IMPACT OF OUTSOURCING AND ECONOMIC DEVELOPMENT ON PRODUCTIVITY AND TECHNICAL EFFICIENCY OF AIRLINES

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ABSTRACT

The principal objectives of this study are twofold. Firstly, it attempts to evaluate the technical efficiency and productivity growth of 56 global airlines that operate in two types of business models namely full cost and low cost carriers. Secondly, this study aims to investigate the influence of outsourcing extent and economic development on the performance of airlines from the perspectives of technical efficiency and productivity growth. The study assesses the technical efficiency of full cost and low cost carriers by applying the concept of metafrontier technical efficiency which is introduced by O' Donnell et al. (2008). Next, the evaluation of productivity change employs the metafrontier concept of Malmquist Productivity Index (MPI) as suggested by Oh and Lee (2010). Finally, the influence of outsourcing and economic development on the technical efficiency and productivity growth are estimated using the One Step System, Generalized Method of Moments estimator (GMM). The findings from the technical efficiency analysis indicate that full cost carrier is narrowing the technical efficiency gap between the group frontier and the metafrontier technologies as depicted by the high scores of the technology gap ratio throughout the period of study from 2002 to 2011. This implies that full cost carrier is moving closer towards the world technology frontier. As such, this suggests that the full cost carrier forms the world technology frontier. On the other hand, the findings from the productivity analysis demonstrate that the low cost carriers gained the highest change in productivity growth of 3.7 percent throughout the period examined from 2002/2003 to 2010/2011, whilst full cost carriers recorded a marginal fall of 0.5 percent in the productivity growth. The main contributing factors to the decent productivity growth of low cost carriers are due to two reasons. Firstly, the capability of low cost carriers to efficiently squeeze its available inputs in order to maximize the production of output. In essence, the result implies that low cost carriers are good at

catching up. Secondly, the positive change in technology gap ratio suggests that low cost carriers has the capacity to speed up the technological development as shown by a moderate growth rate of 0.7 percent annually in the technology gap ratio. The findings from the GMM estimators revealed an indirect yet positive relationship between outsourcing and performance indicators which are technical efficiency and productivity growth. The results from the analysis exhibit positive influences of outsourcing on technical efficiency and productivity growth in the context of small-scale airlines. In essence, these findings suggest a significant role of outsourcing in influencing the technical efficiency and productivity growth in small-scale airlines. Similarly, economic development level shows a positive association with the productivity growth of airlines but negative for technical efficiency. These findings further indicate that economic development improves the productivity of airlines only in the presence of high quality of governance.

ABSTRAK

Kajian ini mempunyai dua objektif utama. Pertama, untuk menilai kecekapan teknikal dan pertumbuhan produktiviti bagi 56 buah syarikat penerbangan global yang beroperasi di dalam dua model perniagaan, yakni, syarikat penerbangan kos penuh (FCC) dan syarikat penerbangan tambang murah (LCC). Kedua, kajian ini bertujuan untuk menyiasat impak tahap penyumberan luar dan pembangunan ekonomi ke atas prestasi syarikat penerbangan daripada perspektif kecekapan teknikal dan kadar pertumbuhan produktiviti. Kajian ini mengukur kecekapan teknikal dan pertumbuhan produktiviti bagi syarikat-syarikat penerbangan kos penuh dan tambang murah dengan mengaplikasi konsep kecekapan teknikal metafrontier berdasarkan rangka kerja Analisa Penyampulan Data (DEA) sebagaimana yang diperkenalkan oleh O'Donnell et al. (2008). Seterusnya, pengiraan kadar pertumbuhan produktiviti pula, menggarapkan konsep metafrontier Indek Produktiviti Malmquist (MPI) sebagaimana yang disarankan oleh Oh dan Lee (2010). Manakala, kesan penyumberan luar dan pembangunan ekonomi ke atas kecekapan teknikal dan pertumbuhan produktiviti syarikat penerbangan dianggarkan dengan mengapplikasi teknik penggangar *One Step, Generalized Method of Moments (GMM)*. Keputusan daripada analisis kecekapan teknikal menunjukkan bahawa syarikat penerbangan kos penuh telah merapatkan jurang kecekapan teknikal di antara batasan-batasan kumpulan dan metafrontier sebagaimana ditunjukkan oleh skor nisbah jurang teknologi di sepanjang tempoh pemerhatian kajian daripada tahun 2002 hingga 2011. Hasil penemuan ini, sekaligus menyokong dakwaan literatur yang mengatakan bahawa syarikat penerbangan perkhidmatan penuh semakin menghampiri batasan teknologi dunia, justeru, mencadangkan bahawa syarikat penerbangan tersebut telah membentuk batasan teknologi dunia.

Manakala, keputusan kajian analsis produktiviti, mempamerkan bahawa syarikat penerbangan tambang murah mencapai kadar pertumbuhan produktiviti yang tertinggi, yakni, sebanyak 3.7 peratus di sepanjang tempoh pemerhatian kajian, daripada 2002/2003 hingga 2010/2011. Sementara itu, syarikat penerbangan kos penuh mencatatkan sedikit penyusutan, sebanyak 0.5 peratus, di dalam kadar pertumbuhan produktiviti. Antara faktor-faktor penyumbang utama kepada kadar pertumbuhan produktiviti yang memberangsangkan ini ialah: Pertama, keupayaan syarikat penerbangan tambang murah untuk memaksimakan penggunaan input tersedia ada, untuk memastikan pencapaian output yang maksimum daripada proses pengeluaran. Pada amnya, keputusan kajian ini menggambarkan bahawa syarikat penerbangan tambang murah memiliki keupayaan untuk *catch up*. Kedua, nisbah jurang teknologi menunjukkan kadar perubahan yang positif sepertimana ditunjukkan oleh kadar pertumbuhan tahunan yang sederhana, iaitu, sebanyak 0.7 peratus, sekaligus menggambarkan bahawa syarikat penerbangan tambang murah berupaya untuk mempercepatkan pembangunan teknologi pada masa akan datang. Tambahan pula, hasil penemuan kajian daripada penganggar GMM menyimpulkan bahawa terdapat hubungan positif secara tidak langsung di antara tahap penyumberan luar dan petunjuk-petunjuk prestasi, yakni, kecekapan teknikal dan pertumbuhan produktiviti di dalam kontek syarikat penerbangan berskala kecil. Kajian ini menekankan kepentingan penyumberan luar dalam mempengaruhi kecekapan teknikal dan pertumbuhan produktiviti syarikat-syarikat penerbangan berskala kecil. Manakala, tahap pembangunan ekonomi menunjukkan hubungan yang positif dengan pertumbuhan produktiviti syarikat penerbangan di dalam kontek negara yang mempunyai kualiti governans yang tinggi. Walaubagaimanapun, keputusan sebaliknya berlaku berkenaan perhubungan di antara tahap pembangunan ekonomi dan kecekapan teknikal, di mana, keputusan kajian menunjukkan hubungan yang negatif. Keputusan tersebut menunjukkan bahawa pembangunan ekonomi dapat memperbaiki produktiviti syarikat-syarikat penerbangan dengan adanya pengaruh kualiti governans yang tinggi.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AEA	Association of European Airlines
ASK	Available Seat Kilometre
ASM	Available Seat Miles
ATK	Available Tonnes Kilometre
ATM	Available Tonnes Miles
ATW	Air Transport World
BPC	Best Practice Change
BPG	Best Practice Gap
BPO	Business Process Outsourcing
CAB	Civil Aeronautics Board
CASM	Cost per Available Seat Mile
CCD	Caves, Christensen, and Diewert
CCR	Charnes, Cooper, and Rhodes
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DEA-DA	Data Envelopment Analysis-Discriminant Analysis
DMU	Decision Making Unit
EBIT	Earnings Before Interest and Taxes
EC	Efficiency Change
FAA	Federal Aviation Administration
FCC	Full Cost Carrier
GAMS	General Algebraic Modelling System
GDS	Global Distribution System

GLS	Generalised Least Square
GMM	Generalised Method of Moments
HDI	Human Development Index
HM-TFP	Hicks-Moorsteen TFP
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IEP	Input Efficiency Profiling
ILO	International Labour Organisation
IV	Instrumental Variable
JAL	Japan Airlines
KPMG	Klynveld Peat Marwick Goerdeler
LCC	Low Cost Carrier
LP	Linear Programming
MERS	Middle East Respiratory Syndrome
MLPI	Malmquist Luenberger Productivity Index
MPI	Malmquist Productivity Index
MRO	Maintenance, Repair, and Overhauls
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Square
PFP	Partial Factor Productivity
RBV	Resource Based View
RPK	Revenue Passenger Kilometre
RPM	Revenue Passenger Miles
RTK	Revenue Tonnes Kilometre
SARS	Severe Acute Respiratory Symptoms

SBM	Slack Based Model
SCSC	Strong Complementary Slackness Condition
SEM	Structural Equation Modelling
SFA	Stochastic Frontier Approach
TCE	Transaction Cost Economics
TFP	Total Factor Productivity
TGC	Technology Gap Change
TGR	Technology Gap Ratio
TKA	Tonnes Kilometre Available
VRS	Variable Returns to Scale
WGI	World Governance Indicators

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Brief history of the development of civil air transportation

Despite mounting efforts and experiments that have been putting forward by a line of scientists since the middle of the 19th century to invent an airplane and a significant breakthrough in the airplane invention by the well-known Wright brothers, Orville (1871-1948) and Wilbur (1867-1912), another major breakthrough in the aviation industry was identified in the work of Otto Lilienthal. Being an engineer, Lilienthal who was an entrepreneur and also an independent researcher by himself, later as a pilot for his own aeroplane models has marked a significant starting point in the development of the aircraft engineering in the West. His research findings and the knowledge that he gained from a list of experiments were disseminated through publications which have attracted the attention of many scientists to further promote aircraft invention.

The development of aviation dates back to 1905 when the first practical aircraft was launched. During the first decade of an introduction of aircraft from 1919 to 1930, it was reported that even the most efficient operators could only cover a small chunk of operational costs between 10 to 20 percent (Brooks, 1967). Aircraft technology during that time was incredibly basic and traditional, in that flying is not a safe option of transportation. Surface carriers such as land and sea transportations were options of many people during that time used due to its reliability and safety assurance compared to aviation.

The modern technological development in civil air transportation today, actually resulted from an incredibly high investment in the defense sector where Europe and the United States allocated extremely high air development budgets to develop and equip their military aviation for the preparation of the World War 1 which began in 1914. Initially development of the civil aviation took place at a relatively slower pace from end of the World War 1 in 1930 until the Second World War, which began in 1939 and ended in 1945.

Since the end of the World War Two, air transport has been progressing technologically at a much faster pace with the aid of improved and more efficient aircraft technologies which were specially designed for deployment in the Second World War. It was the World War Two which marked the turning point in the development of modern civil aviation used today. The highly improved and efficient model of today's airplanes has been brought up and developed from the modern aircraft models made for use during the World War Two.

When the focus on military gradually was reduced after the end of World War Two, the civil aviation marked a significant development in the airline industry with the introduction of jet engine which enables aircraft to double its speed and increase its safety aspect by enabling aircraft flying higher above the cloud. Actually, it was economic recovery reasoning in the post-World War Two which played a pivotal role to further intensifying research and development in the civil aircraft, due to a high demand for frequent travel between the Western continents in the effort to boost economic growth of the Western block. Since then, aviation has emerged gradually in replacing surface carriers by sea and rail particularly for long-distance travel. Not only that, air transport has gained increased popularity as a preferred mode of transport for carrying passenger and freight for both short and medium distance travels owing to a great improvement in the aviation technology which enables greater cost savings and higher safety assurance as compared to achievements of airplanes in an earlier stage of development of civil aircraft.

Nevertheless, the success of today's jet airliners does not exempt itself from failures experienced during its initial stage of invention. Initially, the first model of civil jet airliner named De Havilland DH106 Comet which was manufactured by British aircraft maker, Havilland has met with three accidents after a year entering into commercial service. These series of incidents have called for withdrawal of Comet jet liners from service. Since the Comet incident episodes, newcomers in the jet airliner manufacturing industry such as Boeing and McDonald-Douglas have learnt their lesson and have developed equally successful jetliners in the market such as B-707 and DC-8 with upgraded safety and interesting features such as faster speed and ample cabin space which can accommodate much more freight and passenger load. These features have helped to reduce flying hours and promote greater cost saving to about 15 percent as compared to older models produced earlier namely as DC-7 and DC-6.

The success of new manufacturers after Havilland has led to a much faster development in the jet airliner manufacturing industry. The introduction of aircraft model B-747 has provided a significant improvement in the history of the air transportation in terms of higher loadings of both cargo and passenger as well as efficient fuel consumption. The monopoly era of Boeing manufacturer in air jetliner manufacturing market was between 1960s and 1970s. However, since 1980s, the jetliner manufacturing industry saw a new entry of market player which is the Airbus manufacturer. In the turn of the twenty-first century the air jetliner market has been dominated by two major manufacturers namely as Boeing and Airbus. However, today there are a few new potential entries in commercial aircraft manufacturer market among others Embraer (Brazil), Bombardier (Canada), AVIC (China), Mitsubishi and Sukhoi (Russia). The entrance of new players in the aircraft manufacturing market will increase competition. This is explicit with the introduction of the two highly cost saving commercial jet aircrafts such as Dreamliner, B787 and Airbus A380 in the beginning of the 21st century. It is hoped that in future more innovation will be introduced in commercial jet fleet which will further reduce cost per seat-mile to enable passenger and goods be transported at minimal costs along with time saving advantage.

1.2 Airline Business Model

In the rise of competition today, airlines strategize their business through appropriate management of revenue and cost. This is reflected in the business model that the airline adopts. Airlines can be distinguished by two basic business models that they adopt namely as full cost carrier (FCC) and low cost carrier (LCC), although, a hybrid type which has the characteristics of both business models is emerging today in the airline endeavor to cope up with rising competition today.

1.2.1 Full cost carrier

The full cost carrier or commonly known as legacy carrier or network carrier is among the earliest form of airline business model which was established before deregulation of air transport market in the United States in 1978. Before deregulation of aviation market in the US and Europe, most of the full cost carriers are flag carriers, and hence were owned and funded by the country of origin. However, as the air transport market liberalized in early 1980s, many of the airlines under the tag of full cost carrier are privatized in the US and Europe with exception for Asian countries where many of the full cost carriers gets support from the government. As reflected by the name, full cost carriers face additional costs. The airline operations as described in German Aerospace Centre (2008) are as follows:

i. Covering combination of both domestic and international routes, including serving both short haul and long haul destinations.

ii. Operating from primary and busy airports.

Full cost carrier has an advantage of economies of density due to the nature of hub-and-spoke operation which enable a large volume of traffic distributed to and from major hub airports (for examples Dubai and London Heathrow) to regional airports using connecting flights to transfer traffic to the final destinations. Besides that, other advantages gained by full cost carrier from hub-and-spoke operation is frequent flights and high number of destinations (Borenstein, 1992 as cited in Bitzan and Peoples, 2016). The business model usually offers advanced services to make connecting flight as convenient as possible through baggage transfer service to the connecting flights.

iii. Traditionally utilized complex yield management systems and outsource ticket sales via travel agencies.

This situation increases the fare, as the revenue from the operation is now shared with the travel agents. In addition, price discrimination by full cost carrier is a common practice of pricing policy.

iv. Pre-flight and in-flight services

With regard to the tag of full cost carrier, this business model offers pre-flight services such as check in and baggage handling. In addition, the business model also offers a range of in-flight services including food, drinks, in-flight entertainment and other related in-flight services in accordance with the service classes.

v. Offering different service bundles within each flight.

In line with full cost carrier model, the business model offers different service bundles to cater the willingness to pay for different segment of passengers. Full cost carrier usually offers two to four classes of services ranging from economy to business and first class.

However, today, the full cost carrier is facing heavy competition from its low cost counterparts which forces some of the carriers to review the services that they offer before and results in charging of fees for certain services which used to be bundled in the fare before. For example, selection of a preferred seat is subject to an additional fee.

1.2.2 Low cost carrier

Deregulation of the air transport market in the United States in 1978 has attracted an airline business model objective of which is to achieve lowest cost structure that is capable of competing in the US domestic air transport market. Historically, the birth of the 'low cost carrier' business model is originated from Southwest airlines, the first low cost structure business model which was established to compete with the network carriers in the US domestic market. Nevertheless, the term low cost carrier was only made popular with an introduction of Ryanair, an Irish based first low cost airline which was established in 1996. The Economist (2004, June 8) as cited in Morrison and Mason (2007, p.3) describes the essential characteristics low cost airlines business model as

"operating a single-type fleet of planes", has short turn-round time, prefer cheap secondary airport, no frills, low fares that rose only as the flight filled up".

i. Operating a single-type fleet of planes.

The choice of homogeneous and young fleet of medium sized aircraft enables the airline to save substantial costs on fuel, pilot, maintenance crew, and overhead. The airline can save cost by employing pilot and maintenance crews who are experts in handling a single model of aircraft.

ii. Point-to-Point Service

Low cost carriers offer direct short haul non-connecting flight services which enable the airline to maximized daily block hours and aircraft utilization.

iii. Short turn-round period

Frequency of trips that the aircraft can make affects the revenues generated by the airline. The more trips an aircraft can make in a day, the larger the volume of revenue generated. Therefore, the low cost carrier strives its best to lower turn round time by operating from less busy airport, which is the secondary airport. Furthermore, the airport charges are usually much lower for secondary airport than primary airport.

iv. Use of secondary airport.

Low cost carrier prefers to operate from less busy and low cost secondary airport as it can lower idle time for the aircraft thus increase the trip frequency of an aircraft in order to maximize revenue from the operation. However, some LCC operates form large hubs. For instance, Easy Jet which operates from few large hubs in Amsterdam, Paris Charles De Guile, Madrid and Munich.

v. No-frills

Since the main objective of the LCC business model is to achieve the lowest cost structure possible, the fare is charged based on basic services to fly passengers. However for passengers who need inflight services such as food, entertainment, wifi service could have the services available at additional costs.

vi. Low fare

The low cost carrier's main objective is to cut down as much as possible the operation costs for transporting passengers. By adopting a dynamic pricing policy, LCC offers substantial discounts for long pre-booked tickets in advance which creates large demand from low yield and leisure travellers.

vii. Ancillary revenue

It is also a practice for low cost carrier, to sell products and services other than the main services offered on board and through the websites to complement the revenue generated from the airline operation. Besides that, baggage handling which is part of the services offered by FCC is also charged by LCC which adds to the airline revenues.

1.2.2.1 Ultra Low Cost Carriers (ULCC)

This business model is gaining popularity among passengers in the United States and Europe today. The ULCC model deviates from the standard LCC operation by offering the cheapest fare than the standard LCC. The business model able to cope with the lowest price due to minimal inclusions in the fare and greater number of add-on fees. An evidence of popularity of the business model can be associated with the willingness of passengers in both United States and Europe to bear for annoyance and discomfort in order to enjoy cheap flight. Some examples of the most profitable airlines in 2016 from the two continents are Allegiant Air, Spirit Airlines and Ryanair (Johnson, 2017). The ULCC such as Wow Air from the United States is expected to pose intense competition to long haul routes. Essentially, according to Bachwich and Wittman (2017), ULCC is defined by the following characteristics which distinguish the business model with the traditional LCC.

i. Enjoys substantial cost cutting for cost per enplaned passenger as compared to the traditional LCC.

ii. Operating revenues derived from the sale of unbundled and ancillary formed the largest portion of revenue generation for the airline.

iii. ULCC falls short the revenue generation of the traditional LCC owing to lower base fare. Nevertheless, the cost advantages of the business model possess enable the airlines to continue profitable from its operation.

It is worth mentioning that in this study, ULCC and the traditional LCC are lump together as LCC due to small sample size of both business models.

1.3 Importance of Air Transportation

Air transport is one of the most important modes of transportation to move human and goods from one country to another besides sea and land transportations. Market analysts project that the demand for air travel will be doubled in the next 20 years (Price Waterhouse Coopers, June 2015). The importance of air transport in supporting world economic and social activities are highlighted in the Facts and Figures provided by The International Air Transport Association (IATA). According to IATA (2015), it was estimated that in 2015 air transport,

- flies 3.5 billion passengers and 50 million tonnes of cargo annually. This indicates the role of aviation to move human and goods from one place in the world to another;
- contributes $2.4 trillion to the economy. This implies its importance on economic growth as much as it helps to eased businesses;
- contributes to 58 million employments worldwide. This reflects the role of aviation in providing employment opportunities in the world job market.

Besides that, air transport also plays an important role as a catalyst for globalization (Vasigh et al., 2008). Knowing that one region to another are distanced, therefore moving people and goods from one place to another across the globe is almost impossible without a fast and efficient means of transportation. Hence, globalization will not be materialized without the help of an efficient air transportation system.

Today, with the advent of modern passenger aircrafts like Dreamliner (Boeing 787) and Airbus 380 which are known to be fuel efficient in its ranges, one can expect to comfortably travel from California to China in 12 hours duration. In addition, with fast technology development in aircrafts after the World War Two, trade can be materialized across borders to save time and costs of transporting goods. It has helped to save immense time and costs for mobilizing people and goods compared to the olden days' aircraft technology where the same trip may take a week or more to reach the same destination. Reduction in air transport cost was estimated at 92 percent between 1955 and 2004 (Hummels, 2007). This reduction is further influenced by increased liberalization particularly in the air cargo market where costs fell by 9% and imports increased by 7% in developed and upper middle income developing countries (Micco & Serebrisky, 2006). These factors have contributed to air transportation's rising popularity as a choice of transportation mode nowadays, be it for mobilizing people or goods.

1.4 Overview of Global Airlines' Performance

The airline business has been constantly quoted by authors in the mass media as volatile and sensitive to changes in the environment surrounding. The complicated nature of the industry which is characterized as cyclical, hence prone to various challenges erupting in the world such as economic recessions, social uprisings, political struggles, the World Trade Center attacks, September 11, 2001, pandemics such as Severe Acute

Respiratory Symptoms (SARS), H1N1 and the like, and recent Middle East Respiratory Symptoms (MERS) have posed a great challenge to airlines across the globe. For instance, the Tsunami which has badly hit the Japanese economy in March, 2011, earthquakes in Australia and New Zealand, social unrest in the Middle East, and sub-prime mortgage crisis in the United States in 2008, and the Eurozone crisis in late 2009 have severely affected the operational performance of airlines in terms of the technical efficiency and productivity. These events have adversely affected the total of world traffic volume, whereby traffic fell from 2.5 billion passengers in 2009 to 2.4 billion passengers in 2011 (World Airlines Traffic Results, 2010 & World Airlines Traffic Results, 2012). The exogenous nature of these phenomena made air traffic highly volatile. A fall in the demand for air travel has greatly affected revenues of many airlines which later on moved onto lower operating profits for a number of regions whilst others recorded losses in financial year 2008/2009 (Table 1.1).

Table 1.1: Operating profits of airlines by regions, 2007-2014 (billions of USD)

Region	2007	2008	2009	2010	2011	2012	2013	2014
Asia Pacific	7.5	-5.5	-1.4	13.8	8.3	9.2	7.6	8.8
Europe	8.9	2.3	-2.2	5.3	2.3	3.2	4.9	5.7
North America	11.1	-14	2.4	12.4	5.6	6.6	12.1	15.9
Latin America/Caribbean	1.0	1.3	1.1	2.1	2.1	0.4	1.8	1.6
Africa/Middle East	1.7	1.0	1.6	1.8	1.5	1.6	1.4	1.9

Source: Computed from World Airline Financial Results, 2007-2014

Besides that, volatility of oil prices across time throughout the period observed also impacted fuel costs of the airline companies. These challenges and the urge for liberalization in the air transport industry have motivated airlines across regions to seek for appropriate strategies to cut down their operational costs so as to improve their profits.

Globally, airlines' net profits fell to $14.6 billion in 2014 from its peak of $15.8 billion recorded in 2013 (World Airline Financial Results, 2015). The positive development is owing to improvement in the global economy (IATA Annual Review, 2015). In general, year 2014 saw some regions recorded improvements while others showed a decrease in the profits. Europe, Africa and Middle East portrayed a further increase in net income from negative $27 million and $592 million in 2013 to $2.5 billion and $1.8 billion respectively in 2014. These favourable developments were attributed to good economic condition and increased capacity in the regions. In contrast, North America, Latin America and Asia Pacific regions exhibited contractions in the net profits due to reductions in capacity and tourism. In 2013, total net incomes in North America, Latin America and Asia Pacific fell from $12 billion, $171 million and $3 billion respectively to $7.5 billion, $19.3 million, and $2.6 billion respectively in 2014. Nevertheless, in terms of volume of the profits, North America recorded the highest net profit of $7.6 billion in 2014 followed by Asia Pacific, Europe, Africa and Middle East with the amount of $2.63 billion, $2.57 billion and $1.8 billion respectively (World Airline Financial Results, 2015).

Uncertainties in the airline business have become obvious according to the statistics of operating profits by regions in Table 1.1. Some of the regions were in the red during the post economic crisis in 2008 and 2009. North American region was the one mostly affected by the crisis with a massive loss of $14.1 billion in 2008, followed by Asia Pacific which registered a loss of $5.5 billion in the same year. In 2009, Asia Pacific recorded a much lower loss when compared to 2008. The region exhibited a contraction in losses of about four times from $5.5 billion in 2008 to $1.4 billion in 2009. In European region, the effect of 2007/2008 economic crisis was only felt a year later when the region encountered a loss of $2.2 billion in 2009. Latin America/Caribbean and Africa/Middle East were among regions which were not affected badly by the crisis. In fact, they were among the fastest recovering regions from the economic crisis impact which sparked in 2007. The operating profits were more than double from $1.1 billion to $2.1 billion in 2007 and 2011 respectively for Latin America/the Caribbean.

The impact of the crisis was highly significant upon European and North American regions whereby in 2011 both regions experienced fall in operating profits of 74 percent and 50 percent respectively. However, in the next two consecutive years between 2012 and 2013, the industry shows a general trend of rebound in the operating profits for all regions. This improvement is attributing to economic recovery from global economic crisis 2008/2009, lower oil prices and structural changes carried out in many airlines to stay vibrant despite other external challenges faced by the industry.

Figures 1.1 to 1.5 illustrates the trends of global air transport operation by regions as manifested in passenger and freight traffic statistics. In general, North America dominated passenger segment as indicated by high volumes of passenger traffic in terms of number of passenger and revenue passenger kilometer throughout the period observed from 2007 to 2013. Meanwhile, Asia Pacific recorded the second largest passenger traffic volumes with average total number of passenger and revenue passenger kilometer fluctuating between 600 million to 800 million and 1.2 trillion respectively throughout the period. Third largest passenger traffic volume was secured by European region with average total passenger and revenue passenger kilometer slightly above 600 million and approximately 1.2 trillion respectively over the years observed. Africa and Middle East secured fourth place in terms of generation of passenger traffic with an average volume of revenue passenger kilometre between 100 million to 150 million. The region which secures the least revenue passenger kilometre is Latin America with an average volume between 150 billion to 200 billion.

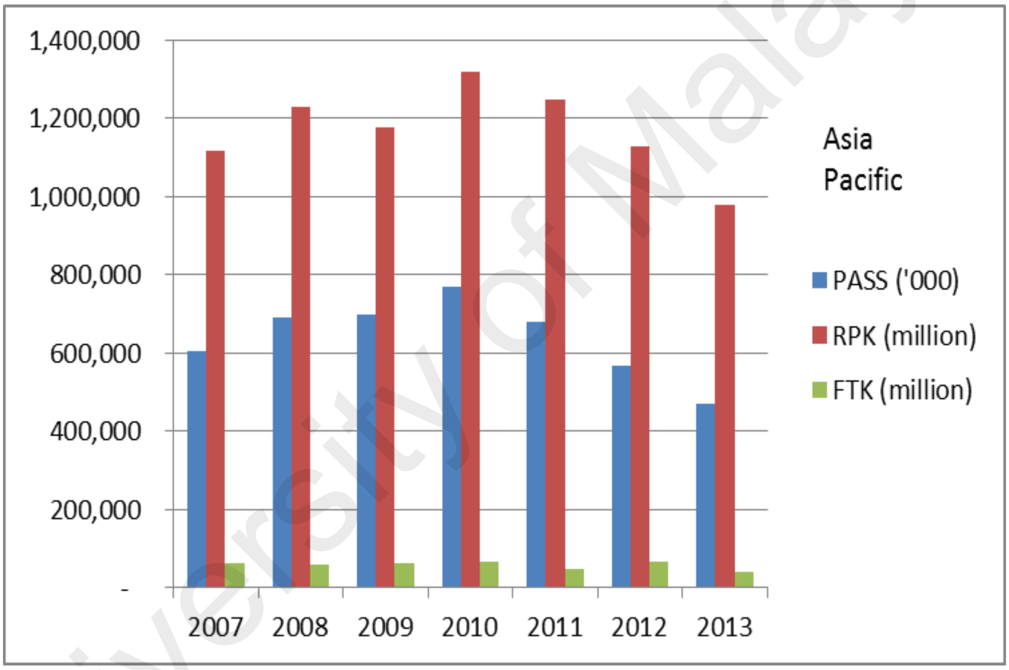


Figure 1.1: Total passenger, RPK and FTK (Asia Pacific)

Source: ATW, 2007-2014

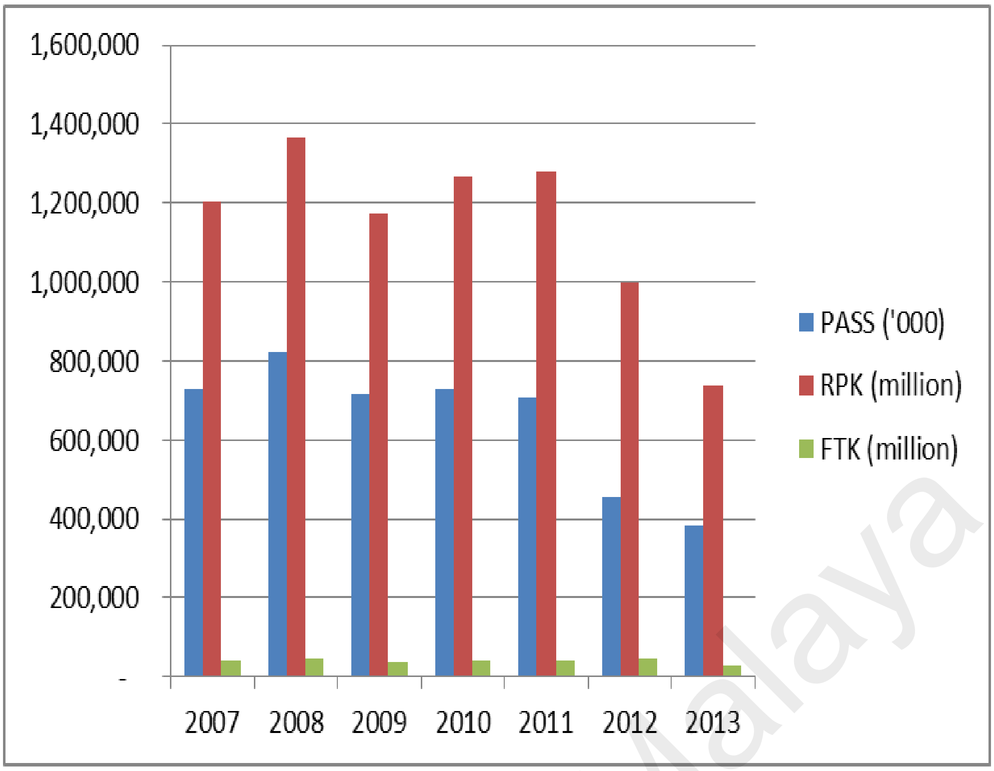


Figure 1.2: Total passenger, RPK and FTK (Europe)

Source: ATW, 2007-2014

Figure 1.3: Total passenger, RPK and FTK (North America)

Source: ATW, 2007-2014

Figure 1.4: Total passenger, RPK and FTK (Latin America/Caribbean)

Source: ATW, 2007-2014

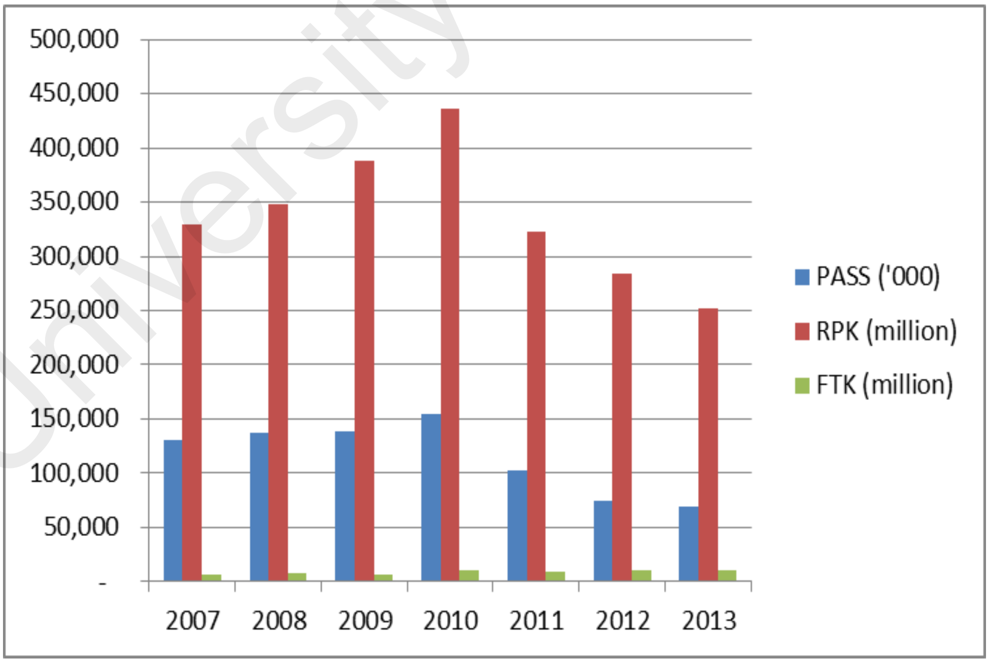


Figure 1.5: Total passenger, RPK and FTK (Africa/Middle East)

Source: ATW, 2007-2014

Asia Pacific has the potential to generate high volume of passenger revenues as shown by the rising trends of total number of passengers and revenue passenger kilometre. In addition, accelerating economic growth in emerging Asia particularly in China and India promises a strong growth in the demand for air travel in the region (IATA, 2015). Rapid expansion of passenger traffic in the region over the last decade was attributed to a high increase in the demand for air travel. In future, the trend of passenger volume in the region may over-ride the present dominance of North America. This notion is further supported by a forecast of Airbus (2006) that the number of seats flown by airlines in Asia Pacific and Europe are expected to exceed that of North America in years to come (Vasigh et al., 2008). In fact, presently the two regions have dominated the market for international passenger and freight segments as mentioned in Tables 1.2 and 1.3 respectively.

Table 1.2: Percentage share of international Revenue Passenger Kilometre by regions, 2007-2011

Region	2007	2008	2009	2010	2011
Europe	34	34.2	34.9	37.6	28.3
Asia Pacific	31.8	31.1	29.6	28.8	28.9
North America	18.8	18.8	17.8	14.2	27.9
Middle East	8	9.1	11.4	11.5	7.3
Latin America	3.7	4.4	4.4	4.1	5.3
Africa	3.1	2.4	1.8	3.8	2.3

Source: IATA Website (www.iata.org)-facts and figures-monthly traffic

Table 1.3: Percentage share of international Freight Tonne Kilometre, by Regions, 2007-2011

Region	2007	2008	2009	2010	2011
Asia Pacific	46.1	44.6	44.6	44.3	40.5
Europe	25.9	27.4	25.5	25.2	22
North America	17.2	17	16.6	15.2	23.6
Middle East	7.4	7.8	10.2	10.8	9.8
Latin America	2.2	2.1	2.2	3.1	3
Africa	1.1	1.1	1	1.3	1.1

Source: IATA Website (www.iata.org)-facts and figures-monthly traffic

Table 1.4 exhibits world total passenger and freight traffic for Asia Pacific, Europe, North America, Latin America, Africa and the Middle East in 2010 and 2013 respectively. With regards to the share of world total passenger in 2010, Asia secures second place, right after North America whilst Europe falls third (World Airline Traffic Results, July 2011).

Table 1.4: Percentage Share of Traffic by Regions, 2010&2013

Year	2010			2013		
Region	World Passengers (%)	World RPK (%)	World FTK (%)	World Passengers (%)	World RPK (%)	World FTK (%)
Asia/Pacific	28.8	28.3	39.9	26.1	27.7	33.3
Africa/Middle East	5.8	9.4	5.6	3.8	7.1	8.7
Europe	27.4	27.2	23.1	21.1	20.9	28.9
Latin America/Caribbean	6.8	3.9	2.6	8.4	5.8	3.6
North America	31.1	31.1	28.9	40.5	38.5	29.5

Source: ATW, July 2011 & 2014

Table 1.4 above shows that in 2010, Asia/Pacific and Europe hold the second largest share of passenger traffic of 28.8 percent and 27.4 percent respectively well behind North American share of 31.1%. The reason for the dominance of the U.S. airlines is due to the region's large domestic market. Meanwhile, both Asia Pacific and Europe dominated the international passenger and freight's segment. Other region which is expected for a fast growth in the air travel industry in future is West Asia (the Middle Eastern countries). This claim is supported by a contribution of 5.8 percent in terms of the share of world passengers for the region in 2010 (Table 1.4).

As for the air freight segment, Asia/Pacific is at the top list in terms of the percentage of world total freight tonnes carried in 2010 with a share of 39.9 percent, followed by North America (28.9%) whilst Europe falls third (23.1%). However, in the international freight segment, both Asia Pacific and European regions play a dominant role. The reason for a high achievement in air freight services in Asia and Europe is in part due to the regions' high international trade volumes in 2010. Asia Pacific is at the top list for international freight in 2014 with a massive volume of freight at 12.9 million tonnes. The second place goes to Europe, whilst North America secures the third place with freight volumes of 7.5 million tonnes and 5.5 million tonnes respectively (IATA, 2014).

1.5 Problem statements

Air transport plays an increasingly significant role in the economy of today's nations. In 2015, it was estimated that aviation would contribute $2.4 trillion to the global economy (IATA, 2015). Furthermore, it was anticipated that about $16 billion of goods would be transported by aviation in the same year. Not only that, air transport contributed to 58 million employments worldwide. These developments suggest that the overall air traffic is on the rise both in the passenger and freight segments.

However, despite a favorable traffic growth in both the passenger and the air freight segments throughout the years observed up to 2013, globally airlines do not record satisfying revenues as compared to costs. The statistics show that the industry is capable of generating decent yields instead, looking at an exceptional rise in traffic volume and in total revenues generated by airlines over the years. This is evidenced by a total of 3 billion passengers carried by air transport in 2012 and this figure is forecasted to be doubled to 6 billion passengers in the next two decades. Surprisingly, the yields received by airlines do not commensurate to the high increased in both the total traffics and total revenues recorded by airlines (Pilarski, 2007). Throughout history, even during favourable economic climate, the industry's profit margin is relatively low and rarely hit 10 percent of their revenues (Doganis, 2006). In 2013 on the overall airlines posted a slim profit margin at 1.6 percent of total revenue (World Airline Traffic Results, 2014). The marginal profit margin is insufficient to cover the losses suffered during bad times. In this respect, cost reduction has been playing a pertinent role in long term financial survival of airlines for both legacy and low cost carriers (Doganis, 2006).

Globally, the total airline revenue in March 2013 was slightly over $700 billion but the net post-tax profit was merely marginal at 1.8% of the total revenue or $12.6 billion (World Airline Financial Results, July, 2013). Operational costs incurred by airline companies everywhere around the world are increasing at a rate almost identical to the rise in operating revenues derived from their business activities. In a way, the pattern of relationship between revenues and costs suggests that airlines are now paying more for each additional resource used in order to achieve a marginal increase in revenues.

Airlines are now more strategized in revenue management as can be seen from the contribution of 5% of ancillary revenue on total revenue in 2012 (World Airline Report, July 2013). Nevertheless, this positive development does not help much in uplifting yields. This situation is further aggravated by the hikes in operating costs resulting from oil price volatility (exceptional rise at one time and down on the other) and other exogenous factors discussed above which are beyond the control of airline managers.

The inconsistency in financial performance discussed above may be attributed to low productive efficiency and low productivity of a particular airline company. This economic reasoning has been used by Fried et al. (2008) in an attempt to explain different variations in financial performances of three airline business models in the United States namely the domestic carrier also popularly called regional carriers, low cost carriers and the large scale network carriers which serve the international market segment and are associated to hub and spoke business model. The literature also associates poor financial performance of airlines with productive inefficiency in the contexts of cost inefficiency, revenue inefficiency and low productivity. Cost inefficiency may be in the forms of technical or allocative inefficiency. Meanwhile, technical inefficiency may be resulted from the use of excessive resources or inputs against a fixed amount of traffic. On the other hand, allocative inefficiency is best explained by employment of wrong mix of resources at given prices. Revenue inefficiency consists of two forms: Technical inefficiency refers to the failure to provide maximum services using the available resources. Allocative inefficiency on the other hand implies provision of services using wrong mix of inputs given their price levels.

The unfavourable development in revenue generation mentioned above suggests the incapability of airlines to face various internal and external challenges thus resulting in failure in achieving a higher level of technical efficiency and productivity growth from its operation. Lusthaus (2002) asserts three drivers of firm's performance. These elements include internal capacity, internal motivation and external environment. Internal capacity refers to organizational capacity, strategic leadership and other micro level firm related factors. Meanwhile internal motivation refers to personal characteristics of an organization such as history, mission, culture and incentive which drives the staff to perform. Besides internal factors, internal motivation, and external environment are factors which play a critical role in influencing the performance of a firm. Organization needs the support from their environment in order to survive and perform well (Lusthaus, 2002).

Therefore, this study investigates the impact of outsourcing on performance of airlines which is one of the elements in internal capacity, as this strategy has been constantly associated with cost cutting measure. Globalization and increased competition in the airline industry have led to many major airlines outsourcing large activities of their business to outside suppliers (Rieple & Helm, 2008). One of the largest components of cost in an airline's operation is labour. This component is among one of the factors that may become a substantial source of competition between airlines because other costs such as landing fees, fuel, aircraft purchase and maintenance are almost similar across airlines. Reducing the number of labour may greatly raise the labour productivity. Therefore, outsourcing is one of the answers to slash labour costs. By outsourcing activities which are used to be carried out in house to other countries which offer a relatively lower wage structure, may significantly improve the labour productivity of airlines (Doganis, 2006).

In addition to examining outsourcing's effect, this study also examines the impact of economic development level on performance of airlines, which is one of the elements in external environment. The trend of financial performance in the airline industry suggests, that the performance of the industry is closely associated with world economic environment (Doganis, 2006). An increase in GDP has a positive impact on the demand for air travel. For emerging economies, an increase in one unit of GDP growth has an even larger impact on the demand for air travel than in developed markets (IATA Annual Review, 2015).

Another issue which merits a special attention from researcher who apply the approach of Data Envelopment Analysis in estimating technical efficiency and productivity growth, is the assumption that DMUs are homogeneous entity which deserves an appropriate resolution as this issue may result in misleading measurement of technical efficiency and productivity growth thus leading to a vague policy direction.

There have been many attempts to measure airlines' performance in terms of the technical efficiency and productivity at local and global levels. However, to our knowledge most studies which evaluate airline's technical efficiency and productivity change assumed airlines as homogeneous as in the neoclassical economics theory of production, but in reality, they are not, as they are facing different resources and technological constraints. Full cost airlines, for example, are quite established and are usually financially backed by the government as it is viewed in some countries as a national symbol. Meanwhile, the low cost carriers which were established quite recent relatively compared to the full cost carriers, and were emerged as a result of liberalization in the air transport sector are privately owned and have less capital ability. These differences, have determined their inputs and technological capabilities among the two groups of airlines. Therefore, treating all airlines as homogenous may give misleading indicator of technical efficiency and productivity scores, what more if the performance estimates are meant for policy improvement in the air service industry.

Hence, this study seeks to address two issues. First, is to investigate the effects of outsourcing extent and economic development level on the technical efficiency and productivity growth of airlines. Second, is to address the issue of homogeneity assumptions found in many DEA studies in measuring technical efficiency and productivity growth of airlines. By adopting a DEA model which address the issue of homogeneity assumption in the conventional DEA model, this study provides a more reliable and unbiased benchmarking measure for technical efficiency and productivity.

1.6 Research Questions

This study seeks to answer the following research questions:

i. What are the differences between the technical efficiency estimates measured with respect to group full cost carrier’s frontier, group low cost carriers’ frontier, and their respective metafrontiers?

ii. Which group forms best practice frontier?

iii. What are the differences in the technical efficiency change, technical change, and total factor productivity change when the airline is measured relative to contemporaneous, intertemporal and global technologies?

iv. Which group is catching up with the world frontier technology?

v. Does outsourcing influence the technical efficiency and productivity growth of airlines?

vi. Does economic development path of the country where individual airlines originated from (external environment) associates with technical efficiency and productivity growth of airlines?

1.7 Objectives of Study

News and stories reported in magazines and newspapers relating to the airline industry frequently label the industry as vulnerable and fragile. This is because the industry’s performance is very sensitive to internal and external changes which took place at both domestic and international levels. Therefore, this study seeks to investigate drivers of airlines’ performance in the context of technical efficiency and productivity. Specifically, the study examines the influence of outsourcing and economic development path on the performance measures-the technical efficiency and productivity change in selected airlines.

This research has four specific objectives as follows:

i. To evaluate and compare the level of technical efficiency for full cost carriers and low cost carriers, and to suggest which group forms best practice frontier.

ii. To assess and compare the productivity change for full cost carrier and low cost carriers and to identify which group is catching up with world technology frontier in terms of productivity growth.

iii. To investigate the impact of outsourcing level on technical efficiency and productivity growth of airlines.

iv. To examine the influence of economic development level on technical efficiency and productivity growth of airlines.

1.8 Scope of study

The main objective of this study is to investigate the sources of performance variations in the contexts of technical efficiency and productivity change in selected global airlines. Efficiency and productivity are used as measures of performance in the context of this study, because the two indicators are commonly used as performance indicators metrics to evaluate producer's performance, although in various settings, the ultimate success indicator of firm refers to financial performance (Miller, 1984). The examination centered on the influence of outsourcing (organizational capacity), which is an increasingly popular choice of competition strategy commonly practiced by airlines companies, in particular and firms in general upon performance variables namely as technical efficiency and productivity change. Next, the study examines the influence of economic development path (an external environment) which plays an influencing role in affecting the performance of firms.

The sample of airlines for this study consists of 56 established airlines from various countries (North America, Europe, Africa/ Middle East and Asia Pacific), regions and sizes which are selected on the basis of availability of data. Out of this figure, 43 are full cost carriers or legacy carriers, while the remaining are low cost carriers which consists of 13 airlines. The selected sample comprises of airlines which carry both loads of passenger and cargo. The number of airlines is limited to 56 because comprehensive data on financial statements are limited for many airlines, and in many situations particularly for new airlines, annual reports are not made available to the public. These shortcomings are particularly prevalent among low cost carriers where many airlines do not publish their annual reports for some reasons. Although the sample is limited to 56 airlines, this number is justifiable in the sense that it represents about 70-80 percent of the carrying capacity of total airlines worldwide. Since the nature of the data is in panel form, the time dimension is annual and the period selected for this study spans from 2002 to 2011. The cross section and time dimension of the data is appropriate for estimating of productivity change using the DEA technique. In terms of the regression analysis, the panel size of the data in the selected sample is suitable for GMM estimators to provide efficient estimates due to short observation of time period, but long dimension of cross section.

There has been considerable amount of literature which examined the impact of various internal factors and external factors on the performance of airlines in various contexts of performance measures. Among the variables which have attracted high attention from researchers in airlines performance study, are that related to outsourcing, business model, ownership, corporate governance, liberalization, alliances, and labour union. Nonetheless, there is a dearth of research investigating the influence of outsourcing on the performance of airlines (Abdullah et al., 2013). The measurement used to represent outsourcing is the extent of outsourcing and this study employs labour costs as the proxy for extent of outsourcing by an airline company. In this study, extent of outsourcing is employed due to limitation of secondary data where the data on the actual value or quantity of outsourcing activities in airlines is absent. It is the most accessible data available on outsourcing and has been recommended and, in fact, has been used in some recent studies on airlines' outsourcing including Morrison & Mason (2007) and Tayeb (2012).

1.9 Research Contributions

This study contributes to the body of knowledge in three aspects: 1. Literature contribution; 2. Empirical contribution; and 3. Policy contribution. The research contributes empirically, by employing the metafrontier approach to the standard Data Envelopment Analysis framework to estimate the technical efficiency and the productivity change which, to our knowledge, has not been applied to measure technical efficiency and productivity change in the context of airline's benchmarking. By employing the metafrontier approach, the study has relaxed the standard assumption in DEA which assumes those airlines, as homogeneous.

Hence, this study estimates the technical efficiencies and the productivity growth for two groups of technologically heterogeneity airlines, namely as the full cost carriers and the low cost carriers. Meanwhile, a large volume of researches on airlines' benchmarking using the standard DEA and other DEA approaches has neglected the heterogeneity nature between the two groups of airlines by treating the two airline groups as homogeneous in terms of technology. Therefore, this study contributes in terms of providing more reliable estimates of technical efficiency and productivity change scores. To our concern, the metafrontier approach has not been applied in airlines' benchmarking despite its wide applications in other areas of research such as agriculture, banking, engineering, hotels, country, and provinces. In our study, measures of performance are in the forms of technical efficiency and productivity growth which are estimated using DEA metafrontier approach. Both of these measures of performance used in our study are closely related to financial performance of airlines, for instance, profitability.

The second contribution of the study is towards literature on airlines' performance and airlines outsourcing in particular. There is a dearth of researches linking outsourcing with performance of airlines. To the researcher's knowledge, there is almost inexistence of literature attempted to investigate the impact of outsourcing upon the technical efficiency and productivity growth in airlines. The first attempt to investigate the influence of outsourcing on airlines' performance is made by Tayeb (2012). However, the measurements of performance used in his study are load factor and daily aircraft utilization. Load factor is a proxy for operational performance, whereas aircraft utilization captures maximum use of aircraft. Furthermore, the study examines the direct impact of outsourcing on airlines' performance. In practice outsourcing alone, may be ineffective in uplifting the performance of airline. Past literature outlined a number of conditions which may lay a conducive environment for outsourcing to successfully improve the performance of firms. Among others, the size of the firm has been argued in literature as an enabler to influence the firm performance (Abraham and Taylor, 1996; Ono and Stango (2005). Hence by interacting outsourcing extent with the size of the airline companies, this study contributes to literature in the areas of outsourcing in general and airline outsourcing in particular.

In addition, the influences of external environment (economic development path) on technical efficiency and the productivity growth are also investigated. There have been many attempts to introduce economic indicator in modelling the determinants of technical efficiency and productivity in various economic sectors. However, most of the studies used a rather narrow approach of economic indicator such as GDP and inflation as a measurement for an economic achievement of a country. In this study, the author adopts a rather comprehensive measure of economic development by employing the Human Development Index (HDI) as a proxy for economic development path. HDI provides a good measure of development because it does not only indicate economic achievement but more than that to include social well-being of a country. To my knowledge, there is no attempt to associate economic development path and performance of airlines in the context of technical efficiency and productivity. Nevertheless, this study examines the influence of institutions which is proxied by governance quality on economic development as represented by Human Development Index (HDI) in affecting the variations in technical efficiency and productivity. Some of the attempts which are closely associating HDI with the performance of airlines are reported in Jenatabadi and Ismail (2014), and Ismail and Jenatabadi (2014). The main contrast between these studies and that of the present research is that those studies create an index of economic indicator for use in the multiple regression analysis using the Structural Equation Modeling where the indicator is formed from a set of constructs such as GDP, HDI and inflation. Meanwhile the measurement of airline performance is referring to an index of overall performance which is derived using constructs such as load factor, operating profit, revenue passenger kilometre (RPK), market share, Gross Domestic Product (GDP), inflation and HDI.

Therefore, results from the regression analysis are expected to provide a better understanding pertaining to factors that affect performance of airlines. The results from the analysis will add new empirical contributions to the body of knowledge in airlines economics, particularly, that relates to productive efficiency and productivity growth in particular and outsourcing from the perspective of aviation industry in general.

Finally, the findings from the technical efficiency analysis, the productivity analysis and the regression analysis aid the airline managers on ways to raise the performance of airlines under their managements. As for the shareholders, the findings from the study will help them in deciding which airlines are worth investing.

1.10 Thesis structure

This thesis is organised as follows: Chapter 2 presents the theoretical frameworks and concepts relating to performance from the perspective of a firm. Among the scope covered in chapter 2 are determinants of performance, production theory of firm, and concept of outsourcing which includes common economic theories in supporting the idea of outsourcing including transaction cost economics, resource based view, competition (principle of comparative advantage and competitive advantage), and international division of labour. Next, chapter 3 provides an extensive literature related to airlines' benchmarking based on technical efficiency and productivity performance to support the empirical findings discussed in chapters 5 and 6. The heart of chapter 3 lies on literary works associating with efficiency and productivity which help in designing the main conceptual framework for this study.

The methods applied in this study, which include DEA metafrontier technique used to estimate the technical efficiency and productivity change scores are discussed in chapter 4. Next, the panel data method namely as the Generalized Method of Moment (GMM estimators) is employed in examining the influence of outsourcing level and economic development path on the chosen performance measures of airlines- technical efficiency and productivity change are also elaborated in chapter 4.

The findings and discussions relating to the technical efficiency and the productivity change scores derived from the metafrontier techniques are reported in chapter 5. The efficiency and productivity change score results obtained from this analysis will provide an input and will become dependent variables for the performance measures which will be investigated in the next chapter on econometric estimations.

Next, chapter 6 reveals the findings from the econometric estimations which are carried out using GMM estimators with regards to the influence of outsourcing and economic development path on the technical efficiency and the productivity change in airlines. The discussions on the results from GMM estimators are also outlined in this chapter.

The final chapter provides overall summary of conclusions derived from both analytical chapters 5 and 6. Besides that, this chapter also presents implications from the study-namely theoretical and policy implications. In addition, limitation and future direction for research pertaining to this study is also deciphered in the final chapter.

CHAPTER 2: CONCEPTS AND THEORIES

2.1 Introduction

The objectives of this chapter are four-fold. First, is to expound the concepts of firm performance in general and technical efficiency and productivity in particular. Next, theories associated with concepts of technical efficiency and productivity growth which will be evaluated using the metafrontier technique of Data Envelopment Analysis, will be explicated. Third, the concept of outsourcing and its association with economics and management theories: the transaction cost economic and the resource based view will be explored which has become the focus of discussion in this study. The concept of institutions is deciphered in the last sub-section. Overall, this chapter provides a detailed review on the concepts of performance viz. technical efficiency and productivity which form the basic analytical framework for airlines' benchmarking analysis in this study. Next, in order to explain the variation in the score of the technical efficiency and the productivity growth obtained from airlines' benchmarking, the chapter brings together theories as outlined in the field of industrial organization to explain outsourcing and economic development which is the main focus of the discussion in this study.

The chapter is organized in the following manner. First section discusses general concepts of performance commonly debated in economics and management literature. Next, the economics' concepts of production theory which provides the basic framework for measuring performance in the contexts of technical efficiency and productivity are discussed. The discussion then moves on to the next section, which pins down the concepts of performance found in the literature into the concept of technical efficiency and productivity which will be used in this study. Later, explanation of performance from the frameworks of economic and management disciplines will be focused upon, in order to provide a better understanding on how outsourcing and economic development with an influence of institutions fits into our model. After that, the detail concept of outsourcing is discussed which include motives, views, and economics' theories related to outsourcing. In the subsequent sub chapter, the basic framework for explaining the concept of economic development and its connection with firm's performance is elaborated. In addition, historical background, concept, and theory related to institutional economics are deciphered in the last section.

2.2 Concepts of performance

The term 'performance' has been constantly used in the fields of industrial organization, management, and engineering. Performance has a broad concept and meaning. It can give different meanings ranging from efficiency to robustness, resistance, return on investment and many other measures which deem to indicate the positive outcome from a business operation.

In the field of industrial organization, performance is explained using the structure-conduct-performance (SCP) paradigm as explained in Bain (1968). Market performance in industrial organization context refers to the outcome of the market conduct of sellers and buyers. Market performance aspects are important indicators to show improvement in general material welfare. According to the author, among few important aspects of market performance for many industries are, technical efficiency, allocative efficiency, and sales promotion or selling costs. Other dimensions of performance which are equally important are, for instance, technological progressiveness, product and conservation performances, and price flexibility.

Since the 1940s, the concept of performance in management has been linked with organizational performance to include effectiveness, efficiency and employee morale. After which, these concepts of performance have been considered major components of performance since the 1960s (Campbell, 1970). Performance is defined from the management perspective as future capability of a business unit (Lebas, 1995). In this respect, performance is measured using past data to forecast future potential achievement of a firm or a business unit.

Meanwhile, Janic (2007) defines performance from the perspective of the air transport industry to include airlines, airports, and air traffic control/management. He introduces a general framework of performance which is applicable for all modal of transportations. He classifies performance into six categories namely as technical/technological; operational; economic; social; environmental; and institutional. These concepts are interrelated as they influence one another and may be a consequence of one or more of other concepts. However, for the purpose of explanation in this thesis, the focus will be on airlines performance as it is the main issue to be addressed in this study. There have been many measures commonly used in literature as the proxies for performance in the context of airline. Basically, these measures of airlines' performance can be broken into two parts: First, measures which are commonly reported as performance indicators in terms of operating statistics include for instance, load factor and revenue passenger kilometer (RPK), Secondly, financial performance such as operating profit, revenues, and market share, as commonly found in the financial report of an individual airline. All of these measures are direct measures obtained from the airlines. Another concept of performance is derived performance which is commonly measured in forms of technical efficiency and productivity. These measures are usually estimated using the stochastic approach and non-parametric data envelopment analysis technique depending on availability of data. Sub section 2.1.1 will discuss the direct measures of performance as outlined by Janic (2007). The indirect concept of performance viz technical efficiency and productivity will be discussed in subsection 2.1.2.

2.2.1 Direct measures of performance

The following are various measures of performance found in different literature as outlined in Janic (2007).

2.2.1.1 Technical or technological performance

This context of performance is related to the technical or technological features or capability of aircrafts owned by an airline company. The performance of an aircraft in the airline's fleets might differ in terms of the engine power, fuel consumption, air pollutants (CO_2 and noise emissions) which are very much determined by the state of the technology which engineered an aircraft.

2.2.1.2 Operational performance

Operational performance is very much related to management objective of optimization in producing airline services using scarce resources like aircraft, employees, fuel and other intermediate materials under given technological capability of the aircrafts, economic and environmental constraints which are associated with the production of airline services. The services of an airline include number of trips, routes and destinations made by a particular aircraft in the airline's fleet mix. The output of an airline is expected to be energy efficient hence leaving less negative impact to the environment (in a way to cut the emission of air pollutants). To achieve these characteristics of production, appropriate blend of technology, economic and environmental factors are required (Janic, 2003). Among commonly used measure of operational performance in airlines studies, are load factor (Davila and Venkatachalam, 2004; Dai et al., 2005) and revenue passenger kilometer (Youssef and Hansen, 1994; Guzhva, 2008).

2.2.1.3 Economic performance

Economic performance in the context of an airline company comprises of financial performance as reflected in the accounting system of an airline company namely as profits, revenues and costs. These components of performance relied much on the type of business model embraced by an airline company. An airline company may establish itself as full cost carrier (legacy carrier), low cost carrier or charter carrier[1]. These business models determine the levels of profits, revenues and costs of an airline company.

Profit is the most important component of economic performance. It is derived from the difference between total revenue and total costs. Profitability of an airline company may affect other components of performance of an airline business such as operational, social and environmental. For instance, a profitable airline also ensures safety first, and has the motivation to mitigate environmental hazards posed by its business operation. Applications of operational profits which are successful indicators of performance are reported in Bailey (1985), Bruning and Hu, (1988) and Antoniou (1992). Revenues on the other hand are determined by the volume of sale, in this case, total number of seats sold in a year. Meanwhile, costs reflect the costs of input used in transporting passengers and cargo. The principal inputs for an airline business operation comprises of aircraft (capital), fuel, and employees (labour).

[1] Charter carrier is similar to LCC in terms of the strategies that the carrier uses to lower their costs. What distinguishes between the two groups of air carriers is that LCC operates scheduled flights whilst charter carrier's operation is unscheduled.

2.2.1.4 Social performance

The social performance is made up of direct and indirect forms. An example for direct social performance is employment opportunities that the airline company generates from its business operation which depends on the size of fleets. The indirect performance is more relevant to positive externality that the business has generated in the form of job opportunities created outside the airline business itself, for instances, job opportunities created in other sectors at domestic level which bridged the airline business such as tourism, trade, and investment. Besides that, job creations resulting from new business opportunities created from the airline operation are examples of indirect social performance in an airline business.

2.2.1.5 Environmental performance

As we are aware, airline operation posed two major negative externalities to the atmosphere in form of air and noise pollutions. In today's modern aviation business, environmental performance has been incorporated as one of the important goals to be achieved along with profits (economic performance), social as well as other goals deemed to be important for the existence of an airline company. A profitable airline company should take the responsibility to mitigate environmental detrimental that it releases to the atmosphere through better management of waste and resource consumptions. In a way, a successful airline business is not only viewed from its financial achievements but, investments in environmental preservation is also central in order to ensure sustainable production in the form of increased output level, whilst at the same time, mitigate pollutants released to the environment.

2.2.1.6 Institutional performance

Institutional performance can be viewed from two different angles namely as internal and external. An example of internal institutional performance is the structure of airline ownership. Evidence from past studies tends to associate private ownership of airlines with high efficiency achievement and vice versa. External institutional performance on the other hand relates to control measures or regulations imposed to the airline business usually at the state level to protect the airline company from intense competition. These measures encapsulate among other regulations with respect to market entry/exit, airfare structure, and foreign ownership of an airline company. Blending of the two categories of institutional performance may largely affect the sustainability of an airline business.

Coelli, Rao, O'Donnell and Battese (2005) regard performance as a relative concept whereby on one hand, performance of a firm can be benchmarked at different time frame. On the other hand, performance can also be compared among different firm in the same period. For an example, performance of an airline company in 2010 can be benchmarked against its performance in 2011. Besides that, performance of an airline company in 2010 can also be compared against performance of other airline company in the same year.

Having defined the different perspectives of performance as discussed above, next this study will review basic theory of production in economics which is formed on the basis for understanding the concept of technical efficiency and productivity that will be applied in this research.

2.2.2 Derived concepts of performance

A. Theory of production

In this section, key economic concepts in the production theory are reviewed in order to provide a deeper understanding of the concepts of efficiency and productivity to be adopted throughout the study. The explanation starts by describing the technological possibilities faced by firms using production function in a case of single output production possibilities. Next, the discussion is extended to case of multiple output production possibilities using transformation function.

i. Production function

The process of production requires a firm to consume inputs in order to produce outputs or what is called as product in the economy. This sub section provides a summary of the production theory for single output production technology. Consider a production process using multiple inputs to produce a single output:

$$Q = f(x) \tag{2.1}$$

where Q is output level, x represents multiple inputs ($x_1, x_2, \ldots, x_n$) of N x 1 vector of inputs used in the production process. The production function in equation 2.1 implies the maximum level of output generated from a production process using a specific amount of inputs. In a way, it indicates the technically feasible attainment of outputs when a firm operates efficiently using combination of inputs.

For easy understanding and simplicity, three assumptions are observed in this part. First, the production takes place in one period. Second, producers have information on prices of inputs and outputs in the production. Third, firms are assumed to be technically efficient whereby it transforms inputs into outputs so that outputs are maximized using available inputs. It is also further assumed that the inputs in equation 2.1 are the within effective control of the decision makers (Coelli et al., 2005).

The production function in equation 2.1 meets all the following regularity properties for economic analysis:

Q.1 *Non-negativity*

The value of f(x) is a finite, non-negative, real number.

Q.2 *Weak essentiality*

It is impossible to produce output using zero amount of input.

Q.3 *Non-decreasing in x (monotonicity)*

Additional unit of input will not decrease output. If $x^{o}>x^{1}$, then $f(x^{0})\geq f(x^{1})$. If the production function is continuously differentiable, monotonicity implies all marginal products are non-negative.

Q.4 *Concave in x*

Any linear combination of the vectors x^{0} and x^{1} will produce an output that is no less than the same linear combination of f(x^{0}) and f(x^{1}). Formally f(Θx^{0}+(1-Θ)x^{1}≥Θf(x^{0})+ (1-Θ)f(x^{1}) for all 0≤Θ≤1. If the production is continuously differentiable, concavity implies all marginal products are non-increasing.

2.2.3 Set theoretic representation of production technology

The multiple inputs, multiple outputs production technology can be generalized from the single output production function. However, generalization in this way is inconvenient. A more convenient approach in representing multi input, multi output technology by applying the technology set, S. The technology set, S is given by:

$$S = \{ (x,q) : x \text{ can produce } q \}, \tag{2.2}$$

Where according to Fare and Primont (1995), the notation x and q indicates non-negative real numbers of N x 1 input vector and M x 1 output vector respectively. The technology set above consists of all input-output vectors (x,q), which imply that x can produce q.

a. Distance functions

The distance function concept which has gained its popularity in the last four decades was first introduced by Malmquist (1953) and Shephard (1953). The distance function concept is very useful in measuring efficiency and productivity. It is also associated with production frontiers. This concept can be used to explain multiple inputs, multiple outputs technology without behaviourial objective specification. This concept can be divided into input distance function and output distance function. An input distance function is defined as a minimal contraction of the input vector, given an output vector. Meanwhile, an output distance function can be defined as maximum proportional expansion of output vector, given an input vector.

I. Output distance function

The output distance function is defined as the output set, $P(x)$, as:

$$d_o(x, q) = \min\{\delta : (q/\delta) \in P(x)\} \quad (2.3)$$

The output distance function above has the following properties:

i. $d_o(x, 0) = 0$ for all non-negative input vectors, x;
ii. $d_o(x, q)$ is non-decreasing in q and non-decreasing in input vector, x;
iii. $d_o(x, q)$ is linearly homogenous in output vector, q;
iv. $d_o(x, q)$ is quasi convex in input vector, x and convex in output vector, q;
v. if q belongs to the production possibility set of x (i.e., $q \in P(x)$), then $d_o(x, q) \leq 1$; and
vi. distance is equal to unity (i.e, $d_o(x, q) = 1$) if the output vector, q belongs to the frontier of the production possibility set (the PPC of x).

The concept of output distance function where two outputs q_1, and q_2 are produced using input vector, x can also be illustrated using graphical approach below.

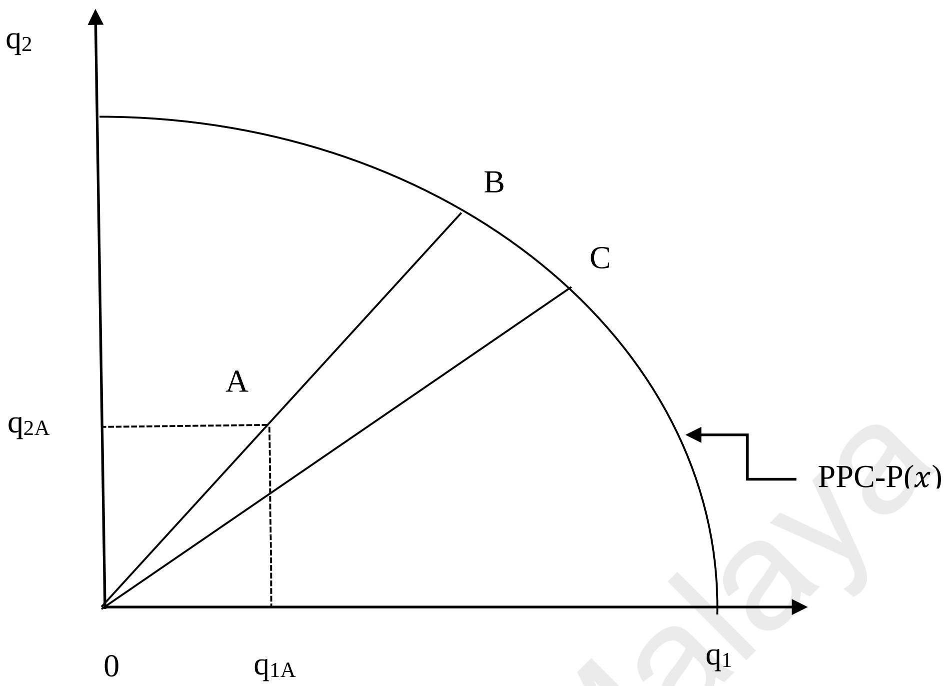


Figure 2.1: Output distance function and production possibility set

Source: Coelli et al. (2005)

From figure 2.1, the value of distance function at point A for the firm using input vector x to produce outputs is equal to the ratio δ = OA/OB

II. Input distance function

The input distance function is defined as:

$$d_1(x,q) = \max \{\rho : x/\rho) \epsilon L(q)\} \quad (2.4)$$

whereas, L(q) is the input set. All input vectors, x produces the output vector, q. The distance function above meets all the general axioms which defined the input sets and output sets in the set production technology denoted by the notation, S. Therefore, the input distance function in equation 2.4 meets all these requirements:

- the input distance function is not decreasing in input vector, x and non-decreasing in output vector, q;
- linearly homogenous in input vectors, x;
- $d_i(x,q)$ is concave in x and quasi concave in q;
- if $x \in L(q)$, then $d_i(x,q) \geq 1$; and
- $d_i(x,q) = 1$, if vectors of input, x belong to the frontier of the input set.

The input distance function for two inputs, x_1 and x_2 which produces output vector, q can be illustrated by graphical analysis in figure 2.2 below.

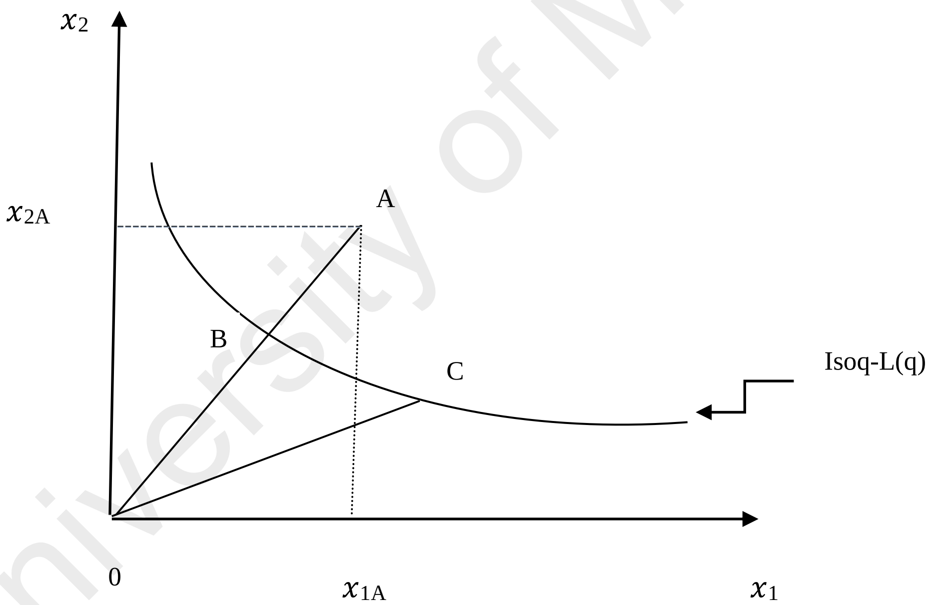


Figure 2.2: Input distance function and input requirement set

Source: Coelli et al. (2005)

Following the concept of input distance function, in figure 2.2 above, the distance at point A is given by the ratio of, ρ = OA/OB. At point A, the production technology utilizes x_{1A} of input x_1 and x_{2A} of input x_2, in order to produce the output vector, q

The distance functions discussed above can be estimated using econometrics or mathematical programming methods which give the scores of efficiency and productivity measures. The efficiency estimates can be solved using parametric and non- parametric approaches.

However, as the production activity become complex whereby it utilizes more than two inputs and producing two outputs, the basic production function concept in equation (2.1) can be generalized in the form of transformation function. In this respect, the transformation function for multi input and multi output production technology is given by:

$$T\,(x,\mathrm{q}) = 0, \tag{2.5}$$

Where $q=(q_1, q_2,\ldots,q_m)$, and is M x1vector of outputs. Implicitly, the production function expressed in equation (2.1) can also be expressed in transformation function as:

$$\mathrm{T}(x,\mathrm{q})=\mathrm{q}-\mathrm{f}(x)=0 \tag{2.5.1}$$

Note also that this form of transformation function also meet all the properties associated with equation 2.1. It is also important to note that if the transformation function in equation (2.1) is twice continuously differentiable, one may apply calculus to compute economic quantities of interest such as marginal product, marginal rate of substitution, output elasticity and direct elasticity of substitution.

2.2.4 Concept of efficiency

The concept of efficiency can be dissected into two, namely as the traditional efficiency approach which is measured by the ratio or index of output to input, and the frontier approach which is originated from the production theory in economics. In the frontier approach, the efficiencies of firms are given by benchmarking the firms' frontiers against its best practice frontiers. However, this chapter will only discuss the modern concept of efficiency as it has been widely found in efficiency literature today.

Basically, the concept of efficiency in economics is originated from the engineering field when engineers attempted to measure the efficiency of machines or processes (Farrell, 1957). According to Farrell, the efficiency of a firm comprises two efficiency components which are technical efficiency and allocative efficiency. Technical efficiency according to him refers to ability of a firm to produce maximum output from a given sets of inputs. Meanwhile, allocative efficiency refers to use of optimal combination of inputs at given prices and technology level. Since then, the concept of technical efficiency has been increasingly applied in economics and other disciplines. Prior to Farrell, there have been a number of attempts to develop better measures to studying efficiency in economics. Among others are partial productivity of labour and 'indexes of efficiency'. According to Farrell, the two measures have disadvantages where the former is facing with the issue of index number whilst the latter is associated with the failure to account for other inputs which potentially contributing to the increase in productivity level.

The modern concept of efficiency is expanded from the works of Debreu (1951) and Koopmans (1951) by disaggregating efficiency into the technical efficiency and the allocative efficiency where the sum of the two forms what is termed as economic efficiency (Coelli, 1996). Technical efficiency can be defined by referring to a production frontier. A firm is technically efficient if it operates on the points along the production possibility frontier and the reverse holds true (Coelli et al., 2005). In a way, the highest the output level obtained using available inputs or the lowest quantity of inputs used in a production process for a given output level conveys that the process is technically efficient (Mandl et al., 2008). Allocative efficiency on the other hand is defined as firm's ability to find inputs mix that minimizes their cost for a given quantity of output. It requires availability of cost information (price information) or profits and firm's behavior assumptions for example maximizing output or minimizing cost (Coelli et al., 2005).

I. Input-orientated measure of efficiency

This approach of efficiency measurements is provided by Farrell (1957) in an input-output space which is explained using the distance function approach. Technical efficiency can be measured by referring to unit isoquant of fully efficient firm in figure 2.3. In this context, Farrell assumes that firms use two inputs, x_1 and x_2 to produce a single output, q. It is worth noting an additional assumption applied in the study to include the assumption of constant returns to scale. Additional assumption which is put in place is that the production technology is known. Measuring the technical efficiency using the input orientated approach requires a proportional contraction in input quantities without changing the quantities of output produced.

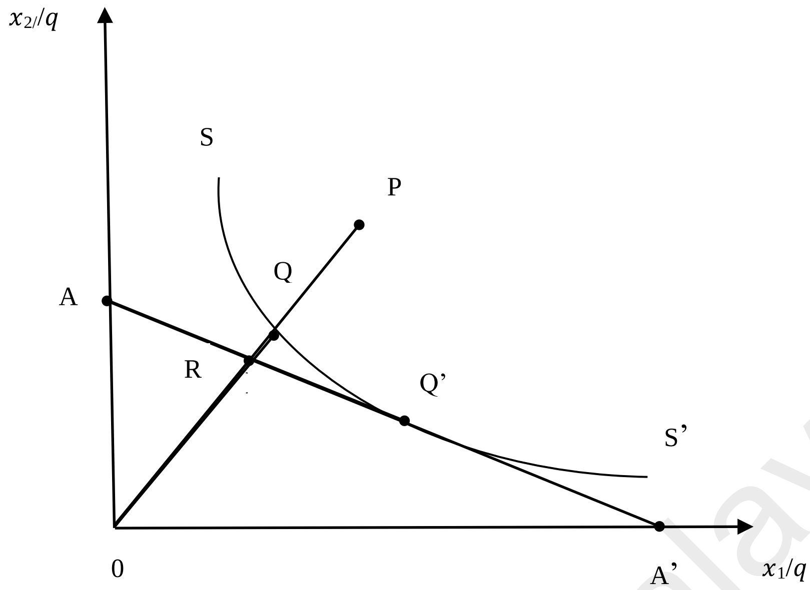


Figure 2.3: Input-orientated measures of technical efficiency and allocative efficiency

Source: Coelli et al. (2005)

Let's take an example of point P where a firm uses quantities of x_1 and x_2 inputs to produce output, q. From the graph in figure 2.3, the technical efficiency for the production technology at point P is given by the ratio:

$$TE = 0Q/0P \tag{2.6}$$

The ratio ranges from zero to one. The value of 1 indicates that the given firm is fully efficient, whereby it operates on the isoquant denoted by SS'. For instance, point Q is a technically efficient point. The technical efficiency of a firm from the perspective of the input orientated measure can also be computed using the input distance function, $d_i\ (x,q)$ as shown below:

$$TE = 1/d_i\ (x,q) \tag{2.7}$$

The value of distance function for the production technology which uses input vectors x, to produce output vectors, q should equal to one if the technical efficiency value, TE is equal to 1.

If we have information on input prices, we may measure cost efficiency of the firm. Let us take w, as the vector of input prices, and x, as the vector of inputs in a production activity at point P. Let us also take, $\hat{x}$ and $x*$ as input vectors related to technically efficient point, Q and the cost minimizing input vector at Q' respectively.

We then, compute the cost efficiency of the firm at point P which is defined as:

Cost efficiency= w'$x*$/w'x = 0R/0P (2.8)

Equation 2.8 gives the ratio of input costs with respect to cost minimizing vector at point Q' to the technically efficient point, denoted as point, Q.

Furthermore, if we have information on the ratio of input prices, we can make use of the isocost line AA' to compute the technical efficiency and the allocative efficiency of the firm in question. Hence:

Allocative efficiency = w'$x*$/w'$\hat{x}$ = 0R/0Q (2.9)

Technical efficiency = w'$\hat{x}$/w'x = 0Q/0P

Mathematically, the total overall cost efficiency is given by the product of technical efficiency and allocative efficiency as follows:

CE = TE x AE =(0Q/0P) x (0R/0Q) = 0R/0P

An allocatively efficient firm operates using inputs quantities x_1 and x_2, hence producing q, quantity of output which is at point Q'. Note that point Q also indicates a technically efficient point of a firm operation.

II. Output-orientated measure of technical efficiency

The output orientated measure is defined as how much output quantities could be proportionally increased without changing the quantities of inputs. Graphically, the output orientated measure of technical efficiency can be portrayed by taking the case of two outputs, q_1 and q_2 produced using single input, x. By assuming constant returns to scale technology assumption, the graph can be expressed in figure 2.4 below. In figure 2.4, the output orientated technical efficiency is given by the ratio,

$$\text{Technical efficiency} = OA/OB = d_o\,(x,q) \tag{2.10}$$

Where $d_o\,(x,q)$ represents output distance function using the vector of input, x to yield the vector of output, q. From figure 2.4, point A refers to an inefficient point of operation where the firm which operates at that point need to raise its output level by the amount of AB in order to become fully efficient whilst at the same time operating on the unit production possibility curve denoted by curve ZZ'.

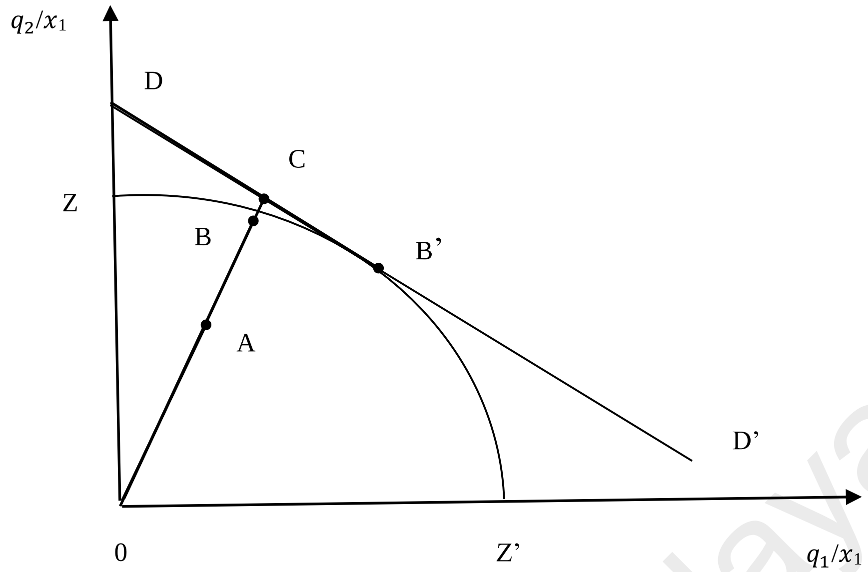


Figure 2.4: Output-orientated measures of technical efficiency and allocative efficiency

Source: Coelli et al. (2005)

Now, if we know output prices, which are given by the vector of p, we may estimate the revenue efficiency of the firm. Now, let's assume output vectors q, $\hat{q}$, and q^*refers to output vectors with respect to point A, technically efficient production vector, B, and revenue efficient production vector, B'. The revenue efficiency value is given by:

RE = $p'q/p'$q* = OA/OC (2.11)

The allocative efficiency estimates can be computed if we have the information with regards to the price. The allocative efficiency value is given by:

AE = $p'\hat{q}/p'q*$ = 0B/0C; (2.12)

TE = $p'q/p'\hat{q}$ = 0A/0B

Like in the input orientated measures, the output orientated measures also give the overall revenue efficiency which is the product of the technical efficiency and the allocative efficiency. The overall revenue efficiency is measured as follows in the output distance function setting:

RE = (0A/0C) = (0A/0B) x (0B/0C) =TE x AE

Note that values for all efficiency measures discussed in this sub section also range from zero to one. It is also worth noting, that the measure of output orientated technical efficiency also similar to that of the output distance function measure of technical efficiency.

The technical efficiency discussed in this study is called the radial efficiency measure which measures the technical efficiency along a ray from the origin to the observed production point. One advantage of this approach is that it is unit invariant, whereby changing the unit of measurement will not affect the value of technical efficiency estimates obtained using this approach. Meanwhile, in the non-radial measure, where technical efficiency is measured based on the shortest distance from the production point to the production surface, altering the unit of measurement in input and output space will change the value of technical efficiency score obtained.

2.2.5 Concept of productivity

Coelli et al. (2005) argued that productivity and technical efficiency are two different concepts to measure performance which often spark confusion in its meaning particularly among non-economic background users. They also stressed that productivity is measured by the ratio of output to inputs or the slope of a ray through the origin of a production frontier while technical efficiency refers to points along the production frontier. The authors added that the tangent point between the two curves entails the highest productivity level which no other points on the production frontier could achieve. For instance, a number of firms may be technically efficient if they operate on the points along the production frontier. However, these firms may not be equally productive if they are operating on variable return to scale technology although they are technically efficient, for a reason which due to scale inefficiency (Coelli et al., 2005).

Performance benchmarking using the productivity concept can be done at "level" by measuring the productivity of a firm at a given point of time. In this respect, the productivity measure provides a static comparison across firms at a single point of time. However, productivity measure may also provide "dynamic" comparison by observing the productivity of firms across certain time frame using panel data. In this case, the productivity analysis is carried out temporally which gives the state of productivity change or growth over time.

I. Productivity

Recall that basically productivity is measured by taking the ratio of output to input level or $^{y}/_{x}$. In a simple case, which involves single input and single output, measuring the level of productivity level is quite simple as output per unit of input can conveniently be computed to give the comprehensive measure of productivity levels of firms. However, as production becomes complex and involved multiple inputs and multiple outputs, calculating the productivity levels are becoming complicated. To measure productivity in the event of multiple inputs and multiple outputs, partial productivity measures are used by researchers and managers. Example of productivity measures given from the partial productivity approach are output per worker, output per hectare, or output per capital. The application of partial productivity measure in giving the picture of firm's performance may sometimes mislead. Therefore, to cater for multiple inputs and multiple outputs technology, and to enable comparison of firm performance over time, the multifactor or total factor productivity (TFP) measure is introduced as a way out to overcome the shortfalls in the partial factor productivity approach.

The simple TFP approach is defined as the ratio of aggregate outputs to aggregate inputs. Consider the case of TFP measure for multiple inputs and multiple outputs production technology. A simple way to calculate TFP measure for two firms is by comparing its profit levels, that is:

$$\pi_1 = \frac{p_1{}'q_1}{w_1{}'x_1} = \frac{\sum_{m=1}^{M} p_{m1}q_{m1}}{\sum_{k=1}^{K} w_{k1}x_{k1}} \quad \text{and} \quad \pi_2 = \frac{p_2{}'q_2}{w_2{}'x_2} = \frac{\sum_{m=1}^{M} p_{m2}q_{m2}}{\sum_{k=1}^{K} w_{k2}x_{k2}} \tag{2.13}$$

By taking the ratio of profits for firm 2 to firm 1 yields the measure of relative performance between firm 2 and firm 1. Although the ratio gives scalar measure of total factor productivity, however making a strict comparison between the two profits is difficult as this ratio has been influenced by price differences. Assuming a simple case of a single input and single output firms where we have the data related to output vector price and input vector price of p and w and output vectors of q_1 and q_2 respectively for firms 1 and 2. These data set for firm 1 and firm 2 are given by $((p_1, q_1, w_1, x_1)$ and $(p_2, q_2, w_2, x_2\ )$ respectively. The profitability ratio is defined as:

$$\frac{\Pi_2}{\Pi_1} = \frac{(p_2 \cdot q_2 / w_2 \cdot x_2)}{(p_1 \cdot q_1 / w_1 \cdot x_1)} = \frac{(p_2 \cdot q_2 / p_1 \cdot q_1)}{w_2 \cdot x_2 / w_1 \cdot x_1} \qquad (2.14)$$

This requires that the index in equation 2.14 to be deflated using suitable price index numbers. If we deflate the ratio of π_2/π_1 with price deflators for both output and input by dividing the numerator with ($^{p_2}/_{p_1}$) and the denominator with ($^{w_2}/_{w_1}$), the profitability ratio will reduce to:

$$\frac{\Pi_2 *}{\Pi_1 *} = \frac{(p_2 \cdot q_2 / p_1 \cdot q_1)/(p_2 / p_1)}{(w_2 \cdot x_2 / w_1 \cdot x_1)/(w_2 \cdot w_1)} = \frac{(q_2 / q_1)}{(x_2 / x_1)} = \frac{(q_2 / x_2)}{(q_1 / x_1)} \qquad (2.15)$$

The final ratio of profits of firm 2 to firm 1 in equation 2.15 is the basic productivity measure as discussed in the basic concept of productivity which regards productivity as output per unit of input. While the real form of productivity measure which enables a strict comparison of profits for firm 2 and firm 1 is provided in equation 2.15, in real world where firms are facing more than two types of input and output, finding an appropriate price deflator is not an easy task. Somehow, firms need to deal with this issue appropriately in order to ensure that the productivity measure derived using the ratio approach is meaningful.

II. Productivity change

In literature, productivity change index can be measured based on four different approaches, namely as the Hicks-Moorsteen TFP index (HM TFP), the profitability ratio TFP, Malmquist TFP index, and TFP index by identifying sources of productivity change.

The Hicks-Moorsteen TFP index is quite simple and is provided by taking the ratio of growth in output to growth in input. This TFP change index is quite close to that of the profitability index and the Malmquist TFP index. The index is easy to measure. However, it has a shortfall in the sense that identifying main sources of productivity growth is not an easy task, because the approach does not have a proper conceptual framework on decomposition of sources of productivity change.

Next approach of TFP index measurement is the profitability ratio index where the index is developed by taking the ratio of revenue to cost from period s to period t. In this approach, there is a need to identify an appropriate price index to account for changes in prices from period s to period t. One advantage of this TFP index approach is that it has accounted for price effects due to temporal effect. Therefore, the productivity growth using this approach can be attributed to technical, allocative and scale efficiency changes across the two-time frames.

Another TFP index measure which has become prominent in the last four decades is the Malmquist TFP index. It was introduced by Caves, Christensen and Diewert (CCD) in 1982 (CCD, 1982a, 1982b). The TFP index in this approach is estimated using Malmquist input and output distance functions. Technically, the Malmquist index is computed by measuring the radial distance between the input and output vectors relating to the reference technology. One can choose between input and output orientated to measure the TFP index using this approach. An important note about the two orientations in the Malmquist TFP measure is that both orientations may give different values of TFP index depending on technology assumption where the firms operate. If they operate at a constant return to scale technology (CRS), the values of TFP generated in both orientations are similar. However, the values divert between the two orientations if the technology assumption is non-constant returns to scale.

The fourth approach of TFP index measure is the TFP index by identifying sources of productivity change first, then develop the TFP index once the sources of growth are identified (Balk, 2001). Unlike other approaches, this approach which is also called the *bottom-up approach* does not develop the TFP measure first. In fact, it first, identifies sources of productivity growth, then constructs the TFP index. The TFP index is then measured by summing up all the possible sources of productivity change namely as efficiency change, technical change, scale efficiency change and the like. This approach has an advantage compared to the Malmquist TFP approach where it ensures all sources of productivity changes are accounted for.

The four concepts of productivity measures discussed above, must share similar properties where the indexes must be homogeneous of degree 1 in output vectors and homogeneous of degree (-1) in input vectors.

2.3 Economics and management framework to explain firm's performance

In economics, firm performance can be explained using the framework of Industrial Organization as elaborated in the Structure-Conduct-Performance (SCP) paradigm which is developed by Mason (1939, 1949) and Bain (1959) as cited in Carlton and Perloff (2000). The SCP framework is among the earliest academic literature in economic which explains the performance of firm. The foundation of the SCP approach to explain performance is based on the notion that price-cost margin varies with the number of competitor and the degree of barriers to entry. Empirically the application of SCP approach is expounded in Bain (1951; 1956) as cited in Carlton and Perloff (1994).

Based on the SCP approach, the performance of firm which refers to the success of a firm in delivering benefits for consumers is built upon the conduct (behavior) of sellers and buyers. In this respect, the definition of performance is explicated in terms of social performance as measured by economic variables including allocative (profitability) and technical efficiencies (cost minimization), and innovations. Next, the behaviour of suppliers and consumers lean on the structure of the market. Some examples for structure of market are number of buyers and sellers, barriers to entry of new firms, product differentiation, vertical integration and diversification. Meanwhile, the structure of the market relies on the basic conditions of the market namely as technology and demand. For example, an adoption of high technology in the production process may greatly reduce the costs. This, in turn, determines a small number of firms in the industry. The relationship between performance, conduct and structure is complicated by the interaction between basic condition of firm and government policy. For instance, government policy to promote high economic growth may encourage competition in the market which will affect the number of sellers positively. In contrast, firm may also influence the government to come up with a favourable policy which increases their profitability. In short, the relationship displayed in the SCP model demonstrates a complex relationship between firm performance, market conduct, market structure and the interaction between basic conditions as well as government policy.

Another approach to describe performance is explained in Lusthaus (2002) who develops a framework for improving organizational performance which outlines three major forces of firms' performance. These forces include internal capacity, internal motivation and external environment.

The concept of performance, according to Lusthaus et al. (1999), varies considerably based according to groups and stakeholders. Each group or stakeholders may have their own set of performance indicators which are important for them. According to the performance assessment framework, examples of organizational performance are including effectiveness, efficiency, relevance, and financial viability. An effective organization ensures that its decision moves parallel with its mission to achieve goals. Another measure of performance is efficiency in conducting business. For instance, cost per unit to produce output from an activity. Besides that, an organization needs to be consistent with its relevance by ensuring that the mission, goals, programs and activities are in line with expectations of key stakeholders. Capability in adapting to changes is also an important indicator of performance in order to ensure survival of an organization. Another indicator which reflects the performance of an organization is financial viability. Financial sustainability of an organization is demonstrated in multiple sources of funding, positive cash flow, and financial surplus.

Internal capacity is also referred to as organizational capacity or firm capacity. It describes the efficiency of management in using and managing its resources. Organizational capacity consists of the following elements: strategic leadership; structure, human resources, financial management, infrastructure, program management, process management and inter organizational linkages. Firms' strategy in cost management is embedded in organizational capacity. Meanwhile organizational motivation which is also internal in nature captures the personality of an organization. It is capable in driving the employees to perform. An example of organizational motivation is the organization's missions, values and vision. Clear missions and vision and good value nurtured in the organization have the potential to influence the performance and quality of work.

The original idea of organization's environment as proposed in organizational assessment framework is influenced by the work of North (1994) as cited in Lusthaus (2002) on institutional economics. An organization is surrounded by the environment, thus, interacting with the environment where it operates. Politics, economics, social, cultural, environmental, demographic entities are among external environments which shape the performance of an organization. For example, the government makes rules and is influenced by the rules. The author suggests an organization influences and is influenced by its environment. Clearly, these three factors are important in order to assess the performance of an organization.

2.4 Concept of outsourcing

The term 'outsourcing' has been defined from various viewpoints by academics and managers. For instances, Lei and Hitt (1995: 836) define outsourcing as "reliance on external sources for manufacturing of components and value adding activities". Meanwhile, Gilley and Rasheed (2000) define outsourcing as an alternative and not a mandatory decision for firm to seek for good and service from an outside provider. Linder (2004) on the other hand, defines outsourcing as a decision to procure from outside supplier which is not limited to any activities that are not produced by the firms themselves but may also involves activities which are presently produced in house, or activities of which normally provided within an organization. Friedberg and Yarberry (1991:53), however give a simple definition of outsourcing to encompass "the transfer of internal service function to an outside vendor".

Mol (2007) summarized all the definitions in the above discussions and came out with definition of outsourcing which combined all the above definitions to form a more holistic definition of outsourcing. His definition of outsourcing includes all forms of outsourcing viz. outsourcing, purchasing and sub-contracting as well as strategic outsourcing. Mol also observed that all forms of activities in outsourcing may be discussed together because the motives behind the decisions to outsource are usually quite similar.

Outsourcing can also be defined in terms of the type of outsourcing. For example, Patel and Aran (2005a) defines business process outsourcing (BPO) as "*the delegation of one or more IT intensive business processes to an external provider, who in turn administrates and manages selected processes based on defined and measurable performance metrics*". There are two functions which are commonly outsourced in business process outsourcing. First, horizontal services including functions like finance and accounting, customer service, transaction processing, human resources, content development, financial research, and high-end engineering. Secondly, vertical focused services which are specific to the natures/processes of firm operation. For instances, outsourcing of activities related to the running of operations of health care service, financial services like banking and other financial institutions services, insurance services, and airlines.

2.4.1 Why firms outsource?

There are many reasons behind a firm's decision to outsource some functions in its business activities. Firms regard outsourcing as a new order of competition today (Palley, 2008). Among the drivers for outsourcing are costs reduction, focus in core business activities, sharing of infrastructure, improving of service level, access to talented human resources, process and product innovation, and changing customer needs. Aranca (nd) as cited in Patel and Aran (2005a) highlights the following motivations for outsourcing among firms, which are:

i. Cost reduction

Cost cutting is a central motivation in driving firms to outsource some of its business functions. By outsourcing part of business activities abroad, a firm does not to bear the fix costs associated with establishing a new a new establishment in another country. Offshoring to developing countries which offer lower labour costs helps a firm to slash labour costs particularly in labour intensive activities.

ii. Focus on core operations

Offshoring helps a company to stay focus in its core business operations which demand more attention and investments. Not only that, outsourcing frees up internal resources to be employed in core business activities.

It gives a firm more time and effort to strengthen its position in the market. Besides that, outsourcing ensures provision of high quality of goods and services by external vendors than what is expected from insourcing (Patel & Aran, 2005b). In this respect, both parties are benefited from the relationship.

iii. Shared infrastructure

Infrastructure assets are usually costly to a firm if the services are done in house as they demand a huge amount of investment. Therefore, by outsourcing its business functions, a firm can share the huge infrastructure costs in providing certain services by sharing and spreading the costs among other firms which use the same vendor as their supplier or service provider.

iv. Improvement in service provision

As one knows, outsourcing usually carried out for non-core business activities which in turn is a core business for the vendors. The vendors are competent in providing the services as the activities in which they involve at are niche for them, therefore they give the outsourcer a high quality of services.

v. Access to large talent pool

By outsourcing a business process to foreign countries which have highly trained human capital, a firm have an advantage in terms of access to cheap professional and talented human resources. Costs of recruiting, training and retraining of human capital are substantial in developed world which makes companies in the United States divert their peripheral activities to developing country which has pool of trained and professional human resource at a lower cost like India.

vi. Process and product innovation

A non-core activity which is carried out in house, received less attention compared to the activity if it is outsourced to outside vendors. These vendors are well experienced in dealing with the services thus ensuring best practices and thereby rationalize the processes and costs involved in providing the services. Therefore, they have the motivation to improve the process and look for new and more innovative ways to provide the services to outsourcers.

vii. Leveraging multiple time zone

Due to differences in time zones, if a firm in the States outsourced to other country in Asia for instance, they can ensure maximum utilization of time to carry out an activity 24 hours a day and 7 days a week. This is because, the activity which is carried out in the States during day time can be continued by diverting to Asia during night time, hence ensure timely handling of service to customers.

viii. Changing customer needs

Outsourcing also act as a tool to deal with changing customer needs nowadays. A firm which outsource an activity does not need to invest in maintaining and upgrading systems and manpower to meet complex and demanding customer needs as these tasks are under the care of vendors. Vendors can manage the huge costs involved by spreading the costs across many outsourcers.

ix. Improving the bottom line

Outsourcing of business process has been proved to positively affect 40 to 50 percent of the bottom line. McKinsey's research found that offshoring implies cost saving of 40 to 50 percent and this figure can be raised further to 60 to 70 percent through training and the like.

2.4.2 Views relating to outsourcing and economics theories underpinning outsourcing

Outsourcing is not a new phenomenon in business and economics despite the fact that the concept was only increasingly discussed in management literature in the last few decades of the twentieth century. In fact, an increased level of outsourcing has been observed in the beginning of the twentieth century (Mol, 2007).

The international scope of outsourcing concept has long been debated in economic literature since the novelty work of the trade theorist, David Ricardo on the *Principles of Political Economy and Taxation*, in 1817. Among the concept advocated by him is his work pertaining to the principles of "comparative advantage". In his work, he argued that all nations would benefit from trade although they are inefficient in producing any goods

(Ricardo, 1817). Ricardo contended that firm must not waste its resources by producing goods or services which it does not produce relatively efficiently. The concept later on extended to international division of labour and subcontracting of production activities in Adam Smith's work on *"An Inquiry into the Causes of the Wealth of Nations, in 1776* (Smith, 1976). This argument is supported by Mankiw and Swagel (2006) who associates outsourcing with international division of labour and the principle of comparative advantage. They further argue that outsourcing leads to positive economic gains through a rise in wages and standard of living.

Outsourcing history starts with subcontracting of business activities during industrialization era in Great Britain in the 18th century (Brown & Wilson, 2005). A huge level of outsourcing has been observed in the beginning of the twentieth century. Subcontracting has gained popularity in ways of doing business in Japan in 1920s. In 1970s and 1980s the trend in outsourcing was more focused on vertical integration strategy which has led to enlarged scale of business operations of firms. A classic example of this form of outsourcing is Ford Motor Company in that, its business not only focused on car assembling activities and component productions but also into iron ore mining and car dealerships. By having engaged (ownership) and integration in all the business activities associated with car production, Ford was able to cut down costs whilst increasing its scale and market power (Chandler, 1977; Porter, 1980).

The benefits of outsourcing are met with mixed views from managers contemplating the advantages and disadvantages of this business activity. The outsourcing wave in the 1980s stands behind the importance of concept of strategic outsourcing. In this form of outsourcing, firms view outsourcing as a strategy to gain success in business through cost streamlining advantage resulting from outsourcing of inputs to other lower labour cost countries. This view starts in the United States in 1980s by replicating the strategy found in Japanese firms which outsourced larger part of their production activities abroad.

The second wave of outsourcing views it from the context of competitive advantage. In this context, outsourcing is viewed as a motivation for firms to focus on their core competencies (core business) whilst leaving the production of other activities which are non-core in nature to other firms which are more efficient in producing these goods and services.

Managers' beliefs on value extraction has led to the third outsourcing view which consider it as not only driven by the advantage of cost cutting, but also due to added value developed from their good relationship with external suppliers, and inter-organizational networks. Managers' improved and positive attitudes towards dealing with external suppliers have helped increased the value of outsourcing among firms to outside providers.

Fourth, rapid development in information technology has reduced the transaction costs of doing business hence playing an important role in driving up outsourcing level (Aron and Singh, 2005). For example, the introduction of electronic data interchange (EDI) has enabled fast and efficient communication between outsourcers and suppliers (Malone et al., 1987).

Next, positive association between outsourcing and international trade has become an important driver for outsourcing of business activities to international suppliers (McLaren, 2000). This is evidenced in a large trade volume between United States and countries in Asia, in particular China and India. It is essentially the international trade and international investments which have took an important role in raising outsourcing volume among firms.

Market liberalization is another factor which plays a crucial role in increasing the motivation of firms to outsource. This driver has been responsible in reforming institutions from less market orientated business institutions towards a more market driven environment. In a way, the orientation of institutions that support business has helped in uplifting the volume of outsourcing by firms.

In addition, Mol (2007) views the increase in outsourcing volume over the last two decades, has much to do with the influence of successful Japanese companies in making outsourcing as a useful tool to lower costs down, thus increasing firms' performance. Furthermore, the author also believed that managers' positive perceptions upon the role of competitive advantage, value added of good relations with external suppliers, technological advancement, and institutional change are central in driving up the volume of outsourcing.

The theoretical framework of outsourcing has been derived from multi-disciplinary areas including among others economics, business strategy, organizational theory, and management. Among the widely applicable theories are that related to transaction cost economics and resource based view. These theories have been widely quoted and are equally important thus complementing each other in explaining management decisions whether to outsource or insource certain firm's activities (Poppo & Zenger, 1998; Ellram et. al., 2008; Jacobides & Winter, 2005; Madhok, 2002).

2.4.2.1 Transaction cost economics (TCE)

The transaction cost economic is one of theoretical applications of the price theory besides game theory and contestable market theory as discussed in the field of industrial organization (Carlton & Perloff, 2000). Talking about the economics of outsourcing, voluminous literature on outsourcing explains the choice of outsourcing based on the concept of transaction cost economics as embedded in Coase (1937) and Williamson, (1975). According to Coase (1937), economic activity can be organized in a firm or a market, and, use of marketplace to carry out an activity would impose an additional cost. Williamson (1975), as cited in Carlton and Perloff (2000), outlined four basic concepts behind the analysis of the transaction cost economics:

1. Transactions can be carried out in the markets or firms. Firms may choose between producing the product in house, or, purchasing it from suppliers.
2. Choice of firms whether to buy the product from the market or to produce it in house using its own resources should be based on relative costs derived from both activities.
3. The transaction costs for using the market is greatly depending on the characteristics of the decision makers involved in the transactions and the objectives of the market.
4. The transaction cost across the market and within the firm is influenced by human and environmental factors. Two elements are important in environmental factors namely uncertainty and the number of firms. Uncertainty has a great influence on the decision of a firm whether to outsource or not because of high costs and difficulty in negotiating the contracts as the firm has to back the transaction with contingency plans. Next, the number of firms in the market also has a great impact on the contract. For instance, in a market where the number of the supplier is small, a firm that outsource it supplies to other firms may face a threat from the supplier. Therefore, the decision to appoint a third party to supply the factors for production for a firm is

possible under an environment where the there is less uncertainty, high competition, and limited opportunity for opportunistic behaviour.

The TCE theory provides a guideline to managers whether to outsource or not, a specific activity (Williamson, 1975). According to Williamson (1975; 1985; 1991a; 1991b.), economic transactions involve two types of cost: first, costs that are directly related to the production of goods or services. The first type of cost is generally lower in market, because market is allocatively efficient in providing the goods or services thus resulting in what is called as "inter firm division of labour", which drives competitiveness up and eventually brings down the costs. Secondly, the transaction costs which are also referred to as the "costs of running the economy" (Arrow, 1974). These literature, despite arguing on the advantage of sourcing from market as compared to in house production, also stresses on an undesirable outcome of outsourcing when market transactions impose costs on the transactions: costs which are commonly referred to as relation-specific investment (sunk costs) involved when two parties enter into an outsourcing relationship. The relationship which is specific in nature maybe due to the specificity of the activities involved in the outsourcing relationship which may demand high commitments from both parties. Knowing the impossibility of being not fully committed to the relationship, there is a possibility that one party or both parties to demand more than the initially agreed upon relationship in order to take advantage of the high commitment required for the transaction- a situation called *hold-up* problem. These scenarios are responsible in making an outsourcing decision a costly transaction. This transaction costs refer to the sunk costs mentioned in earlier paragraph. A large transaction costs will discourage outsourcing. This situation is further aggravated by a high cost to enter into a contract which may help in mitigating the high risks of *hold up*. All these arguments explain whether to outsource an activity or carry it in house.

2.4.2.2 Resource based view theory (RBV)

The origin of the resource-based view is pioneered in the work of Penrose (1959). The author showed how a firm's performance was shaped by utilizing its special resources. In explaining the firm's growth, Penrose distinguished her theory from that of the theory of the firm or the price theory by dismissing all the constraints such as assumptions, methods or content which are embedded in the theory of the firm. Other points which differentiate between the conventional theory of the firm and the theory which explains drivers of firms' growth as pursued by Penrose are that firms are viewed as seeking for profit and that managers do not pursue their personal objectives. Firms are motivated to work hard. Nevertheless, they are bounded by uncertainty, that their attitudes towards uncertainty which become a source of motivation to succeed. In her theoretical attempts to explain the growth of the firm, she explicitly outlined following three propositions (Penrose, 1985) as cited in Loasby (2012):

1. The growth of knowledge within firms is central in determining the growth of the firm.
2. Knowledge generation that occurs within each firm can takes places in a number of ways: consequence, intended (targeted) or incidental (unintended).
3. The major source of knowledge within an economy lies on the firm. A well-blended dynamism across the firm as indicated by purposeful activities and diversity characteristics generates eminent knowledge.

The firm is argued as possessing unique assets and resources in the resource based view theory. Employment of these valuable assets in unique ways, may create competitive advantage for a firm as asserted in Peteraf (1993); Conner (1991); and Barney (1991).

The primary argument debated in the RBV theory featured firm as seeking for input which is expensive to imitate. This argument is pivotal because firms' ultimate goal is to achieve above-normal return. According to Porter (1980) as cited in Conner (1991), in order to achieve the objective, the firm must offer a distinctive product or service where the product must meet the following criteria. First, possesses the following attributes such as distinctive, attractive, and well-priced as compared to competitors. Second, a firm which offers a product that is similar to its competitor must produce at low cost to remain in the business. The second argument stresses on ability of input to generate rents. In this respect, firm's ability to distinguish its input depends on manager's capability and creativity. An input which possesses a higher rent faces with two constraints namely as external and internal constraints. The ability of inputs to generate rents depends on three sources of external constraint namely, (1) condition of demand for the product; (2) public policy and; (3) competitor action. In order for an input to generate a higher rent, history or resource endowment of the firm matters for internal constraint element. This is because, resource characteristics of a firm are associated with an individual firm. The third argument of the RBV postulates that the sustainability of input rent is mainly subjected to the length of the contract and enforcement costs in which the input services is deployed. For instance, in the case of an airline, good negotiation skills possessed by a purchasing manager may affect the costs of purchasing or leasing an aircraft from the manufacturers or the lessors. These valuable skills possessed by the purchasing manager determine the ability of an airline to lease or purchase aircrafts at low cost for a long period. Persistence of the rent derived from a specific input can be achieved by the *isolating mechanism* (Rumelt, 1980) as cited in Conner (1991). In this case, the firm can impose the isolating mechanism in the forms of patent, copyright and trademark to control the access of competitors to the input.

According to Barney (1991), in order to create a competitive advantage, these assets and resources have to meet the criteria including value, rarity, imitability and organization. Valuable resources according to the author should enable the organization to exploit the opportunities and provide resistance to threats. In addition, the resources must be unique to the organization and not imitable in order for the resources to give a competitive advantage to the organization. Besides that, in order to exploit the resources and capability, the firm has to be well organized in various management functions. In conclusion, according to the resource based view, it is the firm capability in performing a specific activity relative to external sourcing decides activity to be performed in house. For activities where the firm has lack of resources are better left to the hand of external suppliers. The RBV basically is formed by combining the industrial organization economics theory of competitive advantage of Micheal Porter (1980) and the strategic management theory (Barney, 2001).

2.5 Concept of economic development and firm's performance

Economic development as a discipline in economics only emerges at the end of World War Two. Economic development refers to the achievement of partial or one dimension of total society development. It is measured at national level. Economic development requires a nation to achieve a minimum level of economic, social and political development. Economic development involves interaction between economic and non-economic forces. The definition of economic development by Meier (1975), associates with the process of an increase in per capita income in the long term. According to the author, a sustained increase in per capita income over a period of two to three decades is what suitably called as economic development. Next, the definition of economic development encompasses a more comprehensive coverage in a number of aspects such as improvement in the economic welfare of the poorer segment of population, changes in educational level, output distribution, and the economic structure. (Nafziger, 2006).

Economic development which is recognized as an element of government policy as emphasized in the Structure-Conduct-Performance (SCP) paradigm in order to better explain firm's performance and its interaction with market structure, market conduct and basic condition (for example demand and technology). As contended by Bain (1968), the performance of an organization is also affected by factors which are separated from structure and market conduct of enterprises or what he called as the "physical environment", for instance, geography, resources, technology level, accumulated scientific knowledge, and characteristics of human population. The economic factor which is given by the variable of economic development in this study is one of the elements defined in the physical environment as an important factor which determines the performance of a firm. In addition, institutional and cultural factor shape the outcomes or performance generated from the activities. It was Bain (1951, 1956) as cited in Carlton and Perloff (1994) who is responsible for applying the first empirical analysis on the SCP approach using industry level data. The close relationship between economic development or economic factor is also embedded in the management framework related to the assessment of organizational performance as proposed in Lusthaus et al. (1999). With the support of these two organizational performance frameworks from two distinguished disciplines, it is suspected that there is an association between economic development level where the firm is originated with the firm's performance.

Economic development and institutional economics are proximately related, as the outcome of the former, calculate on favourable characteristics of the latter. The institutional factor where an economic activity takes place apparently, has an influence on the economic development of a country, which in turn affects the performance of firms. The validity of development economics as a branch of discipline in economics can be traced back from its early development where the element of institutions is embedded. What distinguishes between development studies with other economic studies is the element of institutions which explain why markets or market agents could not generate the best outcome from their activities. The role of good institutions in supporting the favourable economic growth is also manifested in one of the earliest works in development economics which are executed by Lewis (1955) as cited in Adams (1993). In his study, Lewis observed variation in the patterns of economic growth throughout societies. Some nations demonstrate a high level of growths whilst others recorded less. In the study, he queries which institutional types are suitable for growth and which types are not. For example, the proponents of development economics argue the incompatibility of traditional institutions in working with the theory of modern economic growth (Adams, 1993). Bonne (1957) as cited in Jhingan (1975) suggests that the suitability of direction, regulation and guidance are important in order to generate and maintain economic expansion. From these elaborations, it is pronounced that institutions are paramount in achieving an encouraging rate of economic growth.

2.6 Brief history and concept of institutions

Walton Hamilton is the personality who coined the phrase "institution economics" as he announced the term at a meeting of the American Economic Association in 1918 in his paper entitled "The institutional approach to economic theory". The paper is regarded by Hamilton as "reconstruction of economics" which is deemed important to effectively deal with economic challenges (Klein, 1993, p.14). Historically, institutional economics have largely influenced the American economics until 1940s. The prominent element behind unification of economic science is, institutional economics which has been contended in Hamilton (1919, p.309-311). Clearly, institutional economics demonstrate how different parts in the economic system interact as a whole. The importance of institutions is asserted in Hamilton (1919, p.314-318), where he argued that "The proper subject-matter of economic theory is institutions. Economic theory which is concerned with matters of process...Economic theory must be based upon an acceptable theory of human behavior".

Hamilton (1919) further describes five propositions which are essential in institutions including:

2.6.1. The definition of institution is not explained by policy despite the claim by institutional economists regarding the tendency to make practical implication from theory.

2.6.2. Institutionalist ideas come from various disciplines of studies including psychology, anthropology, sociology, and political science.

2.6.3. Institution is central in economy. Therefore, studying the institution and the processes of institutional conservation, innovation and change is important to economists.

2.6.4. Treating the economy as an open and evolving system found in a natural environment, affected by technological progress tied up in terms of social, cultural, political and power relationships.

2.6.5. The assumption about individual rationality as spelt in utility maximization is misleading. As far as institutional is concern, individual is not taken as given. In fact, they are affected by institutional and cultural factors. Institutions affect individual in fundamental ways.

The resurgence of institutional economics or sometimes called the "new institutional economics" which began in the 1980s and 1990s are due to failures of the neoclassic economics to explain certain propositions in the theory and the transformation of the socio-economic system in Europe. In short, for institutional economics, its operative mechanism in the market is emergent valuation which is affected by allocative judgements (Klein, 1993, p. 22). Life process is the main contrasting point between institutional economics and the neoclassical economic thought. Nevertheless, embedding the life process in the economic framework of institutionalism is a big challenge faced by the institutional economists. In this respect, societal value entails constant reinterpretation of value premise which is denoted as "continuing the life process". In addition, an economic process is viewed as an endless effort which involves a review of challenges due to changes in circumstances, technology, and so on faced by the economy. Furthermore, the process involved in the market is regarded as manipulation of prices but the allocation of resources behind the process requires emergent values. In a way, institutional economists interprete the economy as involved a dynamic yet interactive process.

One of the most influential theorists on modern institutions is David North who is popularly known for his theory of institutional change. His ideas about institutions are explicitly explained in two of his notable academic works. One of his first attempts to explain institutions is found in his simple theory which argues that the presence of institutions is due to relative prices between land and labour. He, then, expanded the work to a more interactive approach by integrating factors namely as technology, asymmetries, inefficient institutions, the economic entrepreneur, organizations, and individuals with more complex and varying motives in their resource endowments (North, 1990; 1993) as cited in Sjostrand (1995, p. 30).

It is the integration between individual choice and institutional constraints which shaped the foundation for the theory of institutional change. According to the theory, institutions are central, and, with the combination of technology the performance of an economy is determined. Hence, institutions have a great influence on the production costs through costs of exchange (transaction costs) and production. It is further explained by North that institutional change is derived from "changes in rules, informal constraints, and in the type and effectiveness of enforcement procedures". The author added that the change in institutions occurs in a gradual manner owing to ingrained informal compulsion in the societies. On the other hand, Sjostrand (1995) defines the institutions as "constituted by human interaction and exchange, and represents a kind of infrastructure that facilitates-or hinders-certain co-ordination and allocation processes". The author also argues that institutions operate in the boundry of rationality assumption.

2.7 Institutional factors and firm performance

As described in the second proposition related to institutions outlined in sub chapter 2.6, institutions are generally associated with variables such as political systems, business environment, and perceived business constraints, legal and regulatory framework and the judicial system.

Some common variables used in much literature related to the study of institutions are the governance dimensions as reported in the World Governance Indicators published by the World Bank. These indicators are produced by Kaufman and Kraay (1996).

The World Bank defines governance indicators as:

> Governance consists of traditions and institutions by which authority in a country is exercised. This includes the process by which government are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state on for the institutions that govern the economic and social interactions among them. (Kaufmann & Kraay, 2007, p.6).

The governance indicators consist of voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law and the control of corruption. The WorldBank report provides aggregate and individual governance indicators for 215 countries over the period 1996 to 2014. These aggregate indicators are formed from views of numerous enterprises, citizen and expert survey respondents from both developed and developing countries. These indexes of governance indicators will be used in this study to investigate the influence of institutions on economic development which affects the performance of airlines.

2.8 Conceptual framework

From rigorous discussions above pertaining to the concept of performance and theories explaining the reasons behind outsourcing decisions of firms and economic development influence on firms' performance, a solid conceptual framework to model the influence of outsourcing and economic development on airlines' productivity and technical efficiency is derived. Figures 2.5 depicts the conceptual framework to model the influence of outsourcing and economic development upon airline's performance indicators which are technical efficiency and productivity growth respectively. Based on the diagram, outsourcing which is an internal factor within the control of airline managers influenced the technical efficiency and productivity growth of airlines through the interaction with the size of airlines. In a way, the scale of airline plays an important role in influencing the performance of airlines through outsourcing. Without which outsourcing per se may not positively affect the technical efficiency and productivity of airlines.

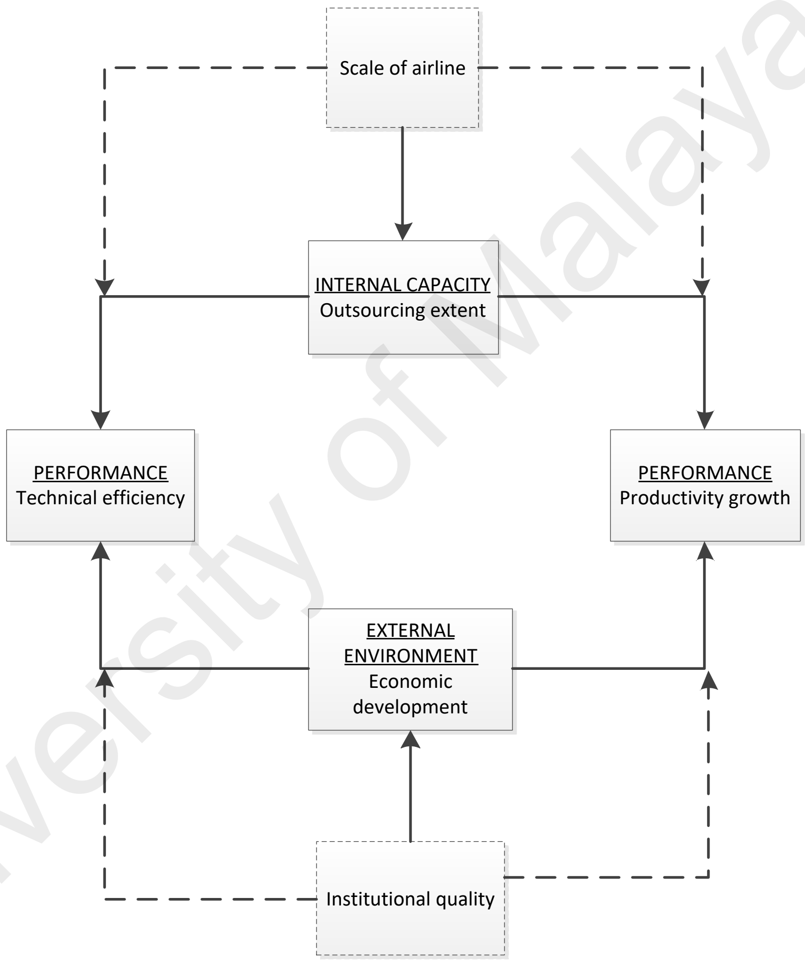


Figure 2.5: Conceptual framework for analyzing the impact of outsourcing and economic development level on the technical efficiency and productivity change of airlines

Source: Adapted from Bain (1968), and Lusthaus (2002)

On the other hand, external environment, where the airline operates and portrayed by economic development level, influences the technical efficiency and the productivity of airline through interactions with each of the six dimensions of quality of governance. The magnitudes of outputs generated are determined by how technically efficient and productive an airline is under the influence of various variables and its interaction effects. In this context, the quality of institution, which is proxied by the quality of governance as given by six dimensions of governance, affects the performance of airlines through economic development level. The impact of economic development on the performance of airlines may be retarded without the influence of high quality of institution. The role of outsourcing in influencing firm's performance has received less attention in past literature. Therefore, it merits further attention looking at the growing trend of outsourcing across the airline industry. Pressures posed by high competition from newly established airlines have motivated airlines to find ways to further slash their operating costs in order to raise their levels of efficiency and productivity. For example, the influx of low cost carriers into the air transportation market today has carved a new history due to its ability to minimize costs which have made outsourcing an alternative to in-house productions.

Airline quality, capacity, and size which are associated with characteristics of the airline do affect the performance of airline particularly in the context of technical efficiency and productivity as found in many studies. Therefore, these variables are included in the two models to control for the airline quality, capacity, and size. Nonetheless, since this study focuses mainly on the impact of outsourcing and economic development level on the performance of airlines, these variables do not explicitly appear in the conceptual framework of the GMM estimations.

2.9 Research hypotheses

The reviews and discussions on firm's performance framework and theories used in explaining the performance of firm in the beginning of this chapter clearly provides a direction to craft the conceptual framework for this study. From the conceptual framework above, six distinct hypotheses are formed as follows:

Hypothesis 1: Full cost carriers do not form the best practice frontier.

Hypothesis 2: Low cost carriers do not catch up with the world technology frontier in terms of productivity growth.

Hypothesis 3: There is no significant relationship between outsourcing and productivity of airlines.

Hypothesis 4: There is no significant relationship between outsourcing and technical efficiency of airlines.

Hypothesis 5: There is no significant influence of economic development on productivity of airlines.

Hypothesis 6: There is no significant influence of economic development on technical efficiency of airlines.

2.10 Conclusion

This chapter explicates a variety of concepts and theories used in the thesis to explain performance including the concepts of technical efficiency and productivity growth in the context of the airline industry. Second, the concept of performance is explained using the

Structure-Conduct-Performance framework of industrial organization and the management framework for organizational performance assessment. Third, concepts and theories related to determinants of technical efficiency and productivity growth which will be investigated in this study such as outsourcing, economic development level and institutions are also discussed in this chapter. In addition, the chapter brings up discussions on why firms outsource by providing the theoretical explanations from both economics and management perspectives. The transaction cost economic theory and resource-based view are both deciphered to explain outsourcing in airlines. Finally, this chapter develops research hypotheses derived from concepts, economics, and management theories to explain firm's performance.

CHAPTER 3: REVIEW OF EMPIRICAL LITERATURE

3.1 Introduction

This chapter reviews, discusses and synthesizes relevant empirical literature related to evaluation of technical efficiency, productivity change, and factors affecting efficiency and productivity change in airlines with an emphasis on outsourcing and economic development level. The role of institutional economics in explaining the influence of economic development level on firms' performance is also deciphered in this chapter. The review covers an extensive period of studies between the period from 1990 to 2015 to reflect the performance of airlines during post liberalization of air transport markets in United States, Europe, and Asia which is characterized by a high level of competition. The literature provides a broad picture regarding the status of efficiency and productivity level of airlines across the globe and the influence of outsourcing and economic development level upon the technical efficiency and the productivity growth of airlines.

The chapter starts with review of articles on the evaluation of technical efficiency in the airline industry. Next, literature on evaluation of productivity change is expounded. After that, the chapter explicates the influence of outsourcing on technical efficiency and productivity change. Finally, the role of economic development level on airline's performance in the contexts of technical efficiency and productivity growth is discussed. The last sub-section concludes.

3.2 Technical efficiency estimates of airlines

There have been numerous studies investigating the determinants of airlines' technical efficiency over the past three decades from the 1990s to 2010s. In the 1990s, among the prominent studies is by Good et al. (1993) on the impact of deregulation upon selected American and European airlines. The study employs stochastic frontier approach to evaluate the technical efficiency of airlines in the two continents. They conclude that U.S airlines are benefiting from the deregulation exercise but not European airlines, hence suggesting that less efficient firms in the former are improving their efficiency. This study employs data from 1976 to 1986, when deregulation exercises just started in the U.S. Therefore, the outcome seems to favor U.S airlines because deregulation initiative only begins in the U.S in 1978. Meanwhile, in Europe, the initiative starts in the late 1990s. Policy-wise, the study concludes an urgent need to close the efficiency gap between the airlines from the two different continents in order to ensure substantial savings in operating costs for European airlines. The saving in costs could be used for compensating of displaced worker during post deregulation period.

Subsequently, in the same year, Schefczyk (1993) contends that business focus and profits play an important role in improving airlines' efficiency. The study evaluates purely operational efficiency by excluding non-flight assets in the input category used for the estimation of efficiency. The DEA assumption of constant returns to scale is adopted to estimate the efficiency level of the given airlines. The result reveals that assets relatedness hold by airlines may potentially affect their performances. Empirically, the results from the analysis show that 14 out of 15 airlines demonstrate rising performance due to business focus. In short, the researcher suggests that by focusing resources on the passenger segment of the airlines service helps in raising the productivity of airlines.

Next, by adopting a contrasting methodological approach, Atkinson and Cornwell (1994) identifies allocative and technical inefficiency of airlines using the parametric translog function approach. The parametric approach has an advantage over the non-parametric approach in the sense that it employs the flexible functional form which allows ignorance of assumptions on firm behaviour, distribution of errors, and technology required to estimate an error component model. Furthermore, the panel data used in the study permits identification and consistent estimation of input and firm specific allocative and technical inefficiencies. The study employs panel data consisting of 13 U.S airlines. It is worth emphasizing that the airline samples in the study focused on domestic routes. The temporal nature of the data is quarterly between years 1970 to 1981. One of the distinctions of the parametric efficiency estimates is that it requires price data of inputs and outputs to be known. Therefore, for this purpose, the data on quantities of inputs and outputs as well as their respective prices information are obtained from CAB Form 41. The output variable is proxied by capacity ton miles. Whilst the input measures consist of capital, labour, energy and materials. On top of that, output characteristics are also considered in the model including average stage length and quality of service, seasonal dummies for example winter, spring and summer and productivity growth to control for time variation. The findings based on the allocative efficiency estimates indicate that firms in the sample have over utilized labour and capital but have underutilized energy relative to material. Besides, the study also reveals a spectacular result where the most technically efficiency airlines are also the most allocatively efficient ones, thus, suggesting that input optimization is important.

The environment where an airline operates also play a significant role in determining the efficiency of an airline as discussed by Coelli et al (1999). Using the stochastic frontier approach, the study concludes that environmental factors are important in affecting the efficiency of airlines. The study uses sample of annual airlines data for 32 international airlines over the period 1977 to 1990 which covers the United States, Europe, Asia and the Oceania operating in different environmental conditions. Output specification is tonnes kilometer available (sum of passenger and cargo services). In terms of input variables, the study employs pure inputs for flying operations namely, labour and capital. Likewise, environmental variables are given by average load factor, average stage length, and aircraft capacity (measured by weighted mean number of seat) in each aircraft. According to the authors, environmental factors affect the efficiency of airlines in two ways: Firstly, it shapes the production technology. Secondly, it affects the degree of technical efficiency. Therefore, based on these two efficiency effects, the study employs two different stochastic models. The results from the model estimations suggest that Asian and Oceanic airlines are technically more efficient than the U.S and the European airlines. The reason for the high technical efficiency of Asian and Oceanic airlines is attributable to favourable environmental condition from where the airlines operate.

Among the first literature investigating the technical efficiency of airlines in the following decade is led by Fethi et al. (2000). The study contends negative effect of business regulation (subsidy) and concentration on technical efficiency of airlines. On the contrary, state ownership has no significant impact on airlines' technical efficiency so long the operational objective of airlines is commercial and there is no political agenda in the provision of the air transport services. The authors employ Data Envelopment Analysis to estimate the technical efficiency in the first stage. Meanwhile, in the second stage, the Tobit regression model is applied to examine the sources of variation in efficiency. The sample of airlines in the study consists of 17 European airlines from years 1991 to 1995. The study underlines the importance of load factor in improving the technical efficiency of airlines.

Afterward, the relationship between operational efficiency and customer service is deciphered by Scheraga (2004a). In the first stage, the author uses a sample of 38 large global international airlines for the year 2000 using the standard DEA approach to assess the efficiency of selected airlines. Later, in the second stage, the study applies the Tobit regression model by regressing state ownership, average flight length, passenger revenues, international passenger revenues and average load factor against the dependent variable which is the technical efficiency. The finding in the first stage analysis observes 20 of 38 airlines in the sample, operating at low efficiency levels. The result also stressed that focused expenditures on operation and passenger services shows a negative linkage with efficiency. Contrarily, focused expenditure on ticketing, sales and promotional activities relates positively with efficiency of airlines. In fact, the result in the second stage regression analysis concludes that state ownership of airlines has no significant impacts on the operational efficiency of airlines.

In another study, Scheraga (2004b) examines operational efficiency in the global airline industry using DEA approach. Subsequently, in the second stage, the study executes the Tobit regression analysis to investigate the association between explanatory variables structural and executional drivers and operational efficiency. The regression method adopted in the second stage analysis is the Tobit censored regression which is contrasted to the stepwise procedure approach. Then, the Tobit regression analysis is performed using LIFEREG procedure in the SAS statistical package. The focus of this research is to investigate operating efficiency and financial position of airlines after September 11, 2001 tragedy. The DEA methodological framework employs in the study follows that of Ali and Seiford (1993) which dissipate 3 variations of DEA namely in model 1 base model is estimated using (non-oriented) approach. Secondly, the DEA input oriented model is employed; and, thirdly, in model 3, the DEA Output oriented model is utilized. The DEA analysis employs a software used by Schefczyk (1993) that is the Integrated DEA System Version 6.1.7 obtained from 1 Consulting (2000). All the three models generate different results.

Likewise, the results from the above study demonstrate that most airlines in the sample experienced rising efficiency levels. In short, the findings stress the importance of operating efficiency but not a sufficient condition to achieve good financial performance. Another spectacular finding is the impact of ownership is not significant and is in line with the finding found from the study by Barros and Peypoch (2009).

Competition, on the other hand no doubt is a significant factor that has the tendency to alter the operating efficiency of airlines as explained by Wong and Chen (2005). The study investigates the competitiveness of 7 Taiwanese domestic airlines over the period of 15 years by adopting Data Envelopment Analysis, specifically the efficiency shift model as introduced by Fare and Grosskopt (1996) to compute geometric shift in production frontier with four inputs comprises of all assets, fuel costs, labour costs, and maintenance costs of physical assets. Meanwhile, outputs mixed are given by operating revenue, available seat kilometer and revenue passenger kilometer. They argue that less stringent restrictions on new entrance of domestic airlines positively affect the competition level and scale efficiency of airlines as indicated by improvement in the efficiency of incumbent airlines. The strength of this study is on the advanced methodology used to compute the technical efficiency, that is the slack analysis which improves the efficiency scores obtained from conventional DEA approach by running a second stage linear programming to cater for the ignorance of slacks issue in the latter.

Next, Inglada et al. (2006) compares the technical efficiency of selected sample of large international air transport companies from Asia, Europe, United States, Canada and Mexico within the new liberalisation framework setting for the period of 1996–2000. By adopting the stochastic frontier approach to evaluate the technical efficiency followed by regressing liberalization variable upon the technical efficiency scores using the random effect within estimator following Schmidt and Sickles (1984), the study employs a panel data set of 20 international airlines for the period 1996-2000. The authors assert that leading Asian airlines namely Cathay Pacific, Singapore Airlines, Korean Air and Japan Airlines have gained efficiency due to rising competition resulting from market liberalization of air transport in the region.

Despite sharing a similar objective to evaluate the technical efficiency of airlines, a major point that contrasts between the study of Wong and Chen (2005); and that of Inglada et al. (2006) is the methodological approaches adopted in both studies, where the former uses the efficiency shift model of DEA technique to estimate efficiency whilst the latter applies an econometric modeling of stochastic frontier approach that requires an estimation of a production function.

Empirically, too, there are strong evidences emphasizing the effect of business focus as stressed in Barbot et al. (2008). The study utilizes the DEA variable returns to scale assumption and the total factor productivity to evaluate the technical efficiency and productivity changes in airlines. Using a large sample of global airlines for year 2005, the study employs mixed of multiple inputs and outputs for the purpose of efficiency and productivity estimations. Input variables are comprised of labour costs, number of fleet, and fuel costs. Meanwhile, output variables are given by available seat kilometer, revenue passenger kilometer, and revenue tonnes kilometer. The findings indicate that low cost carriers are more efficient compared to full service carriers. In terms of consistency of total factor productivity score, North American airlines show greater homogeneity in the TFP scores but in contrast to European airlines and the Asia Pacific airlines. Moreover, the finding underlines the significant influence of labour on productivity of the airlines in the sample studied. Furthermore, it is evidenced that larger airlines are more efficient owing to economies of scale effect. Business model wise, low cost carriers show the highest DEA and TFP scores compared to full cost carriers.

In spite of comparing the efficiency of North American, Asia Pacific and European airlines, the study by Assaf and Josiassen (2011) examine the operational performance of 15 UK airlines for the period of 2002 to 2007. By employing an extended DEA-bootstrap method, the study utilizes the following input and output combinations to measure the technical efficiency of UK sample airlines: On one hand, the output variables consist of tonne km avail (TKA) and operating revenues. On the other hand, inputs consist of labour, fuel, oil expenses and aircraft value. The study concludes that UK airlines experienced deterioration of the efficiency levels from 2004 to 2007 which is largely driven by airline size and load factor. Of all the factors examined, oil price and competition are crucial which explain inefficiency of the air transport industry in the UK during the studied period.

Next, by using a sample of European airlines, Barros and Peypoch (2009) examines the operational performance of the airlines in the region. In the first stage, the technical efficiency for a sample of European airlines is estimated using DEA output oriented and constant returns to scale assumption of Farrell (1957) and Debrew (1951). After that, second stage procedure is executed following Simar and Wilson (2007) study by applying the bootstrap truncated regression to overcome bias estimate due to high correlation between efficiency score and the explanatory variables on the right-hand side. By employing a panel data of 174 observations sourced from the Association of European Airlines (AEA) between the period 2000 to 2005, the study specifies outputs as operating revenue and are proxied by revenue passenger kilometer, earnings before interest and taxes (EBIT) which reflects financial performance of the airline companies in the sample. Meanwhile input variables consist of number of employees, total operational costs, number of planes in the airline's fleet. The data consisted of major European airline companies including some low cost carriers. In general, the findings reveal an increasing trend in the efficiency of European airlines throughout the study period, but at a decreasing rate. In addition, the findings also highlight that majority of the airlines in the sample are scale efficient which is attributed to strong demand from domestic market. Another factor which found to be positively linked to the efficiency of European airlines is global membership of network. Nevertheless, ownership of airlines has no strong association with efficiency of European airlines as seen in the mixed results conveyed in the regression analysis.

Another study that estimates the operational efficiency of airlines within the same year with the study by Barros and Peypoch (2009) is explained by Greer (2009) who seeks to examine the influence of the degree of unionization of an airline's employees on its operational efficiency. That study uses the DEA technique which assumes input orientation and constant returns to scale to measure the technical efficiency of airlines. Next in the second stage, the Tobit regression analysis using Maximum Likelihood method is employed to estimate the parameters for each regressor. Input variables for first stage DEA operating efficiency analysis consists of labor, fuel and seating capacity. In addition, output variable is proxied by available seat miles (ASM). The sample data covers US major passenger airlines for the period 1999 to 2008. The independent variable is represented by percentage of unionized employees. Meanwhile, control variables for the regression analysis in the second stage consist of age of fleets, size of aircraft, average stage length, hub and spoke reliance in the airlines network, international passenger enplanement, and legacy carrier. All the data in first stage DEA analysis utilizes physical unit measurements. The findings from the analysis underline insignificant effect of labour union on airline efficiency in the sample studied. The study also concludes a negative influence of hub-and -spoke strategy on the technical efficiency of airlines. In general, the results suggest that hubbing is more influencing than aircraft size in explaining lower level of technical efficiencies in airlines.

Other researchers who emphasize the association of low cost carriers with efficiency, are explained in Worthington and Lee (2010), and Assaf and Josiassen (2011). A significant difference between these two studies is with regards to the estimation techniques for estimating efficiency and productivity growth. The former employs the standard DEA approach, whilst the latter applies the Bayesian distance frontier approach. Despite differences in terms of methodological approaches, these two studies mutually agreed that low cost carriers are more efficient than full service carriers. Worthington and Lee (2010) evaluate the efficiency of international, domestic, and budget airlines. Using a non- parametric DEA technique based on constant returns to scale and variable returns to scale assumptions, the study utilizes sample data of 52 airlines for year 2006 to estimate the technical efficiency of global airlines. The types of input used are available tonnes kilometer, non-flight assets and operating costs. However, outputs employed in the study are revenue passenger kilometer; and non-passenger revenues. The results from the analysis emphasized that majority of LCCs are efficient. The study also stresses the importance of limiting of employment of non-flight assets in airline operation, as it may lead to increased inefficiency of airlines' operation.

In contrast to the approach used by Worthington and Lee, Assaf and Josiassen (2011) evaluated efficiency and productivity of 31 European and United States airlines using the Bayesian distance frontier model. Both inputs and outputs used in the estimations of the technical efficiency and the productivity are strictly in quantity measurement. Outputs variables for the study consists of passenger service measured in revenue passenger kilometers and incidental revenues (non-airline revenues). Next, inputs consisted of labor, capital, fuel, and other operating inputs. The outcomes from the study reveal superiority of European airlines compared to U.S airlines in terms of score estimates of efficiency and productivity. Another interesting finding reveals that productivity and efficiency of low-cost airlines are significantly higher than full-service airlines.

In the preceding study, Ajayi et al (2010) empirically investigates the operational efficiency in the U.S. airline industry during post-deregulation of the US airline industry in 1978. Secondly, the study aims at investigating whether operational efficiency is associated with changes in financial positions of airlines in the industry. Thirdly, the study aims at observing the difference in the patterns of the efficiency measures for large and small airlines. The researchers use inputs and outputs data and financial ratios sourced from form 41 financial data of the U.S. Department of Transportation. The sample consists of quarterly observed data for 16 airlines consisted of small and large airlines from first quarterly 1977 to third quarterly 2007. In terms of input and output mixed to run the DEA efficiency estimations: Input variables comprise of number of aircraft seat, number of full time employees, quantity of fuel consumed, value of flight assets, and value of non-flight assets. Meanwhile, output variables are given by number of RPM per period, total passenger revenues, total mail, and freight revenues. The study employs the standard DEA technique to estimate the technical efficiency and allocative efficiency of airlines in the sample. In general, the study contends that large U.S. airlines are technically less efficient than small airlines. However, large airlines are allocatively efficient in the operations as compared to small airlines. In addition, the findings show the ability of large airlines to maintain a superior optimal mix of inputs.

Subsequently, Coli et al. (2011) benchmark efficiency of 42 domestic routes of Air One Italy. The study applies both the stochastic and the DEA frameworks to compare the technical efficiency of 42 different routes operated by Air One Italy. Inputs used in the estimation of the efficiency scores comprise of total seats, and direct operating costs. Meanwhile outputs consist of schedule passenger revenue, and undesirable output in the form of delayed flights. Different approaches used to measure the technical efficiency in the studies do not change the results of the efficiency scores. In fact, the efficiency values show a consistent result from the two approaches employed. The majority of the routes operated by Air One demonstrate a significantly high level of efficiencies which implies the capability of the management team in strategizing appropriate routes. This study differs from other studies discussed earlier in the literatures which apply DEA approach because it includes undesirable output that is baggage delayed in addition to good output which may affect the level of efficiency score of airlines if the former is not taken into consideration. Furthermore, other studies discussed above mostly evaluate and compare the performance among different airline companies, whilst this study benchmarks the performance of different routes operated by an airline company.

The next study which is contrasted to the earlier study by Nissi and Rapposelli (2011) is conducted using a sample of airlines from Europe (Lozano & Gutirez, 2011). The research adopts a more advanced DEA technique which employs the Slack Based model (SBM) to measure the efficiency of airlines. This method is superior to other DEA methods because it overcomes projections on weak efficient operating points by inputs and outputs as commonly practiced in ordinary DEA model. Other advantage of the SBM is that it is unit invariant and monotonous as it takes into consideration inputs and outputs slacks in the estimation of the efficiency score. The research utilizes sample of 17 European airlines in year 2006. Outputs for the DEA estimation is defined by revenue tonnes kilometer (integrates metric tonnes on passenger freight and mail) to measure environmental performance of airlines operations. In addition, inputs are defined by: (1) fuel consumption. This is because fuel emits carbon dioxide by assuming direct relationship between fuel cost and fuel consumption and CO2 emission; (2) fleet costs which are given by the sum of aircrafts, ground property and flight equipment assets. However non- tangible assets are excluded from the input definition; (3) Operating costs consist of labour, fuel, selling and other costs related to air transport operation. The study concludes that 8 of 17 airlines are technically efficient. Additionally, only four airlines are scale efficient which imply that most airlines operate at a sub-optimal scale.

Lozano and Gutirez (2011); and earlier study of Barros and Peypoch (2009) give two contrast findings regarding the scale efficiency and the technical efficiency levels of European airlines. In their study, the former contends that majority of European airlines are scale efficient but the later comes with an opposite finding. In terms of technical efficiency measure, the finding in the former confirm that vast majority of the airlines are technically efficient but the later reports that less than half the sample studied are technically efficient. Both studies apply advanced DEA methods namely as the Slack based method, Multi-objective approach and the bootstrapping approach to overcome the loopholes of efficiency estimation found in the traditional DEA approach. A major contrast between the two studies is in terms of the frequency of data observed where the former used single year data of 2006 but the later considers more number of years in their observation to incorporate data from 2000 to 2005. In addition to findings on the scale efficiency and the technical efficiency, Lozano and Gutirez (2011) also stress that investments focused on ground assets has a positive influence on the technical efficiency.

Meanwhile, Barros and Peypoch (2009) reveal that high domestic demand and global alliances are equally important in raising the efficiency level of airlines. A gap identified in the two studies is that they fail to consider intangible assets in their input specification when one knows that intangible assets may sometime contribute to significant amount in sum of assets held by a firm. Other possible argument for the opposite results conveyed in both studies, is the importance to incorporate carbon dioxide which is bad output, a byproduct derived from airlines' operations. The results of technical efficiency derived from the incorporation of bad output which shows that a much lower score of efficiency implies bias in the estimation of efficiency using standard DEA technique.

Another study, carried out in the same year but focused on the influence of management capability in the form of appropriate fleet planning on efficiency of airlines was carried out by Merkert and Hensher (2011). The study utilizes panel dataset of 58 largest passenger based airlines obtained from 2 fiscal years of 2007/2008 and 2008/2009 to evaluate the technical efficiency and allocative efficiency of global passenger airlines. In the first stage DEA, the authors compute the efficiency scores by bootstrapping from the original score using Simar & Wilson (1998; 2000). The study generates two results of efficiency scores, first with respect to CRS orientation, and secondly with respect to VRS orientation. This approach raises the size of observations due to small sample to avoid bias estimates of efficiency scores. In the second stage, variables for Tobit regression employed including airline size as proxied by available tonnes kilometer, aircraft size (number of seats), stage length (average stage length flown), fleet age, aircraft families (aircraft that the same pilot can operate not the specific type of aircraft).

Nevertheless, the sample data for the study excludes merger and acquisitions in airlines that have gained benefits. In terms of inputs for the DEA analysis, the study uses operational data such as capital and labour which are proxied by available tonnes kilometer and full time equivalent staff respectively. Instead, output is defined by revenue passenger kilometer and revenue tonnes kilometer to reflect both outputs of passenger and cargo, mail, etc. It is concluded that strategic management and fleet planning influence the technical efficiency and allocative efficiency of airlines. Furthermore, it is also argued that airlines with large aircraft and only few aircraft families and manufactures in their fleets tend to show high technical, allocative and cost efficiencies. Hence, these findings conform to findings in past studies regarding the negative impact of heterogeneity of fleets on performance of airlines. A major distinction in this study compared to other studies using DEA approach, is that this study corrects the efficiency scores obtained from first stage using bootstrap approach in Simar and Wilson (1999; 2000) to avoid bias estimates in the technical efficiency and allocative efficiency scores measured.

In studying the impact of corporate governance on airline performance, Lu et al. (2011) adopt two stage DEA analysis. The sample of data for the study comprises of 30 US airlines listed in the US Stock Exchange. Input variables are in the forms of number of full time employees, fuel quantity consumed, seat, flight equipment cost, maintenance costs, and ground asset properties. On the other hand, output variables are represented by available seat mile, available tonnes mile (later acts as input variables for second stage DEA) or intermediate variables. Meanwhile, final outputs are given by revenue passenger mile, and non-passenger revenues. In the first stage, an improved DEA approach is utilized to account for the impact of intermediate inputs. The study adopts additive efficiency decomposition (Chen et al., 2009; Cook et al., 2010) under the assumption of input minimization (also known as input orientation) to measure the operating performance of multi-stage production of airlines, with intermediate measures, in a single implementation model. Next, in the second stage, the study uses truncated regression of parametric bootstrapping to estimate the parameters. The variables for the second stage regression comprise of corporate governance indicators which are proxied by board size, committee number, meeting number, non-executive director, directors' age, executive director's ownership, CEO duality (CEO and chairman) and control variables such as production and marketing efficiencies perspectives. The results from the study highlight that low cost carriers are more efficient than full cost carriers. Nonetheless from the marketers' perspective, they are less efficient than full cost carriers. In addition, the finding also found significant differences in terms production efficiency and marketing efficiency among the two types of airlines, where the production efficiency score is 63% whilst the marketing efficiency is 33.

In subsequent study, Zhu (2011) benchmarks airlines performance by employing a quite recent two-stage network DEA approach introduced by Liang, Cook and Zhu (2008). In this approach, performance is reflected by two variables in different stages, namely in stage 1 where the variable used is fleet management. Meanwhile, revenue generation is the variable associated with stage 2. The analysis incorporates intermediate variables which become inputs for generating output in the second stage model. Inputs for first stage model consist of cost per available seat mile for salaries, wages, benefits; fuel expenses per available seat mile, fuel cost, and gallons of fuel used. Meanwhile output variables consist of load factor and fleet size. In the second stage model, input variables comprise of load factor, fleet size (intermediate measures from stage 1). Output variables are defined by revenue passenger mile and passenger revenue. The results from centralized DEA model show that AMR Corp recorded the highest efficiency level in both years, which are between 82-95 % scores followed by Delta, United, Southwest, and Ryanair. Other airlines in the US sample recorded low efficiency scores with Allegiant recorded the lowest score of efficiency.

An attempt to estimate the operational efficiency and financial efficiency is found in Gramani (2012). To execute the estimates for both operational efficiency and financial efficiency, the author carries two phases of DEA analysis following Banker et al. (1984) variable returns to scale and input orientation assumption. The operational DEA performance analysis is measured in phase 1. Next in phase 2, the financial DEA performance analysis is carried out. Inputs in phase 1 consist of fuel, wages and salaries, benefits of staff, and cost per available seat mile. In addition, output for phase 1 comprises of revenue passenger mile which is calculated by taking the ratio of load factor to available seat mile. In phase 2, input is given by the efficiency score obtained from stage one. One needs to take the inverse value of the efficiency score, so that the value is isotonic. Next, output for phase 2, are given by flight revenues and flight income (profit). The findings confirm that good operational performance is not sufficient for a good financial result. Statistical evidence shows a weak yet positive correlation between operational efficiency and financial efficiency in emergent airlines (Brazilian airlines) but a strong correlation is shown in US airlines. In conclusion, the finding demonstrates that operational and financial efficiency does not walk in a parallel manner for emergent airlines. In a way, emerging airlines place a greater emphasis on resource optimization as shown in a consistently higher operational efficiency compared to financial efficiency scores.

The impact of merger and acquisitions on the efficiency of airlines is examined in Merkert and Morrell (2012). The authors employ non-parametric DEA technique following Merkert et al. (2010) and Assaf (2010) using input orientation and constant returns to scale assumption. Nevertheless, the results for both of the variable returns to scale and constant returns to scale efficiency scores are computed. The sample for the study consists of 66 international airlines which cover two periods 2007/2008 and 2008/2009. As for the input variable, the study uses capital which is proxied by available tonnes kilometer, and number of labour as proxied by full time equivalent staff. On the other hand, outputs comprise of revenue passenger kilometer, revenue tonnes kilometer, and non-airline revenues.

However, non-aeronautical revenues are included in stage 2 of the DEA analysis to account for the importance of other revenues which have become equally important for an airline operation. Meanwhile, the calculation of scale efficiency follows that of Simar and Wilson (2002) where efficiency is decomposed into pure tech efficiency and scale efficiency. An additional prescription is taken in calculating the efficiency scores where the direction of the scale inefficiency in the analysis is executed following the examples from Helvoigt and Adams (2008), Färe et al. (1985) and Thanassoulis et al. (2008) by running an additional round of the DEA models with those estimated for the constant returns to scale-based technical efficiency measure. To adjust for biasness in the efficiency scores, the author bootstraps the scores. The results from the two stage analyses confirm the importance of size of airline in ensuring achievement of maximum efficiency level. On the other hand, mergers of big airlines are not beneficial from the perspective of economies of scale. In addition, the findings also suggest the role of bootstrapping procedure in adjusting for the biasness in traditional DEA model. The efficiency scores in DEA2 are consistently higher than DEA 1 suggesting that non-airlines revenue plays an important role in today airlines' operation. Furthermore, there is scale inefficiency issue in the sample of the airlines studied where the results show that small airline and very large airline are scale inefficient.

In a more recent study, Lee and Worthington (2014) evaluate the technical efficiency of mainstream airlines and low cost carriers using bootstrap DEA truncated regression approach. The authors employ DEA Output orientated, with variable returns to scale assumption to estimate the efficiency scores following Bhadra (2009). Next, the study employs double bootstrap technique to correct for bias estimates of efficiency scores obtained from stage 1 due to strong correlation between efficiency scores in first stage and explanatory variables in the second stage. The input variables for DEA efficiency measurement comprise of the number of employees, total assets in US dollar, and number of kilometer flown. Next, output variable is given by available tonnes kilometer. The study suggests that Ryanair and Sata Int. from European airlines category recorded full efficiency scores. Meanwhile in the US category, American, Frontier and United airlines are found to be technically efficient. Interestingly, the study concludes that Frontier is scale efficient which suggests that the airline is operating at an optimal size. On the other hand, the result from the study points out that the US legacy carriers are operating suboptimal scales which implies why the airlines are inefficient. The findings in the second stage regression analysis argue that low cost carriers, load factor, and ownership relate positively with efficiency of global airlines in the sample studied.

A more recent work by Jain and Natarajan (2015) employs the DEA approach to investigate the operational efficiencies of airlines across service type, size and ownership structures in India which cover a more recent period from 2006 to 2010. The authors use variable returns to scale assumption using Input Efficiency Profiling (IEP) model instead of the standard DEA. The model is superior to past studies in part because it is more discriminating than the conventional DEA model when the inputs do not substitute. The sample data for measuring the efficiency of airlines cover full service, LCC or budget, domestic and international carriers. Input variables are given by fleet capacity as proxied by available tonnes kilometer, operating costs excluding capital expenditures, aircraft rental, and depreciation. In addition, output variables consist of revenue passenger kilometer and non-passenger revenues. Generally, the results from the analysis conclude that majority of budget airlines are efficient. Not only that, but the findings also confirm that smaller private sector airlines, both larger and smaller public sector airlines are operationally efficient. This study is among first attempt to benchmark efficiency of Indian airlines in particular and air transport in Asia in general looking at the growing demand for air travel in India.

The following research is contrasted to the DEA input profiling model discussed above by adopting the non-oriented DEA model to overcome the issue of vague orientation in production activities. In a situation where production activities are uncertain whether input or output orientation is appropriate, researcher may apply this approach. In the study by Mallikarjun (2015), the author utilizes unoriented DEA network technique by applying balance between both orientations to the three stages airline network model. Network of three stages with one input, one output, two intermediate products, and two site characteristics is applied in the study. In first stage, input variables consist of operating expenses, whilst output is given by available seat mile. Next, in the second stage, input variable is given by available seat mile. In addition, two site characteristics are defined by fleet size and destinations. After that, in third stage, the process involves producing operating revenues. Meanwhile, intermediate products for the study are defined by available seat mile and revenue passenger mile. According to this study, major US airlines are more efficient than national US airlines with regards to spending operating expenses and gaining operating revenue. However, the study demonstrates no significant difference in their service supply and demand efficiencies.

In their latest study, Min and Joo (2016) evaluate the comparative efficiency of the strategic alliances among global airlines. Next, the literature assesses the managerial impact of airline alliances on the airline's comparative performances. The literature employs DEA output orientation based on CRS and VRS assumption. A major distinction between this study and literature in past studies is that this study accounts for categorical variable which has not been applied in airline's benchmarking using DEA in past studies. Besides that, this study incorporates service rating using algorithm as suggested by Cooper et al. (2007). Sample data for the study comprises of global airlines characterized by 8 SKYTEAM, 27 STAR ALLIANCE, 9 ONEWORLD, and 15 non-member airlines. Input variables for estimation of efficiency scores are given by operating expenses, underutilization index which is computed by deducting load factor from 100 full score of load factor. Meanwhile, output variables are defined by operating revenue, number of passengers, revenue passenger kilometer, service rating (which is an ordinal variable). The main findings from the study highlighted two important points. First, alliances do not necessarily improve airline's comparative operating efficiency. This result is supported by Porter (1997) who argues that alliances do not guarantee managerial success. Second, it is evidenced that smaller alliance groups tend to outperform larger alliance group, thus agreeing with the saying that "*small is beautiful*".

The latest research in 2016 is carried out by Duygun et al. (2016). In the study, the authors adopted the Network Data Envelopment Analysis approach which comprises of two sub-technologies that can share part of the inputs. The procedure for estimation of efficiency score involves two stages: The first stage, involves production output, and the second stage involves consumption of actual output. The sample of data for the purpose of this study includes 87 airlines from 27 European countries covering the period 2000-2010. Input and output variable specifications for measuring efficiency at first stage involves flight capital, which is proxy by number of aircraft, labour index, and material quantity index of non-flight related equipment. On the other hand, output variable is represented by revenue tonnes kilometer for passenger, freight, and mail carried by distance flown. The authors suggest that most of the inefficiencies are generated in the first stage of the analysis. In addition, most of the low-cost carriers' inefficiencies are confined to the first stage. Another interesting result shows a dynamic pattern in the performance variation where the study observes variation, in the efficiency of airlines across type of airlines throughout the period observed from 2000 to 2010.

Another recent work in 2016 is by Tavassoli et al. (2016) who assesses efficiency of 7 Iranian airlines using range-adjusted measure by combining with SCSC (strong complementary slackness condition), and DEA-DA (data envelopment analysis-discriminant analysis) to rank airlines in the sample of study. This approach extends the standard Range-Adjusted Measure in the belief that the conventional DEA models do not fully utilize all inputs and outputs, thus causing zero result for many multipliers. In addition, conventional DEA is biased and suffer from weak discriminatory power which leads to too many efficient DMUs. The input variables for the DEA analysis consist of number of aeroplanes, number of employees and number of flights. Next, the output variables comprise of passenger aeroplane (in kilometer) and cargo aeroplane (in kilometer). The analysis found that Naft Iran leads in terms of efficiency score. The airline company is selected as the best DMU with an efficiency score of 1 in all periods. In contrast, Iran Air Tour was the most inefficient DMU as revealed in the analysis. This study is among limited studies which attempt to benchmark the efficiency of airlines in a single country outside the US and Europe contexts. So far, studies outside US and Europe have been carried out in China and India but very rare in the Middle East. This different has made the study a special one.

There are two conclusions that could be made from the review of literatures in this sub section. First, it is observed that most literatures in the 1990s favor the approach of parametric technique in measuring the technical efficiency of airlines as seen in Good et al. (1993); Atkinson & Cornwell (1994); Coelli et al. (1999). Most literatures during the period employed stochastic frontier technique which involves econometric estimations and ultimately show the popularity of the technique for estimation of technical efficiency. However, the period after 2000 demonstrates the popularity of non-parametric Data Envelopment Analysis estimation approach for evaluating the technical efficiency. This technique is gaining fast development compared to parametric approach and has been a popular choice for non-parametric approach as evidenced in various extended models of DEA found in recent studies of Lee and Worthington (2014); Jain and Natarajan (2015) ; Mallikarjun (2015); Duygun et al. (2016); Tavassoli et al. (2016); Min and Joo (2016). These approaches give different results of the technical efficiency score as they treat for possible biasness in the scores obtained from each DEA technique. Nonetheless, a gap in the method indicate that the metafrontier approach of calculating efficiency estimates has not been applied in the context of airline despite its wide application in other areas such as agriculture, banking, engineering, energy, hospitality, etc.

Secondly, with respect to empirical findings, the literatures identify three major factors influencing the technical efficiency of airlines. Firstly, while Barros and Peypoch (2009) support the influence of ownership on the technical efficiency of airlines, studies by Fethi and Jackson (2000); Scheraga (2004a); Scheraga (2004b) indicate the opposite outcomes. Next, competition is important as shown by improved technical efficiency scores of airlines in Taiwan and Asia due to relaxation of entry policy in the air transport market. A general trend is observed with regards to airlines in Asia as compared to its competitors in US and Europe. Many airlines from Asia recorded higher efficiency scores compared to airlines in US and Europe in 2000s owing to an increase in competition due to liberalization in the air transport market during the period. It is also found that LCC and budget carriers are more technically efficient compared to full service carriers after year 2000. This finding is applied to LCC globally across US, Europe and Asia. It also marked an intense competition imposed by the influx of LCCs in the aviation market. Meanwhile in the 1990s, many efficient airlines associated with US originated carriers, as the deregulation of the air transport market has started much earlier than in other regions. Recent benchmarks showed striking findings of technical efficiency with regards to LCC from Asia particularly LCC from India which dominated the efficiency score in 2016. This phenomenon is in line with a high demand for air transport in the country, due to high economic growth in the region during the period.

3.3 Productivity of airlines

The review of literature in this sub-section is divided into two chronological periods, namely as period 1 which comprises evaluation of literature in the 1990s covering the period from 1990 to 2000. Subsequently, in the next period, the review covers the period from 2000 to 2016. This chronological approach ensures that the researcher cover most recent issues surrounding performance of airlines in general and productivity in particular. Among earlier selected articles in the 1990s associated to productivity benchmarking in the air transport industry are that by Kumbhakar (1992); Truitt and

Haynes (1994); Mar´ın (1998); and Ceha and Ohta (2000). Despite scanty researches on airline's productivity in the 1990s, these literatures have somehow provided a general picture relating to performance issues faced by the airline's industry for a decade.

Truitt and Haynes (1994) evaluate service quality and productivity in the United States regional airline industry. In this study, the authors introduced service quality model and service productivity model. Essentially, this study integrates traditional productivity and quality paradigms and techniques into a hybrid service model. The purpose of introducing the service model is, to evaluate the impact of introduction of newer aircraft in the airline's fleet on regional airline productivity and service quality. In the study, the service quality model is developed by linking the marketing function to the operation function. Productivity is measured by cost per seat miles. Data related to the sample airlines performance are collected from the aircraft manufacturers and are used to construct several productivity indicators. Data for regional airline service quality is collected through survey questionnaire conducted at the San Luis Obispo Regional airport. Meanwhile, quality is measured by customer's satisfaction (effectiveness) from the survey interview. The results from the analysis indicate the importance of larger aircraft in influencing the effectiveness in the service quality model. The study shows that a larger aircraft associates positively with the effectiveness of service quality. This result is not surprising as we are aware that today's passengers care about service quality, thus associating with their perception on aircraft type as an important quality attribute to the airline company. Another spectacular finding is shown in the productivity model, where it is evidenced that productivity gains are possible for US regional airlines during the period studied. This finding is supported by an increase in both output (effectiveness) and input efficiencies.

The subsequent study examines the impact of partial deregulation and short run protection on productivity differences in the sample of the airlines from US and Europe for the period of 1980 to 1988 (Mar´ın, 1998). The study employs stochastic frontier approach following Khumbakar (1990); Battese and Coelli (1988); and Schmidt and Sickles (1984) to calculate productivity change of airlines. The sample airlines consist of 10 European and 9 American carriers which are utilized in the productivity benchmarking exercise. Output variable is proxied by available seats kilometer. Meanwhile, input variables comprise of labour index. The labour index is constructed using 6 categories of personnel indicators. Next, capital input is measured by total seat available in the firm's fleet which is an indicator of capacity installed. Another variable of input is fuel consumption which is one of the major expenses in an airline operation. The findings reveal the pivotal role of deregulation on the productivity of airlines in Europe and US. Another interesting finding is the superiority of European carriers in terms of productivity compared to the US carriers during post liberalization period. Prior to liberalization of aviation market in Europe, European airlines were less productive. However, European flag carriers improve their efficiency because of the introduction of liberal bilateral agreement. In addition, the finding also pointed out the importance of network characteristics on airline's productivity.

Realizing crucial role of productivity in raising the financial and operational performance of airlines, there have been increasing number of studies evaluating the productivity and productivity growth in the context of air transport sector since the beginning of year 2000.

Among earlier study in the beginning of the millennium, is carried out by Ceha and Ohta (2000) who investigates the productivity change of the Indonesian airline industry using the stochastic approach. The study proposes a methodology that decomposed TFP into technological progress and technical efficiency change. By adopting the translog production function, the analysis is carried out using the OLS technique, where two models are constructed: competition model which is represented by a profit function; and performance model or alternatively called the "goal programming model" which gives the measurement for the efficiency of airlines. The efficiency model is then constructed following Coelli et al. (1998) by defining efficiency as technical efficiency and allocative efficiency. Furthermore, by assuming monotonicity assumption for the production set and CRS production frontier, the analysis utilizes sample cross section data from Indonesian air transport sector which covers 182 routes in 1992 to estimate the competition model. In addition, the study adopts Charnes et al. (1996) basic model for performance analysis. Next the analysis is extended to incorporate attractiveness of airlines competition, using the translog function to estimate the parametric frontier. The data for productivity change analysis covers sample of 6 Indonesian airlines over the period of 1989 to 1996. The output variable consists of tonnes kilometer performed, whilst inputs are given by seat kilometer available, cargo ton kilometer available and aircraft hours. The study concludes that 50 percent of the sample airlines (airlines 4, 5 and 6) demonstrate no sign of movement in the Indonesian frontier during the study period of 1989 to 1996. The study also reports that the slowdown in TFP growth is attributed to reductions in the insignificant technological progress and of deterioration in technical efficiency. While other studies examined in the above literature mostly carried out in the context of developed markets such as US and Europe, thus emphasizing the important role of external factors namely as service quality and liberalization of air transport market on productivity of airlines. This study offers an interesting example from developing market, which is Indonesia. In contrast, this study found a significant role of technical efficiency change on TFP growth in Indonesian air transport sector. Therefore, this study is important because it serves as a benchmarking point for case of airlines from less developed countries. The study also merits further attention when one knows the emergence of air transport market in Asia in line with fast economic growth and development in the region.

Next, literature in middle of 2000s are led by Oum et al. (2005) and Duke and Torres (2005). Oum et al. (2005) empirically compare North American air carriers in the context of cost efficiency and yield performance. The study adopts total factor productivity (TFP) approach to compare the efficiencies of airlines in the sample. It is argued that TFP indicator is misleading when in the absent of managerial control such as variation in network and market condition. The decomposition of average TFP applies the regression analysis as utilized in Caves et al. (1981a & b); Ehrlich et al. (1994), Oum and Yu (1995, 1998b). This approach has been evident to provide a more accurate inference on productive efficiency. The study indicates that cost efficiency per se as measured by the TFP residual is not sufficient to ensure financial success of an airline, instead pricing as shown by unit cost competitiveness, and yield management (average yield) are also matter much in determining financially successful airline business.

In the study by Duke and Torres (2005), the authors analyse a sample of US airlines for the period 1972-2001. The paper examines the patterns of air transport multifactor productivity and labor productivity changes over the period 1972-2001. Besides, the study also investigates the sources of labor productivity change such as changes in multifactor productivity, capital intensity, and intermediate purchases intensity. In conducting the analysis, the literature employs aggregate data to describe output and input factors like labor, capital, and intermediate inputs in this industry and how they have changed over time. Next, labour productivity is decomposed into capital effect, the intermediate purchases effect, and multifactor productivity. An advantage of applying multifactor productivity measure is that it conveys valuable insights into efficiency beyond those derived from the labor productivity context. It measures the increase in output over and above the gain due to increases in a combination of inputs. The combined inputs measure is derived from weighted average of labor hours, capital services, and intermediate purchases. The study concludes that productivity gain is an essential part of performance improvement in order to contain cost issues in the airline business. The authors further argue the central role of multifactor productivity in influencing labour productivity growth throughout sample period between 1972 and 2001. Another interesting finding is related to the capability of major airlines in managing their cost during post September 9, 2001 terrorist attack in the US. Surprisingly, the airline industry in the country was able to slash labor cost while raising the labour productivity.

The main contrast between Oum et al. (2005) and Duke and Torres (2005) is that the former study adopts the total factor productivity (TFP) approach to compare the efficiencies of airlines in the sample with incorporation of managerial control variables in the TFP estimation such as variation in network and market condition. Meanwhile the latter argues the importance of multifactor productivity in influencing labour productivity growth in the United States. Basically, the distinction between the two literatures is in terms of the context of productivity