358	27	233	218.036	-6.422	9826	9194.94	-6.422	18882	17669.3	-6.422	0.79	0.79777	0.984	9826	9826	0	91997	91997	0
9	Air Canad	0.9196	31	352	231.137	-34.336	8939	8219.95	-8.044	24500	22529.2	-8.044	0.83	0.83	0	9410	9410	0	56791	56791	0
10	Thai Airw	0.8935	33	100	89.3531	-10.647	7409	6620.17	-10.647	25323	18223.8	-28.035	0.74	0.74	0	6854	6854	0	63479	63479	0
11	KLM	1	1	206	206	0	10723	10723	0	35662	35662	0	0.86	0.86	0	12110	12110	0	89039	89039	0
12	RyanAir	1	1	305	305	0	5206	5206	0	8438	8438	0	0.82	0.82	0	6105	6105	0	79256	79256	0
13	Easy Jet	1	1	217	217	0	4989	4989	0	8945	8945	0	0.89	0.89	0	5620	5620	0	67573	67573	0
14	Delta Airli	1	1	532	532	0	34373	34373	0	78000	78000	0	0.84	0.84001	0.001	37773	37773	0	194988	194988	0
15	Qantas	0.9277	29	312	289.448	-7.228	13516	12539	-7.228	33265	30860.6	-7.228	0.8	0.82282	2.853	13834	13834	0	110905	110905	0
16	South Afri	1	1	55	54.9999	0	2394	2394	0	11462	11460.2	-0.016	0.74	0.74	0	2357	2357.05	0.002	24880	24880	0
17	SAS Airlir	0.9272	30	139	128.886	-7.276	5578	5172.13	-7.276	14127	13099.1	-7.276	0.75	0.80206	6.941	5834	5834	0	34714	34714	0
18	Lufthansa	1	1	622	621.995	-0.001	39221	39220.7	-0.001	118300	118296	-0.004	0.8	0.80001	0.002	40285	40285	0	209652	209652	0
19	United Air	1	1	1265	1264.91	-0.007	37030	37029.8	-0.001	84200	84199.4	-0.001	0.84	0.84001	0.001	38279	38279	0	205167	205167	0
20	Alitalia	0.8534	34	129	110.086	-14.662	4445	3793.26	-14.662	11241	9592.82	-14.662	0.75	0.77513	3.351	4256	4256	0	32000	32000	0
21	Finair	1	1	70	69.9992	-0.001	3008	3007.89	-0.004	5859	5858.93	-0.001	0.8	0.8	0	3000	3000	0	25000	25000	0
22	Aer lingus	1	1	47	47	0	1703	1703	0	3615	3615	0	0.78	0.78	0	1781	1781	0	14807	14807	0
23	Jet Blue	0.9314	28	194	180.682	-6.865	5013	4668.87	-6.865	12447	11592.5	-6.865	0.84	0.84	0	5441	5441	0	35835	36373	1.501
24	West Jet.	1	1	113	113	0	2479	2479	0	8000	8000	0	0.81	0.81	0	2783	2783	0	19591	19591	0
25	LATAM A	0.9359	26	339	317.281	-6.407	12622	11813.4	-6.407	52997	28104.6	-46.97	0.81	0.83277	2.811	13266	13266	0	103000	103000	0
26	Korea Air	1	1	143	143	0	10190	10190	0	20433	20433	0	0.75	0.75	0	11227	11227	0	68000	68000	0
27	Southwes	0.9645	24	681	299.209	-56.063	16421	15837.6	-3.553	44381	42634.9	-3.934	0.8	0.8	0	17699	17699	0	104348	104348	0
28	China Ea	0.919	32	478	381.734	-20.139	13409	12322.2	-8.105	68874	25184.8	-63.434	0.79	0.81272	2.876	13236	13236	0	120461	120461	0
29	Japan Air	1	1	218	218	0	9711	9711	0	31472	31472	0	0.71	0.71	0	11129	11129	0	59135	59135	0
30	Iberia	0.8368	35	95	79.5	-16.316	5945	4975.03	-16.316	18738	12222.5	-34.772	0.76	0.76	0	5293	5293	0	41499	41499	0
31	Alaska	1	1	190	190	0	4318	4318	0	12163	12163	0	0.86	0.86	0	5156	5156	0	28833	28833	0
32	Hawaiian	1	1	50	50	0	2022	2022	0	5249	5249	0	0.82	0.82	0	2155	2155	0	13658	13658	0
33	Kenya Air	1	1	43	43	0	1268	1268	0	4006	4006	0	0.69	0.69	0	1160	1160	0	9579	9579	0
34	Air China	1	1	497	497	0	15520	15520	0	25830	25830	0	0.81	0.81	0	16199	16199	0	141967	141967	0
35	Aeroflot	0.9535	25	239	227.876	-4.654	8747	8339.89	-4.654	30500	25416.2	-16.668	0.78	0.83011	6.425	9387	9387	0	85300	85300	0

			No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
Average	0.9714	10.7714	255.143	234.061	-5.4578	10650.9	10411.6	-2.8624	29241.1	26436.7	-6.9809	0.7889	0.7947	0.7499	11185.6	11185.6	0.0001	80946.5	80961.8	0.0429
Max	1	35	1265	1264.91	0	39221	39220.7	0	118300	118296	0	0.89	0.89	6.941	40285	40285	0.002	209652	209652	1.501
Min	0.8368	1	43	43	-56.063	1268	1268	-16.316	3615	3615	-63.434	0.69	0.69	0	1160	1160	0	9579	9579	0
St Dev	0.0456	13.8778	241.532	227.521	11.5502	9466.54	9494.95	4.5602	25732	24571	14.6388	0.0478	0.0481	1.7681	9961.6	9961.6	0.0003	54831.7	54818.7	0.2537

Appendix 4 DEA-Solver Projection 2014

Model = BCC-I Workbook Name = C:\Users\hamed\Desktop\Japan Correction DEA SOLVER\Japan Corrected data 2014.xlsx

				No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	British Air	1	1	284	284	0	13248	13248	0	40712	40712	0	0.815	0.815	0	14911	14911	0	131333	131333	0
2	Cathay P:	1	1	188	188	0	13253	13253	0	25755	25755	0	0.833	0.833	0	13676	13676	0	115000	115000	0
3	Emirates .	1	1	231	231	0	22534	22534	0	56725	56725	0	0.796	0.796	0	24135	24135	0	215353	215353	0
4	Etihad Air	0.9485	25	121	114.773	-5.146	9000	8536.84	-5.146	26566	22169.5	-16.549	0.79	0.79	0	9020	9098.7	0.873	82400	82400	0
5	Qatar Air	1	1	159	159	0	9064	9064	0	39369	39369	0	0.74	0.74	0	9366	9366	0	104300	104300	0
6	Singapore	1	1	105	105	0	11063.9	11063.9	0	23963	23963	0	0.785	0.785	0	11363.2	11363.2	0	94209	94209	0
7	Ethiopian	1	1	66	66	0	2314	2314	0	8764	8764	0	0.71	0.71	0	2515	2515	0	28700	28700	0
8	Turkish A	0.9894	23	261	258.241	-1.057	11070	10338.6	-6.607	19902	19691.6	-1.057	0.79	0.86517	9.515	11070	11070	0	106787	106787	0
9	Air Canad	0.9207	27	364	313.792	-13.793	9467	8716.58	-7.927	24400	22465.9	-7.927	0.83	0.83	0	10086	10086	0	61616	62770.7	1.874
10	Thai Airw	0.8586	33	102	87.5729	-14.144	7280	6250.3	-14.144	24952	16807.9	-32.639	0.7	0.79423	13.461	6728	6728	0	57194	57194	0
11	KLM	1	1	202	202	0	10786	10786	0	35685	35683.2	-0.005	0.86	0.86	0	12053	12053	0	91477	91477	0
12	RyanAir	1	1	297	297	0	5472	5472	0	9050	9050	0	0.83	0.83	0	6296	6296	0	81668	81668	0
13	Easy Jet	1	1	226	226	0	5208	5208	0	8987	8987	0	0.91	0.91	0	5975	5975	0	72933	72933	0
14	Delta Airli	1	1	499	499	0	38156	38156	0	80000	80000	0	0.85	0.85001	0.001	40362	40362	0	202925	202925	0
15	Qantas	0.8722	31	308	249.841	-18.883	13739	11983.5	-12.778	30751	26821.7	-12.778	0.77	0.78869	2.427	13335	13335	0	109659	109659	0
16	South Afri	1	1	45	45	0	2665	2665	0	11491	11491	0	0.75	0.75	0	2636	2636	0	25606	25606	0
17	SAS Airlir	0.8713	32	138	120.233	-12.875	5683	4951.32	-12.875	12329	10741.7	-12.875	0.77	0.81712	6.119	5700	5700	0	33781	38364.8	13.569
18	Lufthansa	1	1	615	614.996	-0.001	39261	39260.7	-0.001	118800	118792	-0.006	0.8	0.80002	0.002	40220	40220	0	214641	214641	0
19	United Air	1	1	1257	1256.99	-0.001	36528	36528	0	82000	82000	0	0.84	0.84001	0.001	38901	38901	0	205500	205500	0
20	Alitalia	0.8401	34	125	105.007	-15.994	4130	3469.44	-15.994	10088	8474.5	-15.994	0.76	0.81476	7.205	3975	3975	0	31000	31000	0
21	Finair	1	1	67	67	0	2923	2923	0	5172	5172	0	0.8	0.8	0	2855	2855	0	25000	25000	0
22	Aer lingus	1	1	50	50	0	1855	1855	0	3766	3766	0	0.79	0.79	0	1946	1946	0	16088	16088	0
23	Jet Blue	0.9221	28	203	187.18	-7.793	5302	4888.82	-7.793	13280	12245.1	-7.793	0.84	0.84918	1.093	5817	5817	0	37813	39962.2	5.684
24	West Jet.	0.9872	24	122	85.8204	-29.655	2660	2625.86	-1.284	8698	7726.28	-11.172	0.8	0.80222	0.278	3022	3022	0	20828	20828	0
25	LATAM A	0.9183	29	327	292.213	-10.638	11957	10980.3	-8.169	53300	32721.1	-38.61	0.83	0.83	0	12471	12471	0	103000	103000	0
26	Korea Air	1	1	143	143	0	10389	10389	0	20400	20400	0	0.74	0.74	0	11909	11909	0	67500	67500	0
27	Southwes	1	1	665	665	0	16380	16380	0	46278	46278	0	0.82	0.82001	0.001	18605	18605	0	108035	108035	0
28	China Ea	0.9207	27	515	280.866	-45.463	13171	12127.2	-7.925	69849	33233.6	-52.421	0.79	0.81703	3.421	13527	13527	0	127479	127479	0
29	Japan Air	1	1	224	224	0	9902	9902	0	31534	31533.7	-0.001	0.71	0.71001	0.001	11430	11430	0	60103	60103.2	0
30	Iberia	0.8354	35	96	80.2027	-16.456	5821	4863.12	-16.456	17524	12710.3	-27.469	0.76	0.78379	3.13	5333	5333	0	42690	42690	0
31	Alaska	1	1	196	196	0	4406	4406	0	12739	12739	0	0.85	0.85	0	5368	5368	0	30718	30718	0
32	Hawaiian	1	1	51	51	0	2060	2060	0	5380	5380	0	0.82	0.82	0	2314	2314	0	13910	13910	0
33	Kenya Air	1	1	47	47	0	1265	1265	0	3989	3989	0	0.66	0.66	0	1049	1049	0	9308	9308	0
34	Air China	1	1	540	540	0	16772	16772	0	26206	26206	0	0.8	0.8	0	17470	17470	0	154683	154683	0
35	Aeroflot	0.9076	30	261	236.871	-9.245	9951	9031.03	-9.245	32200	24275.1	-24.612	0.78	0.8418	7.923	10290	10290	0	90100	90100	0

			No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
Average	0.9655	11.3714	260	244.846	-5.747	10992.5	10693.4	-3.6098	29731.5	27052.6	-7.4831	0.792	0.8038	1.5594	11592.3	11594.5	0.0249	84952.5	85177.9	0.6036
Max	1	35	1257	1256.99	0	39261	39260.7	0	118800	118792	0	0.91	0.91	13.461	40362	40362	0.873	215353	215353	13.569
Min	0.8354	1	45	45	-45.463	1265	1265	-16.456	3766	3766	-52.421	0.66	0.66	0	1049	1049	0	9308	9308	0
St Dev	0.0544	13.8863	239.415	236.328	10.1699	9721.74	9777.22	5.4503	25968.4	24926	13.0752	0.0509	0.0492	3.2873	10237.1	10236.5	0.1476	59224	59049.8	2.4685

Appendix 5 DEA-Solver Projection 2015

Model = BCC-I Workbook Name = C:\Users\hamad\Desktop\Japan Correction DEA SOLVER\Japan Corrected data 2015.xlsx

				No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	British Air	0.9797	18	293	287.052	-2.03	13027	12762.5	-2.03	40840	32190.7	-21.178	0.812	0.82815	1.989	14997	14997	0	144399	144399	0
2	Cathay P:	1	1	188	188	0	12345	12345	0	26833	26833	0	0.857	0.857	0	13205	13205	0	115340	115340	0
3	Emirates .	1	1	251	251	0	20846	20846	0	61205	61205	0	0.765	0.765	0	23109	23109	0	257000	257000	0
4	Etihad Air	0.8617	33	119	102.539	-13.833	9200	7927.35	-13.833	27000	20526.3	-23.977	0.79	0.80353	1.712	8360	8534.51	2.087	84300	84300	0
5	Qatar Airw	0.9532	20	190	181.102	-4.683	8949	8529.89	-4.683	36549	23003.8	-37.06	0.73	0.81733	11.963	9775	9775	0	105400	105400	0
6	Singapore	1	1	110	110	0	10619.3	10619.3	0	24350	24350	0	0.798	0.798	0	11123.7	11123.7	0	94267	94267	0
7	Ethiopian	1	1	76	76	0	2408	2408	0	10514	10514	0	0.69	0.69	0	2671	2671	0	31000	31000	0
8	Turkish A	0.9232	27	299	276.042	-7.678	10522	9163.84	-12.908	22030	20338.5	-7.678	0.78	0.85747	9.932	10522	10522	0	119372	119372	0
9	Air Canad	0.8911	30	370	266.579	-27.952	9402	8377.68	-10.895	24900	22187.2	-10.895	0.83	0.84916	2.309	10539	10539	0	67545	68073.3	0.782
10	Thai Airw	0.871	32	95	82.742	-12.903	6821	5940.88	-12.903	22864	14870.8	-34.96	0.73	0.80914	10.841	6355	6355	0	60893	60893	0
11	KLM	1	1	199	198.997	-0.001	10800	10799.9	-0.001	35488	35483.6	-0.012	0.87	0.87	0	12381	12381	0	91477	91477	0
12	RyanAir	1	1	308	308	0	5763	5763	0	9586	9586	0	0.88	0.88	0	7067	7067	0	90600	90600	0
13	Easy Jet	1	1	241	241	0	5280	5280	0	9811	9811	0	0.91	0.91	0	6185	6185	0	77619	77619	0
14	Delta Airli	1	1	482	482	0	32902	32902	0	83000	83000	0	0.85	0.85	0	40704	40704	0	209625	209625	0
15	Qantas	0.9181	28	299	274.524	-8.186	12687	11648.5	-8.186	28622	26279	-8.186	0.79	0.8496	7.545	13759	13759	0	112543	112543	0
16	South Afri	0.9383	23	55	51.6061	-6.171	2831	2656.31	-6.171	11476	5839.88	-49.112	0.73	0.81823	12.086	2618	2771.78	5.874	24523	24523	0
17	SAS Airlir	0.9294	24	152	141.266	-7.062	5680	5201.64	-8.422	11288	10490.9	-7.062	0.76	0.84447	11.115	5947	5947	0	36940	48334	30.845
18	Lufthansa	1	1	602	601.989	-0.002	41920	41919.2	-0.002	120700	120696	-0.003	0.85	0.85001	0.001	43863	43863	0	220396	220397	0
19	United Air	0.9417	22	1239	476.252	-61.562	32698	30791.1	-5.832	82100	77312.1	-5.832	0.83	0.8415	1.386	37864	37864	0	208611	208611	0
20	Alitalia	0.8151	35	118	96.1778	-18.493	4130	3366.22	-18.493	12023	8706.68	-27.583	0.76	0.81896	7.758	4140	4140	0	30900	30900	0
21	Finair	1	1	72	72	0	2637	2637	0	4906	4906	0	0.85	0.85	0	2817	2817	0	26700	26700	0
22	Aer lingus	1	1	46	46	0	1992	1992	0	4150	4150	0	0.82	0.82	0	2061	2061	0	17890	17890	0
23	Jet Blue	0.9768	19	215	210.011	-2.321	5200	5079.33	-2.321	14537	14199.7	-2.321	0.85	0.85	0	6416	6416	0	41711	45446.6	8.956
24	West Jet .	0.929	25	140	91.3007	-34.785	2628	2441.31	-7.104	9211	6984.34	-24.174	0.82	0.82628	0.766	3062	3062	0	21525	21525	0
25	LATAM A	0.8728	31	331	288.89	-12.722	9611	8388.28	-12.722	52697	18170.9	-65.518	0.83	0.85193	2.642	10125	10125	0	104000	104000	0
26	Korea Air	1	1	161	161	0	8120	8120	0	20815	20815	0	0.76	0.76	0	9850	9850	0	71600	71600	0
27	Southwes	1	1	704	704	0	15704	15704	0	49583	49583	0	0.84	0.84001	0.001	19820	19820	0	117449	117449	0
28	China Ea	0.9264	26	551	304.939	-44.657	12992	12035.9	-7.359	71033	29601.2	-58.328	0.81	0.84539	4.369	14095	14095	0	146342	146342	0
29	Japan Air	0.9498	21	224	212.758	-5.019	9582	9101.12	-5.019	31986	24071.7	-24.743	0.68	0.83712	23.106	11361	11361	0	64647	64647	0
30	Iberia	0.8419	34	115	96.8224	-15.807	5246	4416.79	-15.807	16564	12142.8	-26.692	0.78	0.80717	3.483	5261	5261	0	43600	43600	0
31	Alaska	1	1	212	212	0	4300	4300	0	13858	13858	0	0.84	0.84	0	5598	5598	0	33578	33578	0
32	Hawaiian	1	1	54	54	0	1868	1868	0	5548	5548	0	0.82	0.82	0	2317	2317	0	14450	14450	0
33	Kenya Air	1	1	52	52	0	1420	1420	0	4002	4002	0	0.63	0.63	0	1015	1015	0	9793	9793	0
34	Air China	1	1	623	623	0	15593	15593	0	27104	27104	0	0.79	0.79	0	18160	18160	0	171713	171713	0
35	Aeroflot	0.917	29	262	240.252	-8.301	11969	10975.5	-8.301	34000	26833.7	-21.077	0.78	0.80123	2.722	13393	13393	0	97600	97600	0

			No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
Average	0.9553	14.1143	269.943	230.338	-8.4048	10505.5	10094.9	-4.6569	30319.2	25862.7	-13.0397	0.7975	0.8222	3.3065	11729.6	11739	0.2275	90438.5	90885.9	1.1595
Max	1	35	1239	704	0	41920	41919.2	0	120700	120696	0	0.91	0.91	23.106	43863	43863	5.874	257000	257000	30.845
Min	0.8151	1	46	46	-61.562	1420	1420	-18.493	4002	4002	-65.518	0.63	0.63	0	1015	1015	0	9793	9793	0
St Dev	0.0545	13.4706	240.566	168.835	14.0942	9197.38	9129.53	5.6308	26403.8	25131.6	18.168	0.0598	0.0509	5.307	10485.8	10480.3	1.0439	64089.2	63751	5.3829

Appendix 6 DEA-Solver Projection 2016

ected data 2016.xlsx

				No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	British Air	0.9979	16	293	292.392	-0.207	13752	13723.5	-0.207	39762	34156.2	-14.098	0.818	0.84264	3.012	16086	16086	0	146561	146561	0
2	Cathay P:	1	1	189	189	0	12035	12035	0	26674	26674	0	0.845	0.845	0	11967	11967	0	120450	120450	0
3	Emirates .	1	1	259	259	0	22452	22452	0	64768	64768	0	0.751	0.751	0	23120	23120	0	276608	276608	0
4	Etihad Air	0.8463	34	115	97.3248	-15.37	7300	6110.04	-16.301	24558	17891.1	-27.148	0.76	0.82222	8.187	6100	6561.93	7.573	85000	85000	0
5	Qatar Air	0.9061	30	215	194.81	-9.391	10217.5	9258.03	-9.391	39369	23139.5	-41.224	0.73	0.81714	11.937	10790	10790	0	107000	107000	0
6	Singapore	0.9397	21	165	155.059	-6.025	10399.4	9427.13	-9.349	25195	23677	-6.025	0.79	0.79445	0.563	10854	10854	0	95760	95760	0
7	Ethiopian	0.9532	20	77	73.3968	-4.679	2543	2424	-4.679	10176	7546.2	-25.843	0.68	0.83639	22.998	2949	2949	0	33700	39904.4	18.411
8	Turkish A	0.8735	32	334	291.748	-12.65	9792	8553.29	-12.65	24124	19515.4	-19.104	0.74	0.88832	20.043	9792	10005.3	2.178	126815	126815	0
9	Air Canad	0.8734	33	381	332.756	-12.663	10132	8849.03	-12.663	26100	18255.2	-30.057	0.82	0.90718	10.632	11154	11154	0	76481	112274	46.8
10	Thai Airw	0.922	27	95	87.5875	-7.803	6034	5563.19	-7.803	21998	14913.2	-32.206	0.73	0.81229	11.273	5987	5987	0	62442	62442	0
11	KLM	1	1	203	202.998	-0.001	10246	10245.9	-0.001	34363	34358.4	-0.013	0.87	0.87	0	12250	12250	0	93228	93228	0
12	RyanAir	1	1	341	341	0	6343	6343	0	10926	10926	0	0.93	0.93	0	8170	8170	0	106400	106400	0
13	Easy Jet	1	1	257	256.993	-0.003	5511	5510.76	-0.004	10273	10272.7	-0.003	0.92	0.92	0	6164	6164	0	81496	81496.1	0
14	Delta Airli	1	1	469	469	0	32454	32454	0	84000	84000	0	0.85	0.85	0	39450	39450	0	213098	213098	0
15	Qantas	0.9258	26	303	280.531	-7.416	12570	11637.9	-7.416	29294	27121.7	-7.416	0.8	0.83864	4.83	14094	14094	0	119054	119054	0
16	South Afri	0.9868	17	53	52.2995	-1.322	2612	2429.38	-6.992	10706	5714.15	-46.627	0.75	0.81827	9.102	2644	2644	0	24234	25176.7	3.89
17	SAS Airlir	0.9118	29	156	142.245	-8.817	5759	5161.47	-10.376	10710	9765.66	-8.817	0.76	0.78982	3.924	5918	5918	0	36900	51155.5	38.633
18	Lufthansa	1	1	617	616.985	-0.002	39686	39685.4	-0.002	124300	124295	-0.004	0.79	0.79002	0.002	42423	42423	0	226633	226633	0
19	United Air	0.9365	22	1231	492.144	-60.021	32214	30169.6	-6.346	83900	75670.4	-9.809	0.83	0.84376	1.658	36558	36558	0	210309	210309	0
20	Alitalia	0.7238	35	120	86.8502	-27.625	4062	2939.88	-27.625	11260	8149.45	-27.625	0.79	0.8385	6.139	3600	3600	0	30500	30500	0
21	Finair	1	1	73	73	0	2787	2787	0	5045	5045	0	0.79	0.79	0	2895	2895	0	27300	27300	0
22	Aer lingus	1	1	47	47	0	1916	1916	0	4200	4200	0	0.82	0.82	0	2119	2119	0	18730	18730	0
23	Jet Blue	0.9767	19	227	221.721	-2.326	5320	5196.28	-2.326	15696	13984.4	-10.905	0.84	0.85087	1.294	6632	6632	0	45619	71240.4	56.164
24	West Jet.	0.9151	28	153	91.6963	-40.068	2798	2560.42	-8.491	9988	6776.45	-32.154	0.84	0.85099	1.308	3133	3133	0	23967	45661.8	90.52
25	LATAM A	0.8823	31	329	290.265	-11.774	8959	7904.2	-11.774	45916	17112	-62.732	0.84	0.88851	5.775	9527	9527	0	115000	115000	0
26	Korea Air	1	1	160	160	0	8806	8806	0	20790	20790	0	0.78	0.78	0	10950	10950	0	75400	75400	0
27	Southwes	0.9817	18	723	390.595	-45.976	16767	16459.3	-1.835	53536	39237.4	-26.708	0.84	0.89901	7.026	20289	20289	0	124797	147739	18.384
28	China Ea	0.9322	23	596	437.294	-26.629	13783	12848.6	-6.779	75333	25448.4	-66.219	0.81	0.85362	5.385	14835	14835	0	167529	167529	0
29	Japan Air	0.926	25	230	212.982	-7.399	9508	8804.48	-7.399	32753	19970.3	-39.028	0.7	0.81911	17.015	10995	10995	0	65183	86664.1	32.955
30	Iberia	1	1	130	130	0	4315	4315	0	16340	16340	0	0.79	0.79	0	5450	5450	0	44200	44200	0
31	Alaska	1	1	57	57	0	2034	2034	0	6199	6199	0	0.84	0.84	0	2432	2432	0	37209	37209	0
32	Hawaiian	1	1	57	57	0	2034	2034	0	6199	6199	0	0.84	0.84	0	2432	2432	0	15484	15484	0
33	Kenya Air	1	1	47	47	0	1196	1196	0	3870	3870	0	0.68	0.68	0	1155	1155	0	10066	10066	0
34	Air China	1	1	655	655	0	16105	16105	0	23258	23258	0	0.81	0.81	0	18993	18993	0	188158	188158	0
35	Aeroflot	0.9288	24	292	271.207	-7.121	13955	12961.3	-7.121	36600	31039.2	-15.193	0.81	0.83427	2.996	15996	15996	0	112100	112100	0

			No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
Average	0.9526	15	275.686	230.168	-9.0082	10468.5	10025.7	-5.0723	30519.4	25150.8	-15.6845	0.7995	0.8329	4.4314	11654.4	11673.7	0.2786	95526	99781.3	8.7359
Max	1	35	1231	655	0	39686	39685.4	0	124300	124295	0	0.93	0.93	22.998	42423	42423	7.573	276608	276608	90.52
Min	0.7238	1	47	47	-60.021	1196	1196	-27.625	3870	3870	-66.219	0.68	0.68	0	1155	1155	0	10066	10066	0
St Dev	0.0615	13.0722	245.361	161.093	14.4525	9099.23	9016.77	6.2542	27372.3	25649.5	18.8971	0.0579	0.0485	6.1308	10303.2	10295	1.3215	67483.7	66040	20.3918

Appendix 7 DEA-Solver Projection 2017

Model = BCC-I Workbook Name = C:\Users\hamad\Desktop\Japan Correction DEA SOLVER\Japan Corrected data 2017.xlsx

				No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	British Airways Plc	1	1	294	294	0	13818	13818	0	38874	38874	0	0.825	0.82502	0.002	16146	16146	0	152177	152177	0
2	Cathay Pacific	1	1	196	196	0	13074	13074	0	26029	26029	0	0.844	0.844	0	12548	12548	0	126663	126663	0
3	Emirates Airline	1	1	268	268	0	23977	23977	0	62356	62356	0	0.775	0.775	0	25087	25087	0	292221	292221	0
4	Etihad Airline	1	1	107	107	0	6900	6900	0	22500	22500	0	0.764	0.764	0	6000	6000	0	87000	87000	0
5	Qatar Airways	0.8647	34	233	201.483	-13.526	11578	10011.9	-13.526	45633	28451.6	-37.651	0.68	0.85241	25.354	11569	11569	0	114000	114000	0
6	Singapore Airline	0.9208	24	179	164.827	-7.918	10766	9913.61	-7.918	25901	23850.2	-7.918	0.814	0.814	0	11538.4	11538.4	0	95885	95885	0
7	Ethiopian Airlines	0.9617	19	87	83.6703	-3.827	3072	2954.43	-3.827	11284	7224.17	-35.979	0.68	0.79233	16.519	3290	3290	0	34950	34950	0
8	Turkish Airlines	0.8992	30	329	295.824	-10.084	10958	9761.93	-10.915	24075	21647.3	-10.084	0.79	0.88554	12.094	10958	10958	0	136947	136947	0
9	Air Canada	0.8794	32	395	347.353	-12.063	11314	9949.23	-12.063	27800	24446.6	-12.063	0.82	0.91851	12.013	12351	12351	0	85137	123464	45.018
10	Thai Airways	0.9572	20	100	95.7246	-4.275	6383	6110.1	-4.275	22370	16136.5	-27.866	0.79	0.79	0	6334	6334	0	71634	71634	0
11	KLM	1	1	204	204	0	10501	10501	0	34872	34872	0	0.88	0.88	0	12925	12925	0	97737	97737	0
12	RyanAir	1	1	383	383	0	6391	6391	0	12438	12438	0	0.94	0.94	0	8310	8310	0	120000	120000	0
13	Easy Jet	1	1	279	278.996	-0.001	6123	6122.85	-0.002	11628	11627.9	-0.001	0.93	0.93	0	5342	5342.37	0.007	89685	89685	0
14	Delta Airlines	1	1	460	460	0	35172	35172	0	87000	87000	0	0.86	0.86	0	41138	41138	0	217712	217712	0
15	Qantas	0.9247	23	309	285.721	-7.534	12586	11637.8	-7.534	29596	27366.3	-7.534	0.81	0.86467	6.75	13969	13969	0	121178	121178	0
16	South Africa Airways	0.8775	33	64	56.1577	-12.254	2914	2410.31	-17.285	10071	5613.75	-44.258	0.75	0.80932	7.909	2670	2670	0	23740	24259.6	2.189
17	SAS Airline	1	1	158	158	0	6219	6219	0	10324	10324	0	0.77	0.77	0	6398	6398	0	36360	36360	0
18	Lufthansa	1	1	728	727.989	-0.002	43510	43509.8	0	129400	129398	-0.001	0.81	0.81001	0.001	47451	47451	0	261149	261149	0
19	United Airways	0.9493	21	1263	441.368	-65.054	34166	32432.2	-5.075	86000	80206.1	-6.737	0.82	0.85952	4.82	37784	37784	0	216261	216261	0
20	Alitalia	0.6998	35	121	84.6795	-30.017	4362	3052.66	-30.017	10871	7607.85	-30.017	0.79	0.82651	4.621	3643	3643	0	30000	30000	0
21	Finair	1	1	79	79	0	3093	3093	0	5852	5852	0	0.84	0.84	0	3210	3210	0	30750	30750	0
22	Aer lingus	1	1	52	52	0	1987	1987	0	4500	4500	0	0.81	0.81	0	2230	2230	0	19000	19000	0
23	Jet Blue	0.9095	26	243	221.019	-9.046	6019	5474.55	-9.046	17118	15569.6	-9.046	0.84	0.86329	2.773	7015	7015	0	47240	71433.1	51.213
24	West Jet Airlines	0.8929	31	168	89.1106	-46.958	3095	2763.55	-10.709	11089	8422.11	-24.05	0.84	0.85965	2.339	3425	3425	0	25903	25903	0
25	LATAM Airlines	0.9008	29	315	283.761	-9.917	9449	8511.92	-9.917	43095	21176.2	-50.861	0.82	0.88888	8.4	10163	10163	0	120000	120000	0
26	Korea Air	1	1	161	161	0	9325	9325	0	20690	20690	0	0.8	0.8	0	11286	11286	0	78000	78000	0
27	Southwest	0.9947	18	706	413.111	-41.486	17739	17644.6	-0.532	56110	41592.3	-25.874	0.84	0.90873	8.182	21146	21146	0	120041	158207	31.794
28	China Easternairways	0.903	28	637	346.346	-45.629	15032	13573.6	-9.702	75277	32548.4	-56.762	0.81	0.88001	8.643	15371	15371	0	183181	183181	0
29	Japan Airlines	0.9251	22	231	213.702	-7.488	10273	9503.73	-7.488	33038	30564	-7.488	0.71	0.87845	23.725	11757	11757	0	67656	94173.3	39.194
30	Iberia	1	1	142	142	0	4443	4443	0	16393	16393	0	0.83	0.83	0	5718	5718	0	44300	44300	0
31	Alaska	0.9193	25	304	279.482	-8.065	6686	6146.77	-8.065	20183	16215.7	-19.657	0.84	0.89507	6.556	7894	7894	0	52338	91105.3	74.071
32	Hawaiian Airlines	1	1	60	60	0	2211	2211	0	6660	6660	0	0.86	0.86	0	2675	2675	0	16307	16307	0
33	Kenya Air	1	1	46	46	0	1044	1044	0	3582	3582	0	0.72	0.72	0	1053	1053	0	9079	9079	0
34	Air China	1	1	670	670	0	18524	18524	0	27858	27858	0	0.81	0.81	0	20464	20464	0	201078	201078	0
35	Aeroflot	0.9059	27	332	300.746	-9.414	15887	14391.4	-9.414	38900	35238	-9.414	0.83	0.86625	4.367	17191	17191	0	130200	130200	0

			No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
Average	0.951	14.1143	294.371	242.602	-9.8445	11388.3	10930.2	-5.066	31696.2	27566.6	-12.0932	0.8098	0.8435	4.4305	12458.6	12458.6	0.0002	101586	106343	6.9565
Max	1	35	1263	727.989	0	43510	43509.8	0	129400	129398	0	0.94	0.94	25.354	47451	47451	0.007	292221	292221	74.071
Min	0.6998	1	46	46	-65.054	1044	1044	-30.017	3582	3582	-56.762	0.68	0.72	0	1053	1053	0	9079	9079	0
St Dev	0.0646	13.4706	250.987	163.735	16.1535	9779.5	9719.42	6.7001	27789.2	26298.4	16.5489	0.0569	0.0499	6.6912	10954.8	10954.8	0.0012	72156.1	71489.6	17.982

Appendix 8 DEA-Solver Projection 2018

Model = BCC-I   Workbook Name = C:\Users\hamad\Desktop\Japan Correction DEA SOLVER\Japan Corrected data 2018.xlsx

				No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
No.	DMU	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
1	British Air	0.998	18	294	293.399	-0.204	14564	14534.2	-0.204	38874	38794.6	-0.204	0.83	0.88592	6.738	17132	17132	0	145180	145180	0
2	Cathay P:	1	1	212	212	0	14139	14139	0	26623	26623	0	0.841	0.841	0	14330	14330	0	130630	130630	0
3	Emirates .	1	1	270	270	0	25885	25885	0	60282	60282	0	0.768	0.768	0	26605	26605	0	304700	304700	0
4	Etihad Air	1	1	102	102	0	6500	6500	0	21529	21529	0	0.787	0.787	0	5900	5900	0	87000	87000	0
5	Qatar Air	0.8205	34	250	205.136	-17.946	13700	11241.4	-17.946	46685	34203.2	-26.736	0.67	0.85328	27.355	13193	13193	0	120000	120000	0
6	Singapore	0.9365	22	195	182.625	-6.346	11136.9	10430.1	-6.346	26534	24850.1	-6.346	0.83	0.83	0	11915.8	11915.8	0	102571	102571	0
7	Ethiopian	0.8771	30	108	94.7285	-12.288	4530	3973.33	-12.288	12994	11397.2	-12.288	0.68	0.82995	22.052	4811	4811	0	35700	37129.9	4.005
8	Turkish A	0.9085	26	332	301.615	-9.152	12855	11678.5	-9.152	26739	24291.8	-9.152	0.82	0.84654	3.236	12855	12855	0	149169	149169	0
9	Air Canad	0.894	29	400	357.597	-10.601	12545	11215.1	-10.601	29900	26730.4	-10.601	0.83	0.91334	10.041	13729	13729	0	92360	128715	39.362
10	Thai Airw	0.9113	25	103	93.8639	-8.87	7002	6380.92	-8.87	22054	15349.7	-30.399	0.78	0.78775	0.993	6619	6619	0	72315	72315	0
11	KLM	1	1	214	214	0	10961	10961	0	35410	35410	0	0.89	0.89	0	13693	13693	0	103487	103487	0
12	RyanAir	1	1	431	431	0	6853	6853	0	13803	13803	0	0.95	0.95	0	8938	8938	0	130300	130300	0
13	Easy Jet	1	1	315	314.997	-0.001	6613	6612.94	-0.001	13104	13103.9	-0.001	0.93	0.93	0	7785	7785	0	98522	98522	0
14	Delta Airli	1	1	445	445	0	39174	39174	0	89000	89000	0	0.86	0.86	0	44438	44438	0	225243	225243	0
15	Qantas	0.9466	21	313	296.286	-5.34	13288	12578.4	-5.34	30248	28632.8	-5.34	0.84	0.86629	3.13	14842	14842	0	126814	126814	0
16	South Afri	0.8965	27	64	57.3751	-10.351	2790	2377.43	-14.787	10040	5742.45	-42.804	0.75	0.79721	6.295	2558	2558	0	23800	23800	0
17	SAS Airlir	1	1	157	157	0	6406	6406	0	10146	10146	0	0.76	0.76	0	6707	6707	0	36496	36496	0
18	Lufthansa	1	1	763	762.984	-0.002	44241	44240.9	0	135500	135498	-0.002	0.82	0.82001	0.001	47741	47741	0	284561	284561	0
19	United Air	0.962	20	1329	426.205	-67.93	38074	36627.9	-3.798	86600	83306.3	-3.803	0.84	0.85361	1.62	41303	41303	0	230155	230155	0
20	Alitalia	0.758	35	117	88.6882	-24.198	4246	3218.55	-24.198	10711	8119.14	-24.198	0.8	0.82172	2.715	3838	3838	0	29800	30825.5	3.441
21	Finair	1	1	81	81	0	3443	3443	0	6360	6360	0	0.82	0.82	0	3542	3542	0	32000	32000	0
22	Aer lingus	1	1	56	56	0	2143	2143	0	4500	4500	0	0.81	0.81	0	2424	2424	0	19430	19430	0
23	Jet Blue	0.8395	33	253	212.389	-16.052	7370	6186.99	-16.052	17766	14914.2	-16.052	0.85	0.85883	1.038	7658	7658	0	50790	73263.1	44.247
24	West Jet.	0.8534	31	177	151.052	-14.66	3479	2968.99	-14.66	11624	7431.36	-36.069	0.84	0.84	0	3597	3597	0	27587	43919.4	59.203
25	LATAM A	1	1	316	316	0	7773	7773	0	41170	41170	0	0.84	0.84	0	9895	9895	0	124521	124521	0
26	Korea Air	1	1	166	166	0	9848	9848	0	20965	20965	0	0.8	0.8	0	11637	11637	0	81000	81000	0
27	Southwes	0.989	19	750	276.152	-63.18	18759	18551.7	-1.105	58803	49828.6	-15.262	0.84	0.88194	4.993	21965	21965	0	133322	136246	2.193
28	China Ea	0.9208	24	692	369.81	-46.559	16930	15589.5	-7.918	77005	34973.5	-54.583	0.82	0.87615	6.848	17291	17291	0	201458	201458	0
29	Japan Air	0.9237	23	231	213.385	-7.626	11812	10911.3	-7.626	34000	31407.3	-7.626	0.73	0.86766	18.857	13399	13399	0	70855	100318	41.582
30	Iberia	1	1	146	146	0	4556	4556	0	16968	16968	0	0.86	0.86	0	5896	5896	0	44700	44700	0
31	Alaska	0.8417	32	330	277.755	-15.832	7621	6414.45	-15.832	21641	18115.7	-16.29	0.84	0.90277	7.473	8264	8264	0	54673	89489.8	63.682
32	Hawaiian	1	1	66	65.9997	-0.001	2523	2522.99	-0.001	7244	7243.65	-0.005	0.85	0.85	0	2837	2837	0	17198	17199.2	0.007
33	Kenya Air	1	1	45	45	0	1133	1133	0	3905	3905	0	0.78	0.78	0	1126	1126	0	11287	11287	0
34	Air China	1	1	699	699	0	20878	20878	0	28320	28320	0	0.81	0.81	0	22567	22567	0	220528	220528	0
35	Aeroflot	0.8958	28	366	327.863	-10.42	19093	17103.5	-10.42	41300	36996.5	-10.42	0.83	0.85156	2.597	19728	19728	0	143200	143200	0

			No. Aircraft			Operating Exp.			Employee No.			Load Factor			Total Revenue			RPK		
	Score	Rank	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)	Data	Projection	Diff.(%)
Average	0.9478	14.1143	308.229	248.854	-9.9303	12367.5	11858.6	-5.347	32524.2	29426	-9.3766	0.817	0.844	3.5995	13450.3	13450.3	0	107467	111605	7.3635
Max	1	35	1329	762.984	0	44241	44240.9	0	135500	135498	0	0.95	0.95	27.355	47741	47741	0	304700	304700	63.682
Min	0.758	1	45	45	-67.93	1133	1133	-24.198	3905	3905	-54.583	0.67	0.76	0	1126	1126	0	11287	11287	0
St Dev	0.067	13.4706	264.935	166.24	16.9097	10538.1	10488.2	6.8353	28487.8	27300.5	13.9461	0.0565	0.0444	6.6184	11524.9	11524.9	0	77120.7	75440.4	17.9309

Appendix 9 DEA-Solver (RTS, Rank & Slacks) Results Summary

Region	DMU	Year	Efficiency	RTS	Rank	No. Aircraft	Operating Exp.	Employee	Load Factor	Total Revenue	RPK
Africa	Kenya Air	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Kenya Air	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Kenya Air	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Kenya Air	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Kenya Air	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Kenya Air	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Kenya Air	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Kenya Air	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	South Africa Airways	2011	0.91	Increasing	22.00	0.00	0.00	0.00	0.04	0.00	0.00
Africa	South Africa Airways	2012	0.88	Constant	33.00	0.00	0.00	1644.25	0.00	108.52	0.00
Africa	South Africa Airways	2013	1.00	Increasing	1.00	0.00	0.00	1.79	0.00	0.05	0.00
Africa	South Africa Airways	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	South Africa Airways	2015	0.94	Constant	23.00	0.00	0.00	4927.97	0.09	153.78	0.00
Africa	South Africa Airways	2016	0.99	Constant	17.00	0.00	148.10	4850.35	0.07	0.00	942.72
Africa	South Africa Airways	2017	0.88	Constant	33.00	0.00	146.62	3223.20	0.06	0.00	519.61
Africa	South Africa Airways	2018	0.90	Constant	27.00	0.00	123.76	3258.26	0.05	0.00	0.00
Africa	Ethiopian Airlines	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Ethiopian Airlines	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Ethiopian Airlines	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Ethiopian Airlines	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Ethiopian Airlines	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Africa	Ethiopian Airlines	2016	0.95	Constant	20.00	0.00	0.00	2153.62	0.16	0.00	6204.35
Africa	Ethiopian Airlines	2017	0.96	Increasing	19.00	0.00	0.00	3627.96	0.11	0.00	0.00
Africa	Ethiopian Airlines	2018	0.88	Constant	30.00	0.00	0.00	0.00	0.15	0.00	1429.89
Asia & Pacific	Air China	2011	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Air China	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Air China	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Air China	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Air China	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Air China	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Air China	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Air China	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Cathay Pacific	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Cathay Pacific	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Cathay Pacific	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Cathay Pacific	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Cathay Pacific	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Cathay Pacific	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Cathay Pacific	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Cathay Pacific	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	China Eastern	2011	0.84	Decreasing	31.00	0.00	0.00	4606.13	0.01	0.00	0.00

Asia & Pacific	China Eastern	2012	0.93	Decreasing	28.00	3.22	0.00	41719.50	0.00	0.00	0.00
Asia & Pacific	China Eastern	2013	0.92	Decreasing	32.00	57.52	0.00	38107.03	0.02	0.00	0.00
Asia & Pacific	China Eastern	2014	0.92	Decreasing	27.00	193.32	0.00	31079.79	0.03	0.00	0.00
Asia & Pacific	China Eastern	2015	0.93	Constant	26.00	205.51	0.00	36204.63	0.04	0.00	0.00
Asia & Pacific	China Eastern	2016	0.93	Decreasing	23.00	118.30	0.00	44777.58	0.04	0.00	0.00
Asia & Pacific	China Eastern	2017	0.90	Decreasing	28.00	228.85	0.00	35425.12	0.07	0.00	0.00
Asia & Pacific	China Eastern	2018	0.92	Decreasing	24.00	267.40	0.00	35934.13	0.06	0.00	0.00
Asia & Pacific	Japan Airlines	2011	0.90	Constant	24.00	0.00	0.00	0.00	0.12	0.00	11806.29
Asia & Pacific	Japan Airlines	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Japan Airlines	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Japan Airlines	2014	1.00	Decreasing	1.00	0.00	0.00	0.30	0.00	0.00	0.16
Asia & Pacific	Japan Airlines	2015	0.95	Constant	21.00	0.00	0.00	6309.01	0.16	0.00	0.00
Asia & Pacific	Japan Airlines	2016	0.93	Decreasing	25.00	0.00	0.00	10359.21	0.12	0.00	21481.14
Asia & Pacific	Japan Airlines	2017	0.93	Constant	22.00	0.00	0.00	0.00	0.17	0.00	26517.34
Asia & Pacific	Japan Airlines	2018	0.92	Decreasing	23.00	0.00	0.00	0.00	0.14	0.00	29462.92
Asia & Pacific	Korea Air	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Korea Air	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Korea Air	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Korea Air	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Korea Air	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Korea Air	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Korea Air	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Korea Air	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Qantas	2011	0.94	Decreasing	21.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Qantas	2012	0.93	Decreasing	27.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Qantas	2013	0.93	Decreasing	29.00	0.00	0.00	0.00	0.02	0.00	0.00
Asia & Pacific	Qantas	2014	0.87	Decreasing	31.00	18.80	0.00	0.00	0.02	0.00	0.00
Asia & Pacific	Qantas	2015	0.92	Constant	28.00	0.00	0.00	0.00	0.06	0.00	0.00
Asia & Pacific	Qantas	2016	0.93	Decreasing	26.00	0.00	0.00	0.00	0.04	0.00	0.00
Asia & Pacific	Qantas	2017	0.92	Decreasing	23.00	0.00	0.00	0.00	0.06	0.00	0.00
Asia & Pacific	Qantas	2018	0.95	Decreasing	21.00	0.00	0.00	0.00	0.03	0.00	0.00
Asia & Pacific	Singapore Airline	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Singapore Airline	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Singapore Airline	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Singapore Airline	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Singapore Airline	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Singapore Airline	2016	0.94	Constant	21.00	0.00	345.65	0.00	0.00	0.00	0.00
Asia & Pacific	Singapore Airline	2017	0.92	Decreasing	24.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Singapore Airline	2018	0.94	Decreasing	22.00	0.00	0.00	0.00	0.00	0.00	0.00
Asia & Pacific	Thai Airways	2011	0.90	Constant	25.00	0.00	0.00	6090.05	0.03	0.00	0.00
Asia & Pacific	Thai Airways	2012	0.98	Constant	22.00	0.00	0.00	6729.18	0.00	0.00	0.00
Asia & Pacific	Thai Airways	2013	0.89	Decreasing	33.00	0.00	0.00	4403.09	0.00	0.00	0.00
Asia & Pacific	Thai Airways	2014	0.86	Constant	33.00	0.00	0.00	4614.87	0.09	0.00	0.00
Asia & Pacific	Thai Airways	2015	0.87	Constant	32.00	0.00	0.00	5042.98	0.08	0.00	0.00
Asia & Pacific	Thai Airways	2016	0.92	Constant	27.00	0.00	0.00	5368.34	0.08	0.00	0.00

Asia & Pacific	Thai Airways	2017	0.96	Increasing	20.00	0.00	0.00	5277.11	0.00	0.00	0.00
Asia & Pacific	Thai Airways	2018	0.91	Constant	25.00	0.00	0.00	4748.08	0.01	0.00	0.00
Europe	Aer Lingus	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Aer Lingus	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Aer Lingus	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Aer Lingus	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Aer Lingus	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Aer Lingus	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Aer Lingus	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Aer Lingus	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Aeroflot	2011	0.78	Constant	35.00	53.98	0.00	0.00	0.00	0.00	0.00
Europe	Aeroflot	2012	0.91	Decreasing	32.00	0.00	0.00	2916.74	0.00	0.00	0.00
Europe	Aeroflot	2013	0.95	Constant	25.00	0.00	0.00	3664.27	0.05	0.00	0.00
Europe	Aeroflot	2014	0.91	Decreasing	30.00	0.00	0.00	4948.04	0.06	0.00	0.00
Europe	Aeroflot	2015	0.92	Constant	29.00	0.00	0.00	4343.98	0.02	0.00	0.00
Europe	Aeroflot	2016	0.93	Decreasing	24.00	0.00	0.00	2954.55	0.02	0.00	0.00
Europe	Aeroflot	2017	0.91	Decreasing	27.00	0.00	0.00	0.00	0.04	0.00	0.00
Europe	Aeroflot	2018	0.90	Decreasing	28.00	0.00	0.00	0.00	0.02	0.00	0.00
Europe	Alitalia	2011	0.83	Constant	33.00	0.00	0.00	0.00	0.06	0.00	7223.58
Europe	Alitalia	2012	0.82	Decreasing	35.00	0.00	0.00	0.00	0.00	0.00	1035.40
Europe	Alitalia	2013	0.85	Constant	34.00	0.00	0.00	0.00	0.03	0.00	0.00
Europe	Alitalia	2014	0.84	Increasing	34.00	0.00	0.00	0.00	0.06	0.00	0.00
Europe	Alitalia	2015	0.82	Constant	35.00	0.00	0.00	1092.86	0.06	0.00	0.00
Europe	Alitalia	2016	0.72	Constant	35.00	0.00	0.00	0.00	0.05	0.00	0.00
Europe	Alitalia	2017	0.70	Increasing	35.00	0.00	0.00	0.00	0.04	0.00	0.00
Europe	Alitalia	2018	0.76	Constant	35.00	0.00	0.00	0.00	0.02	0.00	1025.49
Europe	British Airways Plc	2011	0.96	Decreasing	20.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	British Airways Plc	2012	0.99	Decreasing	21.00	0.00	0.00	3425.45	0.00	0.00	0.00
Europe	British Airways Plc	2013	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	British Airways Plc	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	British Airways Plc	2015	0.98	Constant	18.00	0.00	0.00	7820.21	0.02	0.00	0.00
Europe	British Airways Plc	2016	1.00	Decreasing	16.00	0.00	0.00	5523.25	0.03	0.00	0.00
Europe	British Airways Plc	2017	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	British Airways Plc	2018	1.00	Decreasing	18.00	0.00	0.00	0.00	0.06	0.00	0.00
Europe	Easy Jet	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Easy Jet	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Easy Jet	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Easy Jet	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Easy Jet	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Easy Jet	2016	1.00	Decreasing	1.00	0.00	0.09	0.00	0.00	0.00	0.15
Europe	Easy Jet	2017	1.00	Decreasing	1.00	0.00	0.07	0.00	0.00	0.37	0.00
Europe	Easy Jet	2018	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Finair	2011	0.83	Constant	32.00	0.00	0.00	0.00	0.02	0.00	0.00
Europe	Finair	2012	0.93	Decreasing	29.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Finair	2013	1.00	Decreasing	1.00	0.00	0.07	0.00	0.00	0.00	0.00

Europe	Finair	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Finair	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Finair	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Finair	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Finair	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Iberia	2011	0.89	Constant	26.00	0.00	0.00	6487.60	0.00	0.00	36951.92
Europe	Iberia	2012	0.95	Decreasing	25.00	0.00	547.18	2630.40	0.00	0.00	0.00
Europe	Iberia	2013	0.84	Decreasing	35.00	0.00	0.00	3458.25	0.00	0.00	0.00
Europe	Iberia	2014	0.84	Constant	35.00	0.00	0.00	1930.08	0.02	0.00	0.00
Europe	Iberia	2015	0.84	Constant	34.00	0.00	0.00	1802.98	0.03	0.00	0.00
Europe	Iberia	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Iberia	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Iberia	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	KLM	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	KLM	2012	1.00	Decreasing	1.00	0.00	0.00	0.06	0.00	0.00	0.00
Europe	KLM	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	KLM	2014	1.00	Decreasing	1.00	0.00	0.00	1.74	0.00	0.00	0.00
Europe	KLM	2015	1.00	Decreasing	1.00	0.00	0.00	3.90	0.00	0.00	0.00
Europe	KLM	2016	1.00	Decreasing	1.00	0.00	0.00	4.29	0.00	0.00	0.00
Europe	KLM	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	KLM	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	Lufthansa	2011	1.00	Decreasing	1.00	0.00	0.00	2.32	0.00	0.00	1.04
Europe	Lufthansa	2012	1.00	Decreasing	1.00	0.00	0.00	1.35	0.00	0.00	0.95
Europe	Lufthansa	2013	1.00	Decreasing	1.00	0.00	0.00	3.42	0.00	0.00	0.00
Europe	Lufthansa	2014	1.00	Decreasing	1.00	0.00	0.00	6.85	0.00	0.00	0.00
Europe	Lufthansa	2015	1.00	Decreasing	1.00	0.00	0.09	1.89	0.00	0.00	0.71
Europe	Lufthansa	2016	1.00	Decreasing	1.00	0.01	0.00	2.52	0.00	0.00	0.34
Europe	Lufthansa	2017	1.00	Decreasing	1.00	0.01	0.00	1.13	0.00	0.00	0.00
Europe	Lufthansa	2018	1.00	Decreasing	1.00	0.02	0.00	1.91	0.00	0.00	0.00
Europe	RyanAir	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	RyanAir	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	RyanAir	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	RyanAir	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	RyanAir	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	RyanAir	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	RyanAir	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	RyanAir	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	SAS Airline	2011	0.85	Constant	30.00	0.00	0.00	0.00	0.04	0.00	10653.95
Europe	SAS Airline	2012	0.85	Decreasing	34.00	0.00	0.00	0.00	0.00	0.00	4202.17
Europe	SAS Airline	2013	0.93	Increasing	30.00	0.00	0.00	0.00	0.05	0.00	0.00
Europe	SAS Airline	2014	0.87	Constant	32.00	0.00	0.00	0.00	0.05	0.00	4583.81
Europe	SAS Airline	2015	0.93	Constant	24.00	0.00	77.25	0.00	0.08	0.00	11394.00
Europe	SAS Airline	2016	0.91	Constant	29.00	0.00	89.74	0.00	0.03	0.00	14255.51
Europe	SAS Airline	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Europe	SAS Airline	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00

Europe	Turkish Airlines	2011	0.86	Constant	29.00	0.00	0.00	0.00	0.09	0.00	0.00
Europe	Turkish Airlines	2012	0.94	Increasing	26.00	0.00	0.00	0.00	0.02	0.00	0.00
Europe	Turkish Airlines	2013	0.94	Decreasing	27.00	0.00	0.00	0.00	0.01	0.00	0.00
Europe	Turkish Airlines	2014	0.99	Decreasing	23.00	0.00	614.42	0.00	0.08	0.00	0.00
Europe	Turkish Airlines	2015	0.92	Constant	27.00	0.00	550.27	0.00	0.08	0.00	0.00
Europe	Turkish Airlines	2016	0.87	Decreasing	32.00	0.00	0.00	1556.90	0.15	213.26	0.00
Europe	Turkish Airlines	2017	0.90	Constant	30.00	0.00	91.07	0.00	0.10	0.00	0.00
Europe	Turkish Airlines	2018	0.91	Constant	26.00	0.00	0.00	0.00	0.03	0.00	0.00
Middle East	Etihad Airline	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Etihad Airline	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Etihad Airline	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Etihad Airline	2014	0.95	Decreasing	25.00	0.00	0.00	3029.34	0.00	78.71	0.00
Middle East	Etihad Airline	2015	0.86	Constant	33.00	0.00	0.00	2738.72	0.01	174.51	0.00
Middle East	Etihad Airline	2016	0.85	Constant	34.00	0.00	67.97	2892.40	0.06	461.93	0.00
Middle East	Etihad Airline	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Etihad Airline	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Emirates Airline	2011	1.00	Decreasing	1.00	0.00	0.00	0.18	0.00	0.00	0.14
Middle East	Emirates Airline	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Emirates Airline	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Emirates Airline	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Emirates Airline	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Emirates Airline	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Emirates Airline	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Emirates Airline	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Qatar Airways	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Qatar Airways	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Qatar Airways	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Qatar Airways	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Middle East	Qatar Airways	2015	0.95	Constant	20.00	0.00	0.00	11833.44	0.09	0.00	0.00
Middle East	Qatar Airways	2016	0.91	Decreasing	30.00	0.00	0.00	12532.40	0.09	0.00	0.00
Middle East	Qatar Airways	2017	0.86	Constant	34.00	0.00	0.00	11008.84	0.17	0.00	0.00
Middle East	Qatar Airways	2018	0.82	Constant	34.00	0.00	0.00	4103.86	0.18	0.00	0.00
North America	Air Canada	2011	0.81	Constant	34.00	67.49	0.00	0.00	0.00	0.00	11594.78
North America	Air Canada	2012	0.92	Decreasing	30.00	59.76	0.00	0.00	0.00	0.00	27232.57
North America	Air Canada	2013	0.92	Decreasing	31.00	92.55	0.00	0.00	0.00	0.00	0.00
North America	Air Canada	2014	0.92	Decreasing	27.00	21.36	0.00	0.00	0.00	0.00	1154.71
North America	Air Canada	2015	0.89	Constant	30.00	63.11	0.00	0.00	0.02	0.00	528.27
North America	Air Canada	2016	0.87	Decreasing	33.00	0.00	0.00	4539.83	0.09	0.00	35793.30
North America	Air Canada	2017	0.88	Decreasing	32.00	0.00	0.00	0.00	0.10	0.00	38326.91
North America	Air Canada	2018	0.89	Decreasing	29.00	0.00	0.00	0.00	0.08	0.00	36354.86
North America	Alaska	2011	0.91	Decreasing	23.00	11.82	0.00	0.00	0.00	0.00	16459.94
North America	Alaska	2012	1.00	Decreasing	1.00	0.00	0.00	0.23	0.00	0.00	2.48
North America	Alaska	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Alaska	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Alaska	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00

North America	Alaska	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Alaska	2017	0.92	Constant	25.00	0.00	0.00	2339.53	0.06	0.00	38767.29
North America	Alaska	2018	0.84	Constant	32.00	0.00	0.00	99.07	0.06	0.00	34816.83
North America	Delta Airlines	2011	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.03
North America	Delta Airlines	2012	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.12
North America	Delta Airlines	2013	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.15
North America	Delta Airlines	2014	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.24
North America	Delta Airlines	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Delta Airlines	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Delta Airlines	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Delta Airlines	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Hawaiian Airlines	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Hawaiian Airlines	2012	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Hawaiian Airlines	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Hawaiian Airlines	2014	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Hawaiian Airlines	2015	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Hawaiian Airlines	2016	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Hawaiian Airlines	2017	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Hawaiian Airlines	2018	1.00	Decreasing	1.00	0.00	0.00	0.31	0.00	0.00	1.18
North America	Jet Blue	2011	0.88	Decreasing	27.00	0.00	0.00	0.00	0.00	0.00	12258.54
North America	Jet Blue	2012	0.95	Decreasing	23.00	0.00	0.00	0.00	0.00	0.00	1443.96
North America	Jet Blue	2013	0.93	Decreasing	28.00	0.00	0.00	0.00	0.00	0.00	538.02
North America	Jet Blue	2014	0.92	Constant	26.00	0.00	0.00	0.00	0.01	0.00	2149.19
North America	Jet Blue	2015	0.98	Decreasing	19.00	0.00	0.00	0.00	0.00	0.00	3735.64
North America	Jet Blue	2016	0.98	Constant	19.00	0.00	0.00	1346.56	0.01	0.00	25621.39
North America	Jet Blue	2017	0.91	Constant	26.00	0.00	0.00	0.00	0.02	0.00	24193.13
North America	Jet Blue	2018	0.84	Constant	33.00	0.00	0.00	0.00	0.01	0.00	22473.14
North America	Southwest	2011	0.87	Decreasing	28.00	296.96	0.00	0.00	0.02	0.00	0.00
North America	Southwest	2012	0.95	Decreasing	24.00	361.89	0.00	894.48	0.00	0.00	0.00
North America	Southwest	2013	0.96	Decreasing	24.00	357.60	0.00	169.35	0.00	0.00	0.00
North America	Southwest	2014	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Southwest	2015	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	Southwest	2016	0.98	Decreasing	18.00	319.14	0.00	13316.23	0.06	0.00	22942.44
North America	Southwest	2017	0.99	Decreasing	18.00	289.13	0.00	14219.10	0.07	0.00	38166.10
North America	Southwest	2018	0.99	Constant	19.00	465.56	0.00	8324.72	0.04	0.00	2924.17
North America	United Airways	2011	1.00	Decreasing	1.00	0.04	0.00	0.00	0.00	0.00	0.00
North America	United Airways	2012	1.00	Decreasing	1.00	0.05	0.00	0.28	0.00	0.00	0.00
North America	United Airways	2013	1.00	Decreasing	1.00	0.08	0.00	0.00	0.00	0.00	0.00
North America	United Airways	2014	1.00	Decreasing	1.00	0.01	0.00	0.00	0.00	0.00	0.00
North America	United Airways	2015	0.94	Decreasing	22.00	690.49	0.00	0.00	0.01	0.00	0.00
North America	United Airways	2016	0.94	Decreasing	22.00	660.73	0.00	2905.10	0.01	0.00	0.00
North America	United Airways	2017	0.95	Decreasing	21.00	757.54	0.00	1429.69	0.04	0.00	0.00
North America	United Airways	2018	0.96	Decreasing	20.00	852.32	0.00	4.50	0.01	0.00	0.00
North America	West Jet Airlines	2011	0.96	Decreasing	19.00	36.33	0.00	0.00	0.00	0.00	0.00
North America	West Jet Airlines	2012	1.00	Decreasing	1.00	0.00	0.00	0.00	0.00	0.00	0.96

North America	West Jet Airlines	2013	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
North America	West Jet Airlines	2014	0.99	Increasing	24.00	34.61	0.00	860.07	0.00	0.00	0.00
North America	West Jet Airlines	2015	0.93	Constant	25.00	38.75	0.00	1572.32	0.01	0.00	0.00
North America	West Jet Airlines	2016	0.92	Constant	28.00	48.31	0.00	2363.47	0.01	0.00	21694.85
North America	West Jet Airlines	2017	0.89	Constant	31.00	60.90	0.00	1479.34	0.02	0.00	0.00
North America	West Jet Airlines	2018	0.85	Decreasing	31.00	0.00	0.00	2488.60	0.00	0.00	16332.43
South America	LATAM Airlines	2011	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00
South America	LATAM Airlines	2012	0.91	Decreasing	31.00	0.00	0.00	18079.72	0.00	0.00	0.00
South America	LATAM Airlines	2013	0.94	Decreasing	26.00	0.00	0.00	21497.12	0.02	0.00	0.00
South America	LATAM Airlines	2014	0.92	Decreasing	29.00	8.08	0.00	16225.05	0.00	0.00	0.00
South America	LATAM Airlines	2015	0.87	Constant	31.00	0.00	0.00	27821.88	0.02	0.00	0.00
South America	LATAM Airlines	2016	0.88	Decreasing	31.00	0.00	0.00	23398.01	0.05	0.00	0.00
South America	LATAM Airlines	2017	0.90	Constant	29.00	0.00	0.00	17644.92	0.07	0.00	0.00
South America	LATAM Airlines	2018	1.00	Constant	1.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 10 Distance Summary Index Input DEAP Results

Region	DMU	Year	CRS te (t-1)	CRS te (t)	CRS te (t+1)	VRS te
Africa	Ethiopian Airlines	2011	0.00	1.00	1.25	1.00
Africa	Ethiopian Airlines	2012	1.02	1.00	1.08	1.00
Africa	Ethiopian Airlines	2013	1.06	1.00	1.10	1.00
Africa	Ethiopian Airlines	2014	1.01	1.00	1.03	1.00
Africa	Ethiopian Airlines	2015	1.01	1.00	0.91	1.00
Africa	Ethiopian Airlines	2016	1.04	0.94	1.06	0.95
Africa	Ethiopian Airlines	2017	0.87	0.94	0.94	0.96
Africa	Ethiopian Airlines	2018	0.87	0.87	0.00	0.88
Africa	Kenya Air	2011	0.00	1.00	1.15	1.00
Africa	Kenya Air	2012	0.96	1.00	1.28	1.00
Africa	Kenya Air	2013	1.01	1.00	1.11	1.00
Africa	Kenya Air	2014	0.96	1.00	1.18	1.00
Africa	Kenya Air	2015	0.90	1.00	0.87	1.00
Africa	Kenya Air	2016	1.28	1.00	0.93	1.00
Africa	Kenya Air	2017	1.21	1.00	1.01	1.00
Africa	Kenya Air	2018	1.11	1.00	0.00	1.00
Africa	South Africa Airways	2011	0.00	0.90	0.98	0.91
Africa	South Africa Airways	2012	0.85	0.88	0.93	0.88
Africa	South Africa Airways	2013	0.92	1.00	0.99	1.00
Africa	South Africa Airways	2014	1.19	1.00	1.11	1.00
Africa	South Africa Airways	2015	0.90	0.88	0.90	0.94
Africa	South Africa Airways	2016	0.94	0.95	1.01	0.99
Africa	South Africa Airways	2017	0.81	0.84	0.87	0.88
Africa	South Africa Airways	2018	0.84	0.86	0.00	0.90
Asia & Pacific	Air China	2011	0.00	0.92	1.02	1.00
Asia & Pacific	Air China	2012	0.94	1.00	1.06	1.00
Asia & Pacific	Air China	2013	0.97	1.00	0.96	1.00
Asia & Pacific	Air China	2014	1.05	1.00	1.03	1.00
Asia & Pacific	Air China	2015	1.02	1.00	0.95	1.00
Asia & Pacific	Air China	2016	1.15	1.00	1.12	1.00
Asia & Pacific	Air China	2017	0.98	1.00	0.99	1.00
Asia & Pacific	Air China	2018	1.09	1.00	0.00	1.00
Asia & Pacific	Cathay Pacific	2011	0.00	1.00	1.03	1.00
Asia & Pacific	Cathay Pacific	2012	1.00	1.00	1.02	1.00
Asia & Pacific	Cathay Pacific	2013	1.00	1.00	1.00	1.00
Asia & Pacific	Cathay Pacific	2014	1.01	1.00	1.07	1.00
Asia & Pacific	Cathay Pacific	2015	1.00	1.00	1.04	1.00
Asia & Pacific	Cathay Pacific	2016	0.99	1.00	0.96	1.00
Asia & Pacific	Cathay Pacific	2017	1.06	1.00	0.95	1.00
Asia & Pacific	Cathay Pacific	2018	1.07	1.00	0.00	1.00
Asia & Pacific	China Eastern airways	2011	0.00	0.74	0.88	0.84
Asia & Pacific	China Eastern airways	2012	0.74	0.87	0.89	0.93
Asia & Pacific	China Eastern airways	2013	0.84	0.86	0.85	0.92
Asia & Pacific	China Eastern airways	2014	0.89	0.88	0.83	0.92
Asia & Pacific	China Eastern airways	2015	0.93	0.88	0.85	0.93
Asia & Pacific	China Eastern airways	2016	0.88	0.85	0.84	0.93
Asia & Pacific	China Eastern airways	2017	0.81	0.81	0.80	0.90
Asia & Pacific	China Eastern airways	2018	0.81	0.80	0.00	0.92
Asia & Pacific	Japan Airlines	2011	0.00	0.90	1.02	0.90
Asia & Pacific	Japan Airlines	2012	0.89	1.00	1.03	1.00
Asia & Pacific	Japan Airlines	2013	0.98	1.00	0.98	1.00
Asia & Pacific	Japan Airlines	2014	1.01	0.99	0.92	1.00

Asia & Pacific	Japan Airlines	2015	1.01	0.95	0.95	0.95
Asia & Pacific	Japan Airlines	2016	0.93	0.92	0.92	0.93
Asia & Pacific	Japan Airlines	2017	0.92	0.92	0.91	0.93
Asia & Pacific	Japan Airlines	2018	0.93	0.92	0.00	0.92
Asia & Pacific	Korea Air	2011	0.00	1.00	1.30	1.00
Asia & Pacific	Korea Air	2012	0.97	1.00	1.04	1.00
Asia & Pacific	Korea Air	2013	0.99	1.00	0.97	1.00
Asia & Pacific	Korea Air	2014	1.06	1.00	1.16	1.00
Asia & Pacific	Korea Air	2015	1.06	1.00	0.98	1.00
Asia & Pacific	Korea Air	2016	1.05	1.00	1.02	1.00
Asia & Pacific	Korea Air	2017	1.03	1.00	1.02	1.00
Asia & Pacific	Korea Air	2018	1.02	1.00	0.00	1.00
Asia & Pacific	Qantas	2011	0.00	0.88	0.92	0.94
Asia & Pacific	Qantas	2012	0.86	0.90	0.91	0.93
Asia & Pacific	Qantas	2013	0.90	0.92	0.90	0.93
Asia & Pacific	Qantas	2014	0.88	0.85	0.83	0.87
Asia & Pacific	Qantas	2015	0.95	0.92	0.88	0.92
Asia & Pacific	Qantas	2016	0.94	0.90	0.92	0.93
Asia & Pacific	Qantas	2017	0.89	0.91	0.92	0.93
Asia & Pacific	Qantas	2018	0.92	0.93	0.00	0.95
Asia & Pacific	Singapore Airline	2011	0.00	1.00	1.02	1.00
Asia & Pacific	Singapore Airline	2012	1.01	1.00	1.02	1.00
Asia & Pacific	Singapore Airline	2013	1.00	1.00	1.03	1.00
Asia & Pacific	Singapore Airline	2014	1.02	1.00	1.07	1.00
Asia & Pacific	Singapore Airline	2015	1.01	1.00	1.26	1.00
Asia & Pacific	Singapore Airline	2016	0.94	0.94	0.91	0.94
Asia & Pacific	Singapore Airline	2017	0.93	0.92	0.93	0.92
Asia & Pacific	Singapore Airline	2018	0.92	0.93	0.00	0.94
Asia & Pacific	Thai Airways	2011	0.00	0.89	0.91	0.90
Asia & Pacific	Thai Airways	2012	0.96	0.98	1.00	0.98
Asia & Pacific	Thai Airways	2013	0.87	0.89	0.88	0.89
Asia & Pacific	Thai Airways	2014	0.88	0.85	0.83	0.86
Asia & Pacific	Thai Airways	2015	0.89	0.86	0.92	0.87
Asia & Pacific	Thai Airways	2016	0.90	0.91	0.92	0.92
Asia & Pacific	Thai Airways	2017	0.92	0.96	0.96	0.96
Asia & Pacific	Thai Airways	2018	0.90	0.91	0.00	0.91
Europe	Aer Lingus	2011	0.00	1.00	1.03	1.00
Europe	Aer Lingus	2012	1.03	1.00	1.07	1.00
Europe	Aer Lingus	2013	1.00	1.00	1.06	1.00
Europe	Aer Lingus	2014	1.03	1.00	1.06	1.00
Europe	Aer Lingus	2015	1.13	1.00	1.02	1.00
Europe	Aer Lingus	2016	1.06	1.00	1.12	1.00
Europe	Aer Lingus	2017	1.00	1.00	1.05	1.00
Europe	Aer Lingus	2018	1.06	1.00	0.00	1.00
Europe	Aeroflot	2011	0.00	0.78	0.91	0.78
Europe	Aeroflot	2012	0.83	0.90	0.92	0.91
Europe	Aeroflot	2013	0.93	0.95	0.94	0.95
Europe	Aeroflot	2014	0.92	0.91	0.86	0.91
Europe	Aeroflot	2015	0.97	0.92	0.90	0.92
Europe	Aeroflot	2016	0.94	0.92	0.93	0.93
Europe	Aeroflot	2017	0.87	0.89	0.89	0.91
Europe	Aeroflot	2018	0.86	0.87	0.00	0.90
Europe	Alitalia	2011	0.00	0.83	0.87	0.83
Europe	Alitalia	2012	0.77	0.82	0.84	0.82
Europe	Alitalia	2013	0.84	0.85	0.83	0.85
Europe	Alitalia	2014	0.86	0.84	0.79	0.84

Europe	Alitalia	2015	0.87	0.81	0.81	0.82
Europe	Alitalia	2016	0.73	0.72	0.73	0.72
Europe	Alitalia	2017	0.69	0.70	0.70	0.70
Europe	Alitalia	2018	0.75	0.76	0.00	0.76
Europe	British Airways Plc	2011	0.00	0.88	0.91	0.96
Europe	British Airways Plc	2012	0.90	0.94	0.96	0.99
Europe	British Airways Plc	2013	0.96	0.99	0.97	1.00
Europe	British Airways Plc	2014	1.02	1.00	0.95	1.00
Europe	British Airways Plc	2015	1.04	0.98	0.94	0.98
Europe	British Airways Plc	2016	0.99	0.95	0.98	1.00
Europe	British Airways Plc	2017	0.95	0.99	0.99	1.00
Europe	British Airways Plc	2018	0.98	0.98	0.00	1.00
Europe	Easy Jet	2011	0.00	1.00	1.06	1.00
Europe	Easy Jet	2012	1.01	1.00	1.02	1.00
Europe	Easy Jet	2013	1.03	1.00	0.98	1.00
Europe	Easy Jet	2014	1.06	1.00	1.02	1.00
Europe	Easy Jet	2015	1.04	1.00	0.95	1.00
Europe	Easy Jet	2016	1.00	0.92	0.96	1.00
Europe	Easy Jet	2017	0.91	0.95	0.98	1.00
Europe	Easy Jet	2018	0.95	0.96	0.00	1.00
Europe	Finnair	2011	0.00	0.83	0.84	0.83
Europe	Finnair	2012	0.92	0.93	0.94	0.93
Europe	Finnair	2013	0.97	0.98	0.95	1.00
Europe	Finnair	2014	1.05	1.00	1.00	1.00
Europe	Finnair	2015	1.07	1.00	1.03	1.00
Europe	Finnair	2016	1.00	1.00	1.05	1.00
Europe	Finnair	2017	0.99	1.00	1.03	1.00
Europe	Finnair	2018	1.01	1.00	0.00	1.00
Europe	Iberia	2011	0.00	0.89	0.91	0.89
Europe	Iberia	2012	0.86	0.87	0.89	0.94
Europe	Iberia	2013	0.82	0.84	0.81	0.84
Europe	Iberia	2014	0.86	0.83	0.80	0.84
Europe	Iberia	2015	0.89	0.84	0.81	0.84
Europe	Iberia	2016	1.03	1.00	1.00	1.00
Europe	Iberia	2017	1.02	1.00	1.00	1.00
Europe	Iberia	2018	1.01	1.00	0.00	1.00
Europe	KLM	2011	0.00	1.00	1.23	1.00
Europe	KLM	2012	0.90	0.97	0.98	1.00
Europe	KLM	2013	0.98	1.00	0.99	1.00
Europe	KLM	2014	1.00	0.99	0.93	1.00
Europe	KLM	2015	1.01	0.95	0.93	1.00
Europe	KLM	2016	0.99	0.96	0.97	1.00
Europe	KLM	2017	0.99	1.00	0.99	1.00
Europe	KLM	2018	1.02	1.00	0.00	1.00
Europe	Lufthansa	2011	0.00	0.84	0.90	1.00
Europe	Lufthansa	2012	0.86	0.92	0.94	1.00
Europe	Lufthansa	2013	0.91	0.92	0.89	1.00
Europe	Lufthansa	2014	0.92	0.89	0.83	1.00
Europe	Lufthansa	2015	0.91	0.86	0.87	1.00
Europe	Lufthansa	2016	0.86	0.87	0.90	1.00
Europe	Lufthansa	2017	0.89	0.91	0.90	1.00
Europe	Lufthansa	2018	0.89	0.89	0.00	1.00
Europe	Ryanair	2011	0.00	1.00	1.14	1.00
Europe	RyanAir	2012	1.02	1.00	1.08	1.00
Europe	RyanAir	2013	1.06	1.00	1.05	1.00
Europe	RyanAir	2014	1.02	1.00	0.97	1.00

Europe	RyanAir	2015	1.07	1.00	1.01	1.00
Europe	RyanAir	2016	1.07	1.00	1.12	1.00
Europe	RyanAir	2017	1.10	1.00	1.04	1.00
Europe	RyanAir	2018	1.01	1.00	0.00	1.00
Europe	SAS Airline	2011	0.00	0.85	0.90	0.85
Europe	SAS Airline	2012	0.80	0.85	0.86	0.85
Europe	SAS Airline	2013	0.91	0.93	0.90	0.93
Europe	SAS Airline	2014	0.90	0.87	0.86	0.87
Europe	SAS Airline	2015	0.91	0.93	0.89	0.93
Europe	SAS Airline	2016	0.96	0.91	0.92	0.91
Europe	SAS Airline	2017	1.00	1.00	0.96	1.00
Europe	SAS Airline	2018	1.06	1.00	0.00	1.00
Europe	Turkish Airlines	2011	0.00	0.85	0.88	0.86
Europe	Turkish Airlines	2012	0.89	0.94	0.95	0.94
Europe	Turkish Airlines	2013	0.94	0.93	0.92	0.94
Europe	Turkish Airlines	2014	0.98	0.96	1.00	0.99
Europe	Turkish Airlines	2015	0.95	0.92	0.90	0.92
Europe	Turkish Airlines	2016	0.92	0.82	0.86	0.87
Europe	Turkish Airlines	2017	0.90	0.90	0.88	0.90
Europe	Turkish Airlines	2018	0.94	0.91	0.00	0.91
Middle East	Emirates Airline	2011	0.00	0.98	0.99	1.00
Middle East	Emirates Airline	2012	0.99	1.00	0.99	1.00
Middle East	Emirates Airline	2013	1.02	1.00	0.99	1.00
Middle East	Emirates Airline	2014	1.05	1.00	1.05	1.00
Middle East	Emirates Airline	2015	1.23	1.00	1.05	1.00
Middle East	Emirates Airline	2016	1.04	1.00	1.01	1.00
Middle East	Emirates Airline	2017	1.10	1.00	1.02	1.00
Middle East	Emirates Airline	2018	1.08	1.00	0.00	1.00
Middle East	Etihad Airline	2011	0.00	1.00	1.18	1.00
Middle East	Etihad Airline	2012	1.00	1.00	1.15	1.00
Middle East	Etihad Airline	2013	0.98	1.00	1.08	1.00
Middle East	Etihad Airline	2014	0.96	0.93	0.91	0.95
Middle East	Etihad Airline	2015	0.93	0.86	0.92	0.86
Middle East	Etihad Airline	2016	0.97	0.84	0.93	0.85
Middle East	Etihad Airline	2017	0.92	1.00	0.95	1.00
Middle East	Etihad Airline	2018	1.06	1.00	0.00	1.00
Middle East	Qatar Airways	2011	0.00	1.00	1.10	1.00
Middle East	Qatar Airways	2012	1.02	1.00	1.10	1.00
Middle East	Qatar Airways	2013	0.96	1.00	1.14	1.00
Middle East	Qatar Airways	2014	1.00	1.00	0.92	1.00
Middle East	Qatar Airways	2015	1.02	0.95	0.91	0.95
Middle East	Qatar Airways	2016	0.91	0.87	0.91	0.91
Middle East	Qatar Airways	2017	0.83	0.86	0.85	0.87
Middle East	Qatar Airways	2018	0.82	0.82	0.00	0.82
North America	Air Canada	2011	0.00	0.80	0.86	0.81
North America	Air Canada	2012	0.82	0.88	0.88	0.92
North America	Air Canada	2013	0.89	0.89	0.88	0.92
North America	Air Canada	2014	0.91	0.89	0.85	0.92
North America	Air Canada	2015	0.94	0.89	0.88	0.89
North America	Air Canada	2016	0.87	0.87	0.87	0.87
North America	Air Canada	2017	0.86	0.87	0.87	0.88
North America	Air Canada	2018	0.88	0.88	0.00	0.89
North America	Alaska	2011	0.00	0.90	0.95	0.91
North America	Alaska	2012	0.91	0.96	0.96	1.00
North America	Alaska	2013	1.01	1.00	0.99	1.00
North America	Alaska	2014	1.02	1.00	0.95	1.00

North America	Alaska	2015	1.07	1.00	1.02	1.00
North America	Alaska	2016	1.54	1.00	1.51	1.00
North America	Alaska	2017	0.92	0.91	0.91	0.92
North America	Alaska	2018	0.84	0.84	0.00	0.84
North America	Delta Airlines	2011	0.00	0.87	0.93	1.00
North America	Delta Airlines	2012	0.88	0.94	0.96	1.00
North America	Delta Airlines	2013	0.97	0.99	0.96	1.00
North America	Delta Airlines	2014	0.97	0.94	1.02	1.00
North America	Delta Airlines	2015	1.08	1.00	1.03	1.00
North America	Delta Airlines	2016	0.99	1.00	1.03	1.00
North America	Delta Airlines	2017	1.05	1.00	1.01	1.00
North America	Delta Airlines	2018	1.10	1.00	0.00	1.00
North America	Hawaiian Airlines	2011	0.00	1.00	1.16	1.00
North America	Hawaiian Airlines	2012	1.00	1.00	1.11	1.00
North America	Hawaiian Airlines	2013	0.99	1.00	1.02	1.00
North America	Hawaiian Airlines	2014	1.05	1.00	1.00	1.00
North America	Hawaiian Airlines	2015	1.11	1.00	1.05	1.00
North America	Hawaiian Airlines	2016	0.97	1.00	1.01	1.00
North America	Hawaiian Airlines	2017	1.01	1.00	1.06	1.00
North America	Hawaiian Airlines	2018	0.94	0.98	0.00	1.00
North America	Jet Blue	2011	0.00	0.88	0.92	0.88
North America	Jet Blue	2012	0.89	0.93	0.93	0.95
North America	Jet Blue	2013	0.94	0.93	0.92	0.93
North America	Jet Blue	2014	0.94	0.92	0.88	0.92
North America	Jet Blue	2015	1.03	0.97	0.97	0.98
North America	Jet Blue	2016	0.98	0.98	0.97	0.98
North America	Jet Blue	2017	0.92	0.91	0.91	0.91
North America	Jet Blue	2018	0.83	0.84	0.00	0.84
North America	Southwest	2011	0.00	0.81	0.88	0.87
North America	Southwest	2012	0.82	0.88	0.88	0.95
North America	Southwest	2013	0.91	0.91	0.89	0.96
North America	Southwest	2014	0.96	0.94	0.89	1.00
North America	Southwest	2015	1.04	0.98	0.99	1.00
North America	Southwest	2016	0.94	0.95	0.94	0.98
North America	Southwest	2017	0.94	0.92	0.92	1.00
North America	Southwest	2018	0.91	0.91	0.00	0.99
North America	United Airways	2011	0.00	0.85	0.90	1.00
North America	United Airways	2012	0.82	0.86	0.87	1.00
North America	United Airways	2013	0.89	0.90	0.88	1.00
North America	United Airways	2014	0.93	0.91	0.86	1.00
North America	United Airways	2015	0.97	0.92	0.91	0.94
North America	United Airways	2016	0.90	0.89	0.89	0.94
North America	United Airways	2017	0.87	0.88	0.88	0.95
North America	United Airways	2018	0.87	0.88	0.00	0.96
North America	West Jet Airlines	2011	0.00	0.94	0.96	0.96
North America	West Jet Airlines	2012	0.94	0.97	1.01	1.00
North America	West Jet Airlines	2013	0.97	1.00	0.98	1.00
North America	West Jet Airlines	2014	1.00	0.98	0.90	0.99
North America	West Jet Airlines	2015	1.01	0.93	0.95	0.93
North America	West Jet Airlines	2016	0.90	0.91	0.91	0.92
North America	West Jet Airlines	2017	0.90	0.89	0.90	0.89
North America	West Jet Airlines	2018	0.83	0.84	0.00	0.85
South America	LATAM Airlines	2011	0.00	1.00	1.63	1.00
South America	LATAM Airlines	2012	0.78	0.86	0.89	0.91
South America	LATAM Airlines	2013	0.90	0.92	0.91	0.94
South America	LATAM Airlines	2014	0.92	0.91	0.85	0.92

South America	LATAM Airlines	2015	0.92	0.87	0.84	0.87
South America	LATAM Airlines	2016	0.90	0.85	0.88	0.88
South America	LATAM Airlines	2017	0.87	0.90	0.88	0.90
South America	LATAM Airlines	2018	1.04	1.00	0.00	1.00

Appendix 11 Distance Summary Index Output DEAP Results

Region	DMU	Year	CRS te (t-1)	CRS te (t)	CRS te (t+1)	VRS te
Africa	Ethiopian Airlines	2011	0.00	1.00	1.25	1.00
Africa	Ethiopian Airlines	2012	1.02	1.00	1.08	1.00
Africa	Ethiopian Airlines	2013	1.06	1.00	1.10	1.00
Africa	Ethiopian Airlines	2014	1.01	1.00	1.03	1.00
Africa	Ethiopian Airlines	2015	1.01	1.00	0.91	1.00
Africa	Ethiopian Airlines	2016	1.04	0.94	1.06	0.95
Africa	Ethiopian Airlines	2017	0.87	0.94	0.94	0.95
Africa	Ethiopian Airlines	2018	0.87	0.87	0.00	0.87
Africa	Kenya Air	2011	0.00	1.00	1.15	1.00
Africa	Kenya Air	2012	0.96	1.00	1.28	1.00
Africa	Kenya Air	2013	1.01	1.00	1.11	1.00
Africa	Kenya Air	2014	0.96	1.00	1.18	1.00
Africa	Kenya Air	2015	0.90	1.00	0.87	1.00
Africa	Kenya Air	2016	1.28	1.00	0.93	1.00
Africa	Kenya Air	2017	1.21	1.00	1.01	1.00
Africa	Kenya Air	2018	1.11	1.00	0.00	1.00
Africa	South Africa Airways	2011	0.00	0.90	0.98	0.91
Africa	South Africa Airways	2012	0.85	0.88	0.93	0.95
Africa	South Africa Airways	2013	0.92	1.00	0.99	1.00
Africa	South Africa Airways	2014	1.19	1.00	1.11	1.00
Africa	South Africa Airways	2015	0.90	0.88	0.90	0.89
Africa	South Africa Airways	2016	0.94	0.95	1.01	0.97
Africa	South Africa Airways	2017	0.81	0.84	0.87	0.89
Africa	South Africa Airways	2018	0.84	0.86	0.00	0.92
Asia & Pacific	Air China	2011	0.00	0.92	1.02	1.00
Asia & Pacific	Air China	2012	0.94	1.00	1.06	1.00
Asia & Pacific	Air China	2013	0.97	1.00	0.96	1.00
Asia & Pacific	Air China	2014	1.05	1.00	1.03	1.00
Asia & Pacific	Air China	2015	1.02	1.00	0.95	1.00
Asia & Pacific	Air China	2016	1.15	1.00	1.12	1.00
Asia & Pacific	Air China	2017	0.98	1.00	0.99	1.00
Asia & Pacific	Air China	2018	1.09	1.00	0.00	1.00
Asia & Pacific	Cathay Pacific	2011	0.00	1.00	1.03	1.00
Asia & Pacific	Cathay Pacific	2012	1.00	1.00	1.02	1.00
Asia & Pacific	Cathay Pacific	2013	1.00	1.00	1.00	1.00
Asia & Pacific	Cathay Pacific	2014	1.01	1.00	1.07	1.00
Asia & Pacific	Cathay Pacific	2015	1.00	1.00	1.04	1.00
Asia & Pacific	Cathay Pacific	2016	0.99	1.00	0.96	1.00
Asia & Pacific	Cathay Pacific	2017	1.06	1.00	0.95	1.00
Asia & Pacific	Cathay Pacific	2018	1.07	1.00	0.00	1.00
Asia & Pacific	China Easternairways	2011	0.00	0.74	0.88	0.95
Asia & Pacific	China Easternairways	2012	0.74	0.87	0.89	0.97
Asia & Pacific	China Easternairways	2013	0.84	0.86	0.85	0.95
Asia & Pacific	China Easternairways	2014	0.89	0.88	0.83	0.94
Asia & Pacific	China Easternairways	2015	0.93	0.88	0.85	0.95
Asia & Pacific	China Easternairways	2016	0.88	0.85	0.84	0.95
Asia & Pacific	China Easternairways	2017	0.81	0.81	0.80	0.93
Asia & Pacific	China Easternairways	2018	0.81	0.80	0.00	0.95
Asia & Pacific	Japan Airlines	2011	0.00	0.90	1.02	0.90
Asia & Pacific	Japan Airlines	2012	0.89	1.00	1.03	1.00
Asia & Pacific	Japan Airlines	2013	0.98	1.00	0.98	1.00
Asia & Pacific	Japan Airlines	2014	1.01	0.99	0.92	1.00
Asia & Pacific	Japan Airlines	2015	1.01	0.95	0.95	0.95
Asia & Pacific	Japan Airlines	2016	0.93	0.92	0.92	0.93
Asia & Pacific	Japan Airlines	2017	0.92	0.92	0.91	0.93
Asia & Pacific	Japan Airlines	2018	0.93	0.92	0.00	0.93
Asia & Pacific	Korea Air	2011	0.00	1.00	1.30	1.00
Asia & Pacific	Korea Air	2012	0.97	1.00	1.04	1.00

Asia & Pacific	Korea Air	2013	0.99	1.00	0.97	1.00
Asia & Pacific	Korea Air	2014	1.06	1.00	1.16	1.00
Asia & Pacific	Korea Air	2015	1.06	1.00	0.98	1.00
Asia & Pacific	Korea Air	2016	1.05	1.00	1.02	1.00
Asia & Pacific	Korea Air	2017	1.03	1.00	1.02	1.00
Asia & Pacific	Korea Air	2018	1.02	1.00	0.00	1.00
Asia & Pacific	Qantas	2011	0.00	0.88	0.92	0.98
Asia & Pacific	Qantas	2012	0.86	0.90	0.91	0.97
Asia & Pacific	Qantas	2013	0.90	0.92	0.90	0.95
Asia & Pacific	Qantas	2014	0.88	0.85	0.83	0.89
Asia & Pacific	Qantas	2015	0.95	0.92	0.88	0.92
Asia & Pacific	Qantas	2016	0.94	0.90	0.92	0.93
Asia & Pacific	Qantas	2017	0.89	0.91	0.92	0.93
Asia & Pacific	Qantas	2018	0.92	0.93	0.00	0.96
Asia & Pacific	Singapore Airline	2011	0.00	1.00	1.02	1.00
Asia & Pacific	Singapore Airline	2012	1.01	1.00	1.02	1.00
Asia & Pacific	Singapore Airline	2013	1.00	1.00	1.03	1.00
Asia & Pacific	Singapore Airline	2014	1.02	1.00	1.07	1.00
Asia & Pacific	Singapore Airline	2015	1.01	1.00	1.26	1.00
Asia & Pacific	Singapore Airline	2016	0.94	0.94	0.91	0.96
Asia & Pacific	Singapore Airline	2017	0.93	0.92	0.93	0.96
Asia & Pacific	Singapore Airline	2018	0.92	0.93	0.00	0.97
Asia & Pacific	Thai Airways	2011	0.00	0.89	0.91	0.89
Asia & Pacific	Thai Airways	2012	0.96	0.98	1.00	0.98
Asia & Pacific	Thai Airways	2013	0.87	0.89	0.88	0.93
Asia & Pacific	Thai Airways	2014	0.88	0.85	0.83	0.86
Asia & Pacific	Thai Airways	2015	0.89	0.86	0.92	0.89
Asia & Pacific	Thai Airways	2016	0.90	0.91	0.92	0.91
Asia & Pacific	Thai Airways	2017	0.92	0.96	0.96	0.97
Asia & Pacific	Thai Airways	2018	0.90	0.91	0.00	0.95
Europe	Aer Lingus	2011	0.00	1.00	1.03	1.00
Europe	Aer Lingus	2012	1.03	1.00	1.07	1.00
Europe	Aer Lingus	2013	1.00	1.00	1.06	1.00
Europe	Aer Lingus	2014	1.03	1.00	1.06	1.00
Europe	Aer Lingus	2015	1.13	1.00	1.02	1.00
Europe	Aer Lingus	2016	1.06	1.00	1.12	1.00
Europe	Aer Lingus	2017	1.00	1.00	1.05	1.00
Europe	Aer Lingus	2018	1.06	1.00	0.00	1.00
Europe	Aeroflot	2011	0.00	0.78	0.91	0.89
Europe	Aeroflot	2012	0.83	0.90	0.92	0.93
Europe	Aeroflot	2013	0.93	0.95	0.94	0.96
Europe	Aeroflot	2014	0.92	0.91	0.86	0.91
Europe	Aeroflot	2015	0.97	0.92	0.90	0.92
Europe	Aeroflot	2016	0.94	0.92	0.93	0.93
Europe	Aeroflot	2017	0.87	0.89	0.89	0.93
Europe	Aeroflot	2018	0.86	0.87	0.00	0.92
Europe	Alitalia	2011	0.00	0.83	0.87	0.86
Europe	Alitalia	2012	0.77	0.82	0.84	0.88
Europe	Alitalia	2013	0.84	0.85	0.83	0.88
Europe	Alitalia	2014	0.86	0.84	0.79	0.89
Europe	Alitalia	2015	0.87	0.81	0.81	0.88
Europe	Alitalia	2016	0.73	0.72	0.73	0.91
Europe	Alitalia	2017	0.69	0.70	0.70	0.90
Europe	Alitalia	2018	0.75	0.76	0.00	0.92
Europe	British Airways Plc	2011	0.00	0.88	0.91	0.99
Europe	British Airways Plc	2012	0.90	0.94	0.96	0.99
Europe	British Airways Plc	2013	0.96	0.99	0.97	1.00
Europe	British Airways Plc	2014	1.02	1.00	0.95	1.00
Europe	British Airways Plc	2015	1.04	0.98	0.94	0.98
Europe	British Airways Plc	2016	0.99	0.95	0.98	1.00
Europe	British Airways Plc	2017	0.95	0.99	0.99	1.00
Europe	British Airways Plc	2018	0.98	0.98	0.00	1.00
Europe	Easy Jet	2011	0.00	1.00	1.06	1.00

Europe	Easy Jet	2012	1.01	1.00	1.02	1.00
Europe	Easy Jet	2013	1.03	1.00	0.98	1.00
Europe	Easy Jet	2014	1.06	1.00	1.02	1.00
Europe	Easy Jet	2015	1.04	1.00	0.95	1.00
Europe	Easy Jet	2016	1.00	0.92	0.96	1.00
Europe	Easy Jet	2017	0.91	0.95	0.98	1.00
Europe	Easy Jet	2018	0.95	0.96	0.00	1.00
Europe	Finair	2011	0.00	0.83	0.84	0.87
Europe	Finair	2012	0.92	0.93	0.94	0.96
Europe	Finair	2013	0.97	0.98	0.95	1.00
Europe	Finair	2014	1.05	1.00	1.00	1.00
Europe	Finair	2015	1.07	1.00	1.03	1.00
Europe	Finair	2016	1.00	1.00	1.05	1.00
Europe	Finair	2017	0.99	1.00	1.03	1.00
Europe	Finair	2018	1.01	1.00	0.00	1.00
Europe	Iberia	2011	0.00	0.89	0.91	0.96
Europe	Iberia	2012	0.86	0.87	0.89	0.99
Europe	Iberia	2013	0.82	0.84	0.81	0.93
Europe	Iberia	2014	0.86	0.83	0.80	0.92
Europe	Iberia	2015	0.89	0.84	0.81	0.91
Europe	Iberia	2016	1.03	1.00	1.00	1.00
Europe	Iberia	2017	1.02	1.00	1.00	1.00
Europe	Iberia	2018	1.01	1.00	0.00	1.00
Europe	KLM	2011	0.00	1.00	1.23	1.00
Europe	KLM	2012	0.90	0.97	0.98	1.00
Europe	KLM	2013	0.98	1.00	0.99	1.00
Europe	KLM	2014	1.00	0.99	0.93	1.00
Europe	KLM	2015	1.01	0.95	0.93	1.00
Europe	KLM	2016	0.99	0.96	0.97	1.00
Europe	KLM	2017	0.99	1.00	0.99	1.00
Europe	KLM	2018	1.02	1.00	0.00	1.00
Europe	Lufthansa	2011	0.00	0.84	0.90	1.00
Europe	Lufthansa	2012	0.86	0.92	0.94	1.00
Europe	Lufthansa	2013	0.91	0.92	0.89	1.00
Europe	Lufthansa	2014	0.92	0.89	0.83	1.00
Europe	Lufthansa	2015	0.91	0.86	0.87	1.00
Europe	Lufthansa	2016	0.86	0.87	0.90	1.00
Europe	Lufthansa	2017	0.89	0.91	0.90	1.00
Europe	Lufthansa	2018	0.89	0.89	0.00	1.00
Europe	RyanAir	2011	0.00	1.00	1.14	1.00
Europe	RyanAir	2012	1.02	1.00	1.08	1.00
Europe	RyanAir	2013	1.06	1.00	1.05	1.00
Europe	RyanAir	2014	1.02	1.00	0.97	1.00
Europe	RyanAir	2015	1.07	1.00	1.01	1.00
Europe	RyanAir	2016	1.07	1.00	1.12	1.00
Europe	RyanAir	2017	1.10	1.00	1.04	1.00
Europe	RyanAir	2018	1.01	1.00	0.00	1.00
Europe	SAS Airline	2011	0.00	0.85	0.90	0.89
Europe	SAS Airline	2012	0.80	0.85	0.86	0.90
Europe	SAS Airline	2013	0.91	0.93	0.90	0.93
Europe	SAS Airline	2014	0.90	0.87	0.86	0.91
Europe	SAS Airline	2015	0.91	0.93	0.89	0.93
Europe	SAS Airline	2016	0.96	0.91	0.92	0.93
Europe	SAS Airline	2017	1.00	1.00	0.96	1.00
Europe	SAS Airline	2018	1.06	1.00	0.00	1.00
Europe	Turkish Airlines	2011	0.00	0.85	0.88	0.87
Europe	Turkish Airlines	2012	0.89	0.94	0.95	0.94
Europe	Turkish Airlines	2013	0.94	0.93	0.92	0.94
Europe	Turkish Airlines	2014	0.98	0.96	1.00	0.99
Europe	Turkish Airlines	2015	0.95	0.92	0.90	0.93
Europe	Turkish Airlines	2016	0.92	0.82	0.86	0.89
Europe	Turkish Airlines	2017	0.90	0.90	0.88	0.90
Europe	Turkish Airlines	2018	0.94	0.91	0.00	0.93

Middle East	Emirates Airline	2011	0.00	0.98	0.99	1.00
Middle East	Emirates Airline	2012	0.99	1.00	0.99	1.00
Middle East	Emirates Airline	2013	1.02	1.00	0.99	1.00
Middle East	Emirates Airline	2014	1.05	1.00	1.05	1.00
Middle East	Emirates Airline	2015	1.23	1.00	1.05	1.00
Middle East	Emirates Airline	2016	1.04	1.00	1.01	1.00
Middle East	Emirates Airline	2017	1.10	1.00	1.02	1.00
Middle East	Emirates Airline	2018	1.08	1.00	0.00	1.00
Middle East	Etihad Airline	2011	0.00	1.00	1.18	1.00
Middle East	Etihad Airline	2012	1.00	1.00	1.15	1.00
Middle East	Etihad Airline	2013	0.98	1.00	1.08	1.00
Middle East	Etihad Airline	2014	0.96	0.93	0.91	0.97
Middle East	Etihad Airline	2015	0.93	0.86	0.92	0.96
Middle East	Etihad Airline	2016	0.97	0.84	0.93	0.92
Middle East	Etihad Airline	2017	0.92	1.00	0.95	1.00
Middle East	Etihad Airline	2018	1.06	1.00	0.00	1.00
Middle East	Qatar Airways	2011	0.00	1.00	1.10	1.00
Middle East	Qatar Airways	2012	1.02	1.00	1.10	1.00
Middle East	Qatar Airways	2013	0.96	1.00	1.14	1.00
Middle East	Qatar Airways	2014	1.00	1.00	0.92	1.00
Middle East	Qatar Airways	2015	1.02	0.95	0.91	0.95
Middle East	Qatar Airways	2016	0.91	0.87	0.91	0.91
Middle East	Qatar Airways	2017	0.83	0.86	0.85	0.86
Middle East	Qatar Airways	2018	0.82	0.82	0.00	0.82
North America	Air Canada	2011	0.00	0.80	0.86	0.95
North America	Air Canada	2012	0.82	0.88	0.88	0.95
North America	Air Canada	2013	0.89	0.89	0.88	0.94
North America	Air Canada	2014	0.91	0.89	0.85	0.94
North America	Air Canada	2015	0.94	0.89	0.88	0.93
North America	Air Canada	2016	0.87	0.87	0.87	0.89
North America	Air Canada	2017	0.86	0.87	0.87	0.89
North America	Air Canada	2018	0.88	0.88	0.00	0.90
North America	Alaska	2011	0.00	0.90	0.95	0.99
North America	Alaska	2012	0.91	0.96	0.96	1.00
North America	Alaska	2013	1.01	1.00	0.99	1.00
North America	Alaska	2014	1.02	1.00	0.95	1.00
North America	Alaska	2015	1.07	1.00	1.02	1.00
North America	Alaska	2016	1.54	1.00	1.51	1.00
North America	Alaska	2017	0.92	0.91	0.91	0.92
North America	Alaska	2018	0.84	0.84	0.00	0.90
North America	Delta Airlines	2011	0.00	0.87	0.93	1.00
North America	Delta Airlines	2012	0.88	0.94	0.96	1.00
North America	Delta Airlines	2013	0.97	0.99	0.96	1.00
North America	Delta Airlines	2014	0.97	0.94	1.02	1.00
North America	Delta Airlines	2015	1.08	1.00	1.03	1.00
North America	Delta Airlines	2016	0.99	1.00	1.03	1.00
North America	Delta Airlines	2017	1.05	1.00	1.01	1.00
North America	Delta Airlines	2018	1.10	1.00	0.00	1.00
North America	Hawaiian Airlines	2011	0.00	1.00	1.16	1.00
North America	Hawaiian Airlines	2012	1.00	1.00	1.11	1.00
North America	Hawaiian Airlines	2013	0.99	1.00	1.02	1.00
North America	Hawaiian Airlines	2014	1.05	1.00	1.00	1.00
North America	Hawaiian Airlines	2015	1.11	1.00	1.05	1.00
North America	Hawaiian Airlines	2016	0.97	1.00	1.01	1.00
North America	Hawaiian Airlines	2017	1.01	1.00	1.06	1.00
North America	Hawaiian Airlines	2018	0.94	0.98	0.00	1.00
North America	Jet Blue	2011	0.00	0.88	0.92	0.95
North America	Jet Blue	2012	0.89	0.93	0.93	0.97
North America	Jet Blue	2013	0.94	0.93	0.92	0.96
North America	Jet Blue	2014	0.94	0.92	0.88	0.95
North America	Jet Blue	2015	1.03	0.97	0.97	0.99
North America	Jet Blue	2016	0.98	0.98	0.97	0.98
North America	Jet Blue	2017	0.92	0.91	0.91	0.93

North America	Jet Blue	2018	0.83	0.84	0.00	0.94
North America	Southwest	2011	0.00	0.81	0.88	0.95
North America	Southwest	2012	0.82	0.88	0.88	0.95
North America	Southwest	2013	0.91	0.91	0.89	0.97
North America	Southwest	2014	0.96	0.94	0.89	1.00
North America	Southwest	2015	1.04	0.98	0.99	1.00
North America	Southwest	2016	0.94	0.95	0.94	0.98
North America	Southwest	2017	0.94	0.92	0.92	1.00
North America	Southwest	2018	0.91	0.91	0.00	0.99
North America	United Airways	2011	0.00	0.85	0.90	1.00
North America	United Airways	2012	0.82	0.86	0.87	1.00
North America	United Airways	2013	0.89	0.90	0.88	1.00
North America	United Airways	2014	0.93	0.91	0.86	1.00
North America	United Airways	2015	0.97	0.92	0.91	0.98
North America	United Airways	2016	0.90	0.89	0.89	0.98
North America	United Airways	2017	0.87	0.88	0.88	0.96
North America	United Airways	2018	0.87	0.88	0.00	0.99
North America	West Jet Airlines	2011	0.00	0.94	0.96	0.98
North America	West Jet Airlines	2012	0.94	0.97	1.01	1.00
North America	West Jet Airlines	2013	0.97	1.00	0.98	1.00
North America	West Jet Airlines	2014	1.00	0.98	0.90	0.99
North America	West Jet Airlines	2015	1.01	0.93	0.95	0.98
North America	West Jet Airlines	2016	0.90	0.91	0.91	0.98
North America	West Jet Airlines	2017	0.90	0.89	0.90	0.96
North America	West Jet Airlines	2018	0.83	0.84	0.00	0.96
South America	LATAM Airlines	2011	0.00	1.00	1.63	1.00
South America	LATAM Airlines	2012	0.78	0.86	0.89	0.94
South America	LATAM Airlines	2013	0.90	0.92	0.91	0.95
South America	LATAM Airlines	2014	0.92	0.91	0.85	0.95
South America	LATAM Airlines	2015	0.92	0.87	0.84	0.94
South America	LATAM Airlines	2016	0.90	0.85	0.88	0.92
South America	LATAM Airlines	2017	0.87	0.90	0.88	0.91
South America	LATAM Airlines	2018	1.04	1.00	0.00	1.00

Appendix 12 Malmquist Productivity Index Input year wise DEAP Results

Region	DMU	Year	effch	techch	pech	sech	tfpch
Africa	Ethiopian Airlines	2011					
Africa	Ethiopian Airlines	2012	1.00	0.90	1.00	1.00	0.90
Africa	Ethiopian Airlines	2013	1.00	0.99	1.00	1.00	0.99
Africa	Ethiopian Airlines	2014	1.00	0.96	1.00	1.00	0.96
Africa	Ethiopian Airlines	2015	1.00	0.99	1.00	1.00	0.99
Africa	Ethiopian Airlines	2016	0.94	1.11	0.95	0.99	1.04
Africa	Ethiopian Airlines	2017	1.00	0.91	1.01	0.99	0.91
Africa	Ethiopian Airlines	2018	0.93	1.00	0.91	1.02	0.92
Africa	Kenya Air	2011					
Africa	Kenya Air	2012	1.00	0.92	1.00	1.00	0.92
Africa	Kenya Air	2013	1.00	0.89	1.00	1.00	0.89
Africa	Kenya Air	2014	1.00	0.93	1.00	1.00	0.93
Africa	Kenya Air	2015	1.00	0.88	1.00	1.00	0.88
Africa	Kenya Air	2016	1.00	1.22	1.00	1.00	1.22
Africa	Kenya Air	2017	1.00	1.14	1.00	1.00	1.14
Africa	Kenya Air	2018	1.00	1.05	1.00	1.00	1.05
Africa	South Africa Airways	2011					
Africa	South Africa Airways	2012	0.98	0.94	0.97	1.01	0.92
Africa	South Africa Airways	2013	1.13	0.94	1.13	1.00	1.06
Africa	South Africa Airways	2014	1.00	1.10	1.00	1.00	1.10
Africa	South Africa Airways	2015	0.88	0.96	0.94	0.94	0.84
Africa	South Africa Airways	2016	1.08	0.99	1.05	1.02	1.07
Africa	South Africa Airways	2017	0.89	0.95	0.89	1.00	0.84
Africa	South Africa Airways	2018	1.03	0.97	1.02	1.00	0.99
Asia & Pacific	Air China	2011					
Asia & Pacific	Air China	2012	1.09	0.92	1.00	1.09	1.00
Asia & Pacific	Air China	2013	1.00	0.96	1.00	1.00	0.96
Asia & Pacific	Air China	2014	1.00	1.04	1.00	1.00	1.04
Asia & Pacific	Air China	2015	1.00	0.99	1.00	1.00	0.99
Asia & Pacific	Air China	2016	1.00	1.10	1.00	1.00	1.10
Asia & Pacific	Air China	2017	1.00	0.94	1.00	1.00	0.94
Asia & Pacific	Air China	2018	1.00	1.05	1.00	1.00	1.05
Asia & Pacific	Cathay Pacific	2011					
Asia & Pacific	Cathay Pacific	2012	1.00	0.99	1.00	1.00	0.99
Asia & Pacific	Cathay Pacific	2013	1.00	0.99	1.00	1.00	0.99
Asia & Pacific	Cathay Pacific	2014	1.00	1.00	1.00	1.00	1.00
Asia & Pacific	Cathay Pacific	2015	1.00	0.97	1.00	1.00	0.97
Asia & Pacific	Cathay Pacific	2016	1.00	0.98	1.00	1.00	0.98
Asia & Pacific	Cathay Pacific	2017	1.00	1.05	1.00	1.00	1.05
Asia & Pacific	Cathay Pacific	2018	1.00	1.06	1.00	1.00	1.06
Asia & Pacific	China Easternairways	2011					
Asia & Pacific	China Easternairways	2012	1.19	0.84	1.11	1.07	1.00
Asia & Pacific	China Easternairways	2013	0.98	0.98	0.99	1.00	0.96
Asia & Pacific	China Easternairways	2014	1.03	1.01	1.00	1.03	1.04
Asia & Pacific	China Easternairways	2015	1.00	1.06	1.01	0.99	1.06
Asia & Pacific	China Easternairways	2016	0.96	1.04	1.01	0.95	1.00
Asia & Pacific	China Easternairways	2017	0.96	1.00	0.97	0.99	0.96
Asia & Pacific	China Easternairways	2018	0.98	1.02	1.02	0.96	1.00
Asia & Pacific	Japan Airlines	2011					
Asia & Pacific	Japan Airlines	2012	1.11	0.89	1.11	1.00	0.99
Asia & Pacific	Japan Airlines	2013	1.00	0.97	1.00	1.00	0.97
Asia & Pacific	Japan Airlines	2014	0.99	1.02	1.00	0.99	1.01
Asia & Pacific	Japan Airlines	2015	0.96	1.07	0.95	1.01	1.03
Asia & Pacific	Japan Airlines	2016	0.97	1.00	0.98	1.00	0.98
Asia & Pacific	Japan Airlines	2017	1.00	1.00	1.00	1.00	1.00
Asia & Pacific	Japan Airlines	2018	1.00	1.01	1.00	1.00	1.01
Asia & Pacific	Korea Air	2011					
Asia & Pacific	Korea Air	2012	1.00	0.87	1.00	1.00	0.87
Asia & Pacific	Korea Air	2013	1.00	0.98	1.00	1.00	0.98

Asia & Pacific	Korea Air	2014	1.00	1.05	1.00	1.00	1.05
Asia & Pacific	Korea Air	2015	1.00	0.96	1.00	1.00	0.96
Asia & Pacific	Korea Air	2016	1.00	1.04	1.00	1.00	1.04
Asia & Pacific	Korea Air	2017	1.00	1.01	1.00	1.00	1.01
Asia & Pacific	Korea Air	2018	1.00	1.00	1.00	1.00	1.00
Asia & Pacific	Qantas	2011					
Asia & Pacific	Qantas	2012	1.02	0.96	0.99	1.02	0.98
Asia & Pacific	Qantas	2013	1.02	0.98	0.99	1.03	1.00
Asia & Pacific	Qantas	2014	0.93	1.03	0.94	0.99	0.96
Asia & Pacific	Qantas	2015	1.07	1.03	1.05	1.02	1.11
Asia & Pacific	Qantas	2016	0.98	1.04	1.01	0.97	1.02
Asia & Pacific	Qantas	2017	1.01	0.98	1.00	1.01	0.99
Asia & Pacific	Qantas	2018	1.02	0.99	1.02	1.00	1.01
Asia & Pacific	Singapore Airline	2011					
Asia & Pacific	Singapore Airline	2012	1.00	0.99	1.00	1.00	0.99
Asia & Pacific	Singapore Airline	2013	1.00	0.99	1.00	1.00	0.99
Asia & Pacific	Singapore Airline	2014	1.00	1.00	1.00	1.00	1.00
Asia & Pacific	Singapore Airline	2015	1.00	0.97	1.00	1.00	0.97
Asia & Pacific	Singapore Airline	2016	0.94	0.89	0.94	1.00	0.84
Asia & Pacific	Singapore Airline	2017	0.98	1.02	0.98	1.00	1.00
Asia & Pacific	Singapore Airline	2018	1.01	0.99	1.02	0.99	1.00
Asia & Pacific	Thai Airways	2011					
Asia & Pacific	Thai Airways	2012	1.10	0.98	1.09	1.00	1.08
Asia & Pacific	Thai Airways	2013	0.91	0.98	0.91	1.00	0.89
Asia & Pacific	Thai Airways	2014	0.96	1.03	0.96	0.99	0.98
Asia & Pacific	Thai Airways	2015	1.01	1.03	1.01	0.99	1.04
Asia & Pacific	Thai Airways	2016	1.06	0.96	1.06	1.00	1.02
Asia & Pacific	Thai Airways	2017	1.05	0.98	1.04	1.01	1.03
Asia & Pacific	Thai Airways	2018	0.95	0.99	0.95	1.00	0.95
Europe	Aer Lingus	2011					
Europe	Aer Lingus	2012	1.00	1.00	1.00	1.00	1.00
Europe	Aer Lingus	2013	1.00	0.97	1.00	1.00	0.97
Europe	Aer Lingus	2014	1.00	0.99	1.00	1.00	0.99
Europe	Aer Lingus	2015	1.00	1.03	1.00	1.00	1.03
Europe	Aer Lingus	2016	1.00	1.02	1.00	1.00	1.02
Europe	Aer Lingus	2017	1.00	0.94	1.00	1.00	0.94
Europe	Aer Lingus	2018	1.00	1.00	1.00	1.00	1.00
Europe	Aeroflot	2011					
Europe	Aeroflot	2012	1.15	0.89	1.17	0.99	1.03
Europe	Aeroflot	2013	1.06	0.97	1.05	1.01	1.03
Europe	Aeroflot	2014	0.95	1.01	0.95	1.00	0.96
Europe	Aeroflot	2015	1.01	1.06	1.01	1.00	1.07
Europe	Aeroflot	2016	1.00	1.02	1.01	0.99	1.02
Europe	Aeroflot	2017	0.96	0.98	0.98	0.99	0.95
Europe	Aeroflot	2018	0.98	0.99	0.99	0.99	0.97
Europe	Alitalia	2011					
Europe	Alitalia	2012	0.99	0.94	0.99	1.00	0.93
Europe	Alitalia	2013	1.04	0.98	1.04	1.00	1.02
Europe	Alitalia	2014	0.98	1.03	0.98	1.00	1.01
Europe	Alitalia	2015	0.97	1.07	0.97	1.00	1.04
Europe	Alitalia	2016	0.89	1.01	0.89	1.00	0.90
Europe	Alitalia	2017	0.97	0.99	0.97	1.00	0.95
Europe	Alitalia	2018	1.09	0.99	1.08	1.00	1.07
Europe	British Airways Plc	2011					
Europe	British Airways Plc	2012	1.06	0.97	1.03	1.03	1.03
Europe	British Airways Plc	2013	1.06	0.98	1.02	1.04	1.03
Europe	British Airways Plc	2014	1.01	1.02	1.00	1.01	1.03
Europe	British Airways Plc	2015	0.98	1.06	0.98	1.00	1.04
Europe	British Airways Plc	2016	0.97	1.05	1.02	0.95	1.01
Europe	British Airways Plc	2017	1.04	0.96	1.00	1.04	1.01
Europe	British Airways Plc	2018	0.99	1.00	1.00	1.00	1.00
Europe	Easy Jet	2011					
Europe	Easy Jet	2012	1.00	0.98	1.00	1.00	0.98

Europe	Easy Jet	2013	1.00	1.01	1.00	1.00	1.01
Europe	Easy Jet	2014	1.00	1.04	1.00	1.00	1.04
Europe	Easy Jet	2015	1.00	1.01	1.00	1.00	1.01
Europe	Easy Jet	2016	0.92	1.07	1.00	0.92	0.98
Europe	Easy Jet	2017	1.04	0.95	1.00	1.04	0.99
Europe	Easy Jet	2018	1.01	0.98	1.00	1.01	0.99
Europe	Finnair	2011					
Europe	Finnair	2012	1.12	0.99	1.12	1.00	1.11
Europe	Finnair	2013	1.06	0.99	1.08	0.98	1.05
Europe	Finnair	2014	1.02	1.04	1.00	1.02	1.06
Europe	Finnair	2015	1.00	1.03	1.00	1.00	1.03
Europe	Finnair	2016	1.00	0.99	1.00	1.00	0.99
Europe	Finnair	2017	1.00	0.97	1.00	1.00	0.97
Europe	Finnair	2018	1.00	0.99	1.00	1.00	0.99
Europe	Iberia	2011					
Europe	Iberia	2012	0.98	0.98	1.06	0.92	0.96
Europe	Iberia	2013	0.96	0.98	0.89	1.08	0.94
Europe	Iberia	2014	1.00	1.03	1.00	1.00	1.03
Europe	Iberia	2015	1.01	1.05	1.01	1.00	1.06
Europe	Iberia	2016	1.19	1.03	1.19	1.00	1.23
Europe	Iberia	2017	1.00	1.01	1.00	1.00	1.01
Europe	Iberia	2018	1.00	1.00	1.00	1.00	1.00
Europe	KLM	2011					
Europe	KLM	2012	0.97	0.87	1.00	0.97	0.84
Europe	KLM	2013	1.04	0.98	1.00	1.04	1.02
Europe	KLM	2014	0.99	1.01	1.00	0.99	1.00
Europe	KLM	2015	0.97	1.06	1.00	0.97	1.02
Europe	KLM	2016	1.01	1.03	1.00	1.01	1.04
Europe	KLM	2017	1.04	0.99	1.00	1.04	1.03
Europe	KLM	2018	1.00	1.01	1.00	1.00	1.01
Europe	Lufthansa	2011					
Europe	Lufthansa	2012	1.10	0.93	1.00	1.10	1.03
Europe	Lufthansa	2013	1.01	0.98	1.00	1.01	0.99
Europe	Lufthansa	2014	0.96	1.04	1.00	0.96	1.00
Europe	Lufthansa	2015	0.96	1.07	1.00	0.96	1.03
Europe	Lufthansa	2016	1.02	0.99	1.00	1.02	1.01
Europe	Lufthansa	2017	1.04	0.98	1.00	1.04	1.01
Europe	Lufthansa	2018	0.98	1.01	1.00	0.98	0.98
Europe	RyanAir	2011					
Europe	RyanAir	2012	1.00	0.95	1.00	1.00	0.95
Europe	RyanAir	2013	1.00	0.99	1.00	1.00	0.99
Europe	RyanAir	2014	1.00	0.99	1.00	1.00	0.99
Europe	RyanAir	2015	1.00	1.05	1.00	1.00	1.05
Europe	RyanAir	2016	1.00	1.03	1.00	1.00	1.03
Europe	RyanAir	2017	1.00	0.99	1.00	1.00	0.99
Europe	RyanAir	2018	1.00	0.99	1.00	1.00	0.99
Europe	SAS Airline	2011					
Europe	SAS Airline	2012	1.00	0.94	1.00	1.00	0.94
Europe	SAS Airline	2013	1.09	0.99	1.09	1.00	1.07
Europe	SAS Airline	2014	0.94	1.03	0.94	1.00	0.97
Europe	SAS Airline	2015	1.07	1.00	1.07	1.00	1.07
Europe	SAS Airline	2016	0.98	1.05	0.98	1.00	1.03
Europe	SAS Airline	2017	1.10	0.99	1.10	1.00	1.09
Europe	SAS Airline	2018	1.00	1.05	1.00	1.00	1.05
Europe	Turkish Airlines	2011					
Europe	Turkish Airlines	2012	1.10	0.96	1.10	1.00	1.06
Europe	Turkish Airlines	2013	0.99	1.00	0.99	1.00	0.99
Europe	Turkish Airlines	2014	1.03	1.02	1.06	0.98	1.05
Europe	Turkish Airlines	2015	0.96	0.99	0.93	1.03	0.95
Europe	Turkish Airlines	2016	0.89	1.07	0.95	0.94	0.95
Europe	Turkish Airlines	2017	1.10	0.98	1.03	1.07	1.07
Europe	Turkish Airlines	2018	1.01	1.03	1.01	1.00	1.04
Middle East	Emirates Airline	2011					

Middle East	Emirates Airline	2012	1.02	0.99	1.00	1.02	1.01
Middle East	Emirates Airline	2013	1.00	1.01	1.00	1.00	1.01
Middle East	Emirates Airline	2014	1.00	1.03	1.00	1.00	1.03
Middle East	Emirates Airline	2015	1.00	1.08	1.00	1.00	1.08
Middle East	Emirates Airline	2016	1.00	1.00	1.00	1.00	1.00
Middle East	Emirates Airline	2017	1.00	1.04	1.00	1.00	1.04
Middle East	Emirates Airline	2018	1.00	1.03	1.00	1.00	1.03
Middle East	Etihad Airline	2011					
Middle East	Etihad Airline	2012	1.00	0.92	1.00	1.00	0.92
Middle East	Etihad Airline	2013	1.00	0.92	1.00	1.00	0.92
Middle East	Etihad Airline	2014	0.93	0.98	0.95	0.99	0.91
Middle East	Etihad Airline	2015	0.92	1.06	0.91	1.01	0.97
Middle East	Etihad Airline	2016	0.98	1.03	0.98	1.00	1.01
Middle East	Etihad Airline	2017	1.19	0.91	1.18	1.01	1.08
Middle East	Etihad Airline	2018	1.00	1.06	1.00	1.00	1.06
Middle East	Qatar Airways	2011					
Middle East	Qatar Airways	2012	1.00	0.97	1.00	1.00	0.97
Middle East	Qatar Airways	2013	1.00	0.93	1.00	1.00	0.93
Middle East	Qatar Airways	2014	1.00	0.94	1.00	1.00	0.94
Middle East	Qatar Airways	2015	0.95	1.08	0.95	1.00	1.03
Middle East	Qatar Airways	2016	0.91	1.04	0.95	0.96	0.95
Middle East	Qatar Airways	2017	0.99	0.96	0.95	1.04	0.95
Middle East	Qatar Airways	2018	0.95	1.01	0.95	1.00	0.96
North America	Air Canada	2011					
North America	Air Canada	2012	1.09	0.94	1.14	0.96	1.02
North America	Air Canada	2013	1.02	1.00	1.00	1.02	1.01
North America	Air Canada	2014	1.00	1.02	1.00	1.00	1.02
North America	Air Canada	2015	1.00	1.05	0.97	1.03	1.05
North America	Air Canada	2016	0.98	1.01	0.98	1.00	0.99
North America	Air Canada	2017	1.00	1.00	1.01	0.99	1.00
North America	Air Canada	2018	1.02	0.99	1.02	1.00	1.01
North America	Alaska	2011					
North America	Alaska	2012	1.07	0.95	1.10	0.98	1.02
North America	Alaska	2013	1.04	1.01	1.00	1.04	1.05
North America	Alaska	2014	1.00	1.02	1.00	1.00	1.02
North America	Alaska	2015	1.00	1.06	1.00	1.00	1.06
North America	Alaska	2016	1.00	1.23	1.00	1.00	1.23
North America	Alaska	2017	0.91	0.82	0.92	0.99	0.75
North America	Alaska	2018	0.92	1.00	0.92	1.01	0.92
North America	Delta Airlines	2011					
North America	Delta Airlines	2012	1.09	0.93	1.00	1.09	1.01
North America	Delta Airlines	2013	1.05	0.98	1.00	1.05	1.03
North America	Delta Airlines	2014	0.94	1.04	1.00	0.94	0.98
North America	Delta Airlines	2015	1.07	0.99	1.00	1.07	1.06
North America	Delta Airlines	2016	1.00	0.98	1.00	1.00	0.98
North America	Delta Airlines	2017	1.00	1.01	1.00	1.00	1.01
North America	Delta Airlines	2018	1.00	1.05	1.00	1.00	1.05
North America	Hawaiian Airlines	2011					
North America	Hawaiian Airlines	2012	1.00	0.93	1.00	1.00	0.93
North America	Hawaiian Airlines	2013	1.00	0.94	1.00	1.00	0.94
North America	Hawaiian Airlines	2014	1.00	1.01	1.00	1.00	1.01
North America	Hawaiian Airlines	2015	1.00	1.05	1.00	1.00	1.05
North America	Hawaiian Airlines	2016	1.00	0.96	1.00	1.00	0.96
North America	Hawaiian Airlines	2017	1.00	1.00	1.00	1.00	1.00
North America	Hawaiian Airlines	2018	0.98	0.95	1.00	0.98	0.93
North America	Jet Blue	2011					
North America	Jet Blue	2012	1.06	0.95	1.08	0.98	1.01
North America	Jet Blue	2013	1.00	1.00	0.98	1.02	1.00
North America	Jet Blue	2014	0.99	1.02	0.99	1.00	1.01
North America	Jet Blue	2015	1.05	1.05	1.06	0.99	1.11
North America	Jet Blue	2016	1.01	1.00	1.00	1.01	1.01
North America	Jet Blue	2017	0.93	1.01	0.93	1.00	0.94
North America	Jet Blue	2018	0.92	0.99	0.92	1.00	0.92

North America	Southwest	2011					
North America	Southwest	2012	1.08	0.93	1.09	1.00	1.00
North America	Southwest	2013	1.04	1.00	1.02	1.02	1.04
North America	Southwest	2014	1.03	1.02	1.04	1.00	1.05
North America	Southwest	2015	1.04	1.06	1.00	1.04	1.10
North America	Southwest	2016	0.97	0.99	0.98	0.99	0.96
North America	Southwest	2017	0.98	1.01	1.01	0.96	0.99
North America	Southwest	2018	0.98	1.00	0.99	0.99	0.98
North America	United Airways	2011					
North America	United Airways	2012	1.02	0.94	1.00	1.02	0.96
North America	United Airways	2013	1.04	0.99	1.00	1.04	1.03
North America	United Airways	2014	1.01	1.02	1.00	1.01	1.03
North America	United Airways	2015	1.02	1.06	0.94	1.08	1.07
North America	United Airways	2016	0.97	1.01	1.00	0.97	0.98
North America	United Airways	2017	0.98	1.00	1.01	0.97	0.98
North America	United Airways	2018	1.00	0.99	1.01	0.99	0.99
North America	West Jet Airlines	2011					
North America	West Jet Airlines	2012	1.04	0.97	1.04	1.00	1.01
North America	West Jet Airlines	2013	1.03	0.96	1.00	1.03	0.99
North America	West Jet Airlines	2014	0.98	1.02	0.99	1.00	1.00
North America	West Jet Airlines	2015	0.94	1.09	0.94	1.00	1.03
North America	West Jet Airlines	2016	0.98	0.98	0.99	1.00	0.96
North America	West Jet Airlines	2017	0.98	1.01	0.98	1.00	0.98
North America	West Jet Airlines	2018	0.94	0.99	0.96	0.99	0.93
South America	LATAM Airlines	2011					
South America	LATAM Airlines	2012	0.86	0.75	0.91	0.95	0.64
South America	LATAM Airlines	2013	1.07	0.98	1.02	1.04	1.04
South America	LATAM Airlines	2014	0.99	1.01	0.98	1.00	1.00
South America	LATAM Airlines	2015	0.96	1.06	0.95	1.01	1.02
South America	LATAM Airlines	2016	0.98	1.05	1.01	0.97	1.03
South America	LATAM Airlines	2017	1.06	0.97	1.02	1.03	1.02
South America	LATAM Airlines	2018	1.11	1.03	1.11	1.00	1.15

Appendix 13 airlines and annual report sources

	Airline	Data Source	Remarks
1	British Airways	IAG – International Airlines Group – Results and reports (iairgroup.com)	
2	Cathay Pacific	Cathay Pacific Airways Limited Annual Report 2020	
3	Emirates Airline	Annual reports | Financial transparency | About us | Emirates	
4	Etihad Airline	Fast Facts (etihadaviationgroup.com)	
5	Qatar Airways	Annual reports | Qatar Airways	
6	Singapore Airline	Annual Report and Sustainability Report | Singapore Airlines	
7	Ethiopian Airlines	Ethiopian Airlines Performance Report	
8	Turkish Airlines	Turkish Airlines - Investor Relations	
9	Air Canada	Air Canada - AnnualReports.com	
10	Thai Airways	Thai Airway International (THAI) (thaiairways.com)	
11	KLM	Publications | Air France KLM	
12	Ryanair	Ryanair | Reports & Presentations	
13	Easy Jet	easyJet plc - AnnualReports.com	
14	Delta Airlines	Delta Air Lines, Inc. - Financials	
15	Qantas	Qantas Investors | Investor Centre	
16	South Africa Airways	Financial Results - South African Airways (flysaa.com)	
17	SAS Airline	Annual Reports - SAS (sasgroup.net)	
18	Lufthansa	Financial reports - Lufthansa Group Investor Relations	
19	United Airways	Investor Relations - United Airlines Holdings, Inc.	
20	Alitalia	Account statement (alitalia.com)	**
21	Finnair	Reports and presentations – Finnair	
22	Aer Lingus	IAG – International Airlines Group – Results and reports (iairgroup.com)	
23	Jet Blue	JetBlue | Annual Reports	
24	West Jet Airlines	WestJet Airlines Ltd. - AnnualReports.com	
25	LATAM Airlines	Annual Reports | Financial Information | Investor Relations | LATAM Airlines Group SA	
26	Korea Air	Financial Information | Korean Air	
27	Southwest	Annual Reports – Southwest Airlines (southwestairlinesinvestorrelations.com)	
28	China Eastern airways	Financial reports: China Eastern Airlines Corporation Limited 中國東方航空股份有限公司 (webb-site.com)	
29	Japan Airlines	Investor Relations | JAPAN AIRLINES Corporate Information (jal.com)	
30	Iberia	IAG – International Airlines Group – Results and reports (iairgroup.com)	
31	Alaska	Financial reports | Alaska Air Group Inc	
32	Hawaiian Airlines	Hawaiian Holdings, Inc. - AnnualReports.com	
33	Kenya Air	https://www.dse.co.tz/sites/default/files/Kenya Airways Plc_Annual Report 2019.pdf	
34	Air China	Annual Report and Prospectus | China Airlines (china-airlines.com)	
35	Aeroflot	Financial Results | Aeroflot	

Appendix 14 Selected Previous DEA studies 1993 - 2021

Authors	Sample & Size	Method applied	Input	Output	Second Stage	Main outcome	Journal
Schefczyk (1993)	15 international airlines 1990	DEA input-oriented model	ATK, operating cost, non-flights assets	RPK, non-passenger revenue,		DEA can give objective evaluations of operational performance that are not susceptible to subjective interpretation.	Strategic management journal
Banker and Johnston (1994)	12 US airlines 1981-1985	DEA	10 inputs	RPM		The DEA's value for management is increased by improving its capacity to analyse the realized implications of operational and business strategies.	Theory, Methodology, and Applications
Good et al. (1995)	8 US & 8 EU airlines 1976-1986	DEA	Labour, operating cost, aircraft fleet	Load factor, stage length, per cent of the wide fleet body, turboprops, network size		Carriers in Europe, after deregulation, are expected to be as productively efficient as those in the US.	European journal of operational research
Sengupta (1999)	14 International 1988-1994	DEA	ATK, operating cost, non-flight assets	RPK, non-passengers' revenue		Allocative efficiency and production efficiency Dynamic effectiveness Utilization of Capital	International Journal of Production Economics
Fethi et al. (2000)	17 EU 1991-1995	DEA + TOBIT	ATK, operating revenue, non-flight assets	RPK, non-passengers' revenue	TOBIT regression 2nd stage	When faced with competition, airlines may try to take advantage of economies of scale and density.	University of Leicester Management Centre
Sheraga (2004)	38 international 1995-2000	DEA + TOBIT	ATK, operating cost, non-flight assets	RPK, non-passengers' revenue	TOBIT regression 2nd stage	As a result of the events of September 11th, airlines that had adopted operating techniques that were reasonably efficient found themselves in vulnerable financial circumstances.	Transportation Research Part A: Policy and Practice
Chiou and Chen (2006)	1 Taiwanese (15 routs) 2001	DEA	Fuel cost, labour cost, aircraft cost, number of flights, seat per miles	Number of flights, seat miles, passengers' miles, passenger number		Determine how efficient and successful each route is from three different views, and then group them into four categories.	Transportation Research Part E
Greer (2006)	7 Full service & 7 Low-cost US airlines	DEA	Labour, fuel, fleet widebody capacity	ASM		Low-cost carriers are more efficient the full service	A Data Envelopment Analysis

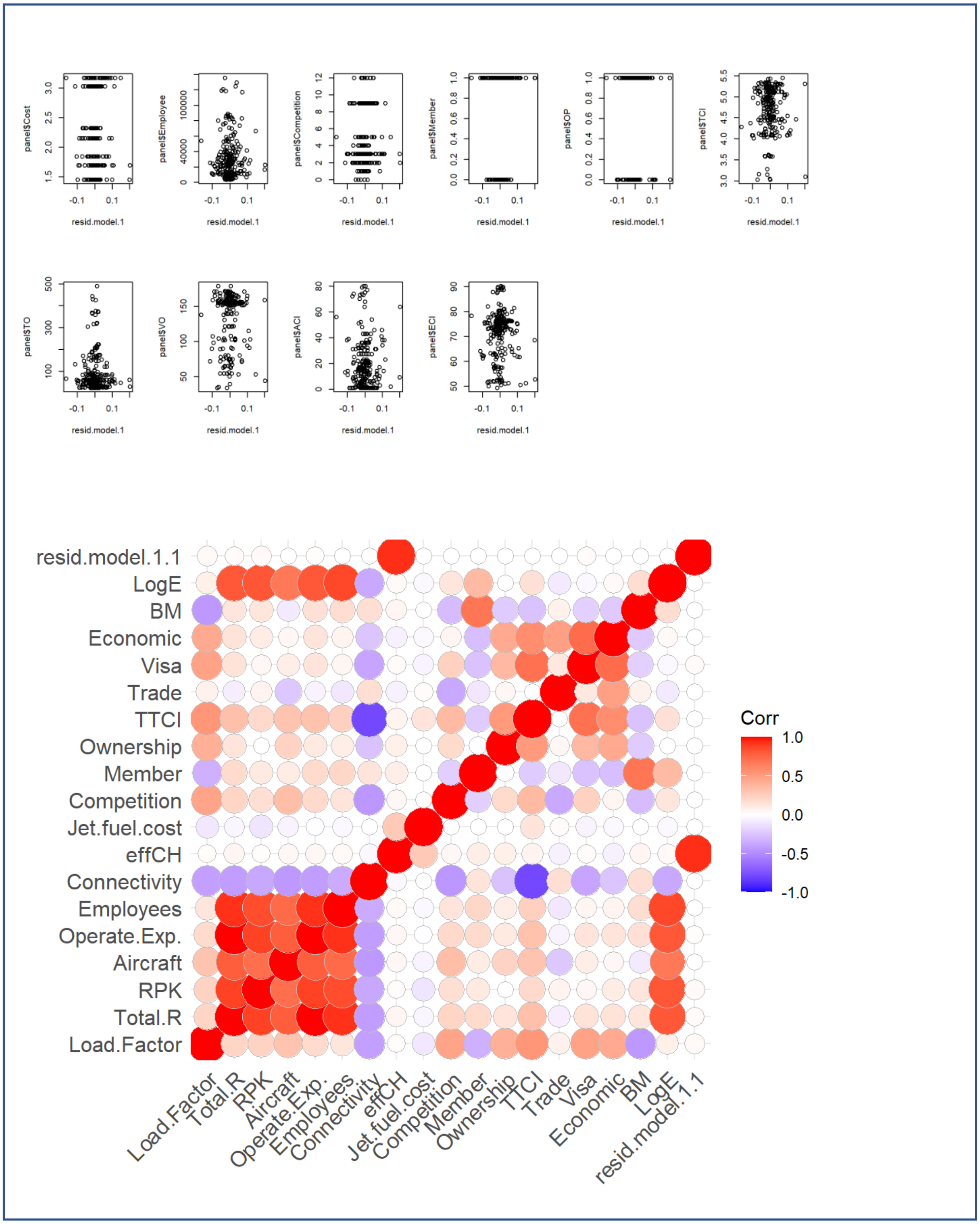
Inglada et al. (2006)	20 International airlines 1996-2000	BCC-DEA and TFP index	Number of employees the capacity of aircraft, ATKs, labour cost, material cost	Operational cost, Labour cost		Two stochastic frontiers are estimated. Cost function and Production function. The main result is that competition affects the efficiency	Transportation Research Part A: Policy and Practice
Barbot et al. (2008)	47 global airlines 2005	BCC-DEA and TFP index	Number of employees, fleet size, fuel	RPK, RTK	Regression	Two methodologies were used to identify which elements had an impact on efficiency.	Journal of Air Transport Management
Greer (2008)	12 US airlines 2000 to 2004	Malmquist Productivity Index (input-oriented)	Employees, fuel, seat capacity	ASMs		Through technological improvement, inefficient carriers are catching up to efficient ones.	Transportation Research Part E: Logistics and Transportation Review
Assaf (2009)	12 US airlines 2002-2007	Bayesian stochastic production frontier	Labour cost, Oil and fuel cost, total expenses cost, number of aircraft and load factor	Total revenue		Using a Bayesian stochastic model. Inefficiency as a result of rising oil costs and the September 11th attacks	Tourism Management
Barros and Peypoch (2009)	12 EU airlines 2000-2005	CCR-DEA, bootstrap truncated regression	Employee, total expenses, aircraft number	RPKs and EBIT	Population, low cost, alliances	Application of bootstrap improved the efficiency scores	International Journal of Production Economics
Greer (2009)	18 US airline 1999-2008	DEA input-oriented and TOBIT regression	Labour, fuel, seat capacity	ASMs	Union density, average fleet age, size, stage length	The driver of airline efficiency is identified via regression analysis.	Transportation Research Part A: Policy and Practice
Chow (2010)	Chine's airlines 2003-2007	DEA and Malmquist output-oriented	Employees, aircraft, fuel and seat capacity	RPKs and RTKs		Measured the productivity change	Journal of Air Transport Management
Ouellette *et al*. (2010)	7 Canadian airlines 1960-1999	DEA input-oriented (allocative efficiency)	Capital, investment, labour, energy, materials	Unit tolls output to passenger output, charter flights		DEA model with adjustment costs and regulatory constraints to avoid the biased conclusion	European Journal of Operational Research
Merkert and Hensher (2011)	58 global airlines 2007-2008 and 2009-2009	DEA input-oriented bootstrap TOBIT regression	ATKs, operating expenses, labour cost	RPKs, RTKs	Asks, stage length, aircraft size, fleet age, aircraft type	Both the correct bias scores and non-biased are as informative and valuable	Transportation Research Part A: Policy and Practice
Sjoogren and Sooderberg (2011)	50 global airlnes1990-2003	Stochastic frontier	Labour, fuel, aircraft capacity, aircraft departures	ASKs, passengers carried, fright carried		Evaluate three factors simultaneously	Transportation Research Part E: Logistics and Transportation Review
Barros et al. (2013)	11 US airlines 1998-2010	DEA model B-Convex	Total expenses, employee number, number of gallons used	Total revenue, RPMs, passengers load factor		The mismatch between inputs and outputs of the airline technical efficiency	Transportation Research Part A: Policy and Practice

Barros and Couto (2013)	23 EU airlines 2000-2011	Malmquist productivity index	Employee, total expenses, ASKs	RPKs, RTKs		Adopted the Luenberger productivity index	Journal of Air Transport Management
Wu et al. (2013)	12 global airlines	DEA CCR-BCC bootstrap truncated	Employees, total expenses cost, number of aircraft	RPKs, total revenue	RPKs, cargo, salaries, Chinese nationality, log population, load factor, fuel cost	The link between airline efficiency and cargo emphasis is in the form of a U shape.	Journal of Air Transport Management
Lee and Worthington (2014)	Airline 2006	SBM-NDEA VRS output-oriented with bootstrap truncated regression	flown kilometre, number of employees, total assets	ATK's	Ownership, LCC, departures, load factors	Restructure and adjust the size of their operations to remain competitive. Private ownership, status as a low-cost carrier, and weight load contributed to organizational efficiency.	Journal of immigrant and minority health
Tavassoli et al. (2014)	11 airlines in Iran	SBM-NDEA two stages	Number of passengers, planes, number of employees and number of cargo planes	ASKs, ATKs	RPKs, RTKs	The proposed model estimates both technical efficiency and service effectiveness.	Journal of Air Transport Management
Barros and Wanke (2015)	29 African airline 2010-2013	TOPSIS	Number of employees, number of aircraft, operating expenses	RPKs, RTKs,	Used 15 variables related to the business of airline	The economics of scope, network size, ownership, and fleet mix explain the efficiency.	Journal of Air Transport Management
Cui and Li (2015a)	11 global airlines 2008-2012	DEA-VFB (virtual frontier benevolent)	Employees, capital stock, ATKs	RPKs, RTKs, TBI, CO2 emission value		Undesirable output and the new (DEA-VEB) model	Transportation Research Part E: Logistics and Transportation Review
Cui and Li (2015b)	10 Chinese airlines 2008-2012	DEA and Malmquist productivity index	Labour, capital,	Passenger turnover, without accidents	Avg. movements per hour, R&D 298contribution, college graduates, service days, pilot experience	This is a first-of-its-kind effort to uncover the elements that affect flight safety using DEA	Transportation Research Part E: Logistics and Transportation Review
Li et al. (2015)	22 international airlines 2008-2012	DEA-VDSBM three stages	Employees, fuel	ASKs, ATKs, fleet size	Output 2nd stage, Input 3ed stage (third stage TBI)	New three-stage DEA analysis	Transportation Research Part E: Logistics and Transportation Review
Malikarjun (2015)	27 US -EU airlines	DEA three-stage unoriented	Operating expenses	ASKs, fleet size, number of destinations	RPMs, (third stage output (total expenses)	DEA unoriented	Journal of Air Transport Management
Merkert and Pearson (2015)	150 global airlines 2011-2012	DEA with regression	ASKs, employees,	RPKs, ASKs, load factor,	Fleet age, total cabin crew, the total number of staff, LCC, load factor	LCC is more profitable than network, regional and charters airlines less efficient	Journal of Transport Economics and Policy
Wanke et al. (2015)	35 Asian airline 2006-2012	TOPSIS	Operational cost, employees, aircraft	Revenue, RPK, EBIT		The use of TOPSIS and Monte Carlo simulation	International Journal of Production Economics

Cui et al. (2016)	21 international airlines 2008-2012	DEA- VDSBM	Employees, fuel, capital stock	RPKs, RTKs, TBI	Total aircraft per capita GDP, fleet age, number of destinations, the average distance travelled,	The new model is superior to the SBM model.	Transportation Research Part D: Transport and Environment
Li et al., 2016	22 International airlines 2008-2012	DEA-SBM	Employees, Fuel	ASKs, ATKs, fleet size	RPKs, RTKs, GHG 3^{rd} (TBI) emission	New three-stage	Energy
Omrani and Soltanzadeh (2016)	8 Iranian airlines 2010-2012	DEA- NDEA CRS, DDEA, DNDEA	Employees, fleet's seats	ASKs, Schedule flights, 2^{nd} stage ATKs, schedule flights	RPKs, RTKs	The internal structure of DMU helps identify inefficient process	Journal of Air Transport Management
Saranga and Nagpal (2016)	13 Indian airline 2005-2012	DEA-VRS TOBIT	Employees, ASKs, employee cost	RPKs, total revenue, RPKs	Yield RPK, average revenue per hour, average stage length, operating expenses	The link between operational efficiency and market performance	Journal of Air Transport Management
Wanke et al. (2016)	19 Latin America airlines 2010-2014	DEA-VDRAM	Employees, aircraft	Number of domestic flights, number of lateen and Caribbean flights, number of international flights	15 contextual variables related to business, airline age, ownership, RPK, network size, fleet mix	The use of the VDRAM model. The impact of fleet mix and ownership cannot be neglected	Journal of Air Transport Management
Yu et al. (2016)	13 LCC airlines 2010	DEA-SBM	Employees, gallons, number of seats, number of destinations	ASKs		Capacity utilization	In Airline Efficiency. Emerald Group Publishing Limited
Min and Joo (2016)	59 International airlines	DEA-CCR output-oriented and VRS	Operating expenses, underutilized load factor	Passengers, RPKs, operating revenue, service ratings	Kruskal- Wallis rank test	Strategic alliances help achieve competitive advantages, and smaller alliances are better than large ones	Journal of Air Transport Management
Seufert et al. (2017)	33 international airlines 2007-2013	Luenberger-Hicks-Moorsteen TFP index	Staff, capital (total flight hours divided by average daily revenue	ATK, CO2 emissions		Middle East airlines perform poorly in terms of pollution control	Transportation Research Part E: Logistics and Transportation Review
Yu et al. (2017)	30 international airlines 2009-2012	DNDEA	Labour, fleet size, fuel cost, operating expenses,	ASK, ATK	ASK, ATK- RPK, RTK	Joining airline alliances affect performance	Transportation Research Part A: Policy and Practice
Kottas and Madas (2018)	30 international airlines 2012-2016	DEA- input-oriented super-efficiency model	Number of employees, operating expenses, aircraft,	Revenue, RPKs, RTKs	Man- Whitney test, Games-Howell test	Super efficiency, positive link with freight revenue, positive link with airline alliances	Journal of Air Transport Management
O'Neal et al. (2020)	Aircraft maintenance in 41 months	DEA CCR-SBM TOBIT regression	Total Canns, total maintenance s action,	Hours flown, aircraft readiness	Input and output in the DEA model	Maintenance efficiency is affected by	International Journal of Quality & Reliability Management

			total man-hours			cannibalization and mission number.	
Costa et al. (2021)	11 international airlines 2013-2019	DEA VRS-CRS	ASKs, fleet size, FTE	Number of flights, passengers, load factor, RPK	Public service obligations	Revisit PSO contracts in order to improve their efficiency	Case Studies on Transport Policy
da Silveira and de Mello, (2021)	3 Brazilian airlines 2019-2020	MCDEA	Number of take-offs, ATKs, fuel,	RTK, Cargo load	Covid effect TRIMAP software to calculate results	MCDEA offer improvements, better negotiations and improved politics with the authorities during uncertain times	Journal of Air Transport Management
Huang et al, 2021	9 U.S. airlines' 2015–2019,	A two-stage Network DEA and a truncated regression	CASM, RASM, Load factor	ROI	Truncated regression	Avg. Stage Length Flown, Total Assets, Fleet Size, Full-Time Employee	International Journal of Global Business and Competitiveness

Appendix 15 Non-Parametric Spearman Correlation Matrix



Appendix 16 Courses/Workshops/Webinar attended

	Activity	Date	Remarks
	Courses		
1	Data Envelopment Analysis DEA	28-29. 06.2021	Aston University
2	Stochastic Frontier Analysis SFA	14-16 .07.2022	Aston University
	Webinars		
3	International Air Travel: Market Share and Prospects for the remainder of 2022	13.07.2022	Official Aviation Guid (OAG)
4	Realizing Potential – Growth Beyond Recovery	15.06.2022	OAG
5	Connectivity after the pandemic	17.05.2022	OAG
6	Has Travel Confidence Returned?	27.04.2022	OAG
7	Zero to Hero: Successful network experimentation by Airlines through Covid - join the discussion	08.02.2022	OAG
8	Publication of Journal Papers	10.01.2022	Research Graduate
9	Reasons for cautious optimism as air travel re-starts (Air Passenger Forecast update)	28.07.2022	Oxford Economics Team
10	Fireside Chat with Willie Walsh, IATA CEO And Director General	24.05.2021	IATA
11	Strapped for Cash: How Airlines Can Survive Winter	02.09.2020	OAG
12	Crisis-focused content to help you plan for the recovery	15.04.2020	Aviation Week Network
13	COVID-19: One Year Later	05.03.2021	Aviation Week
14	Understanding and describing data distributions	28.02.2023	Editage Dr. Jacob Wickham
15	Introduction to EndNote	22.03.02023	Editage Dr. Jacob Wickham
	Workshops		
16	Seminar on Agent-based ordinal classification for group decision making	10.12.2020	Research Centre on Quantitative Methods in Business. Emlyon Business School
17	Crisis-focused content to help you plan for the recovery	15.04.2020	Aviation Week Network
18	Covid Impact Information Session	24.06.2021	Durham University
19	Multinational enterprises and natural disasters: Challenges and opportunities for IB research	23.05.2022	Durham University
20	MIB Publishing Workshop	12.07.2022	Durham University
21	QUANT Seminar	10.11.2022	Emlyon Business School
	Conferences		
22	First DBA Conference	12-13.05.2023	Durham Business School

Appendix 17 Publications and Work in Progress

S/N	Article Tile	Target Journal	Remarks
1	A Century of the Global Airline Industry and the Emergence of the Gulf's Super Connectors	Journal of Air Transport Studies	Accepted for publication on 02.02.2023
2	The US-Gulf Carriers Subsidization Dispute Revisited: Competition, Threat, or Quest for Significance	Case Studies on Transport Policy	Submitted on 20th of March 2023
3	Aviation and External Shocks: How COVID-19 is Revolutionising the Airline Industry	Journal of Air Transport Management	WIP
4	Public Perception of Single-Pilot Operations in Commercial Air Travel	WIP	WIP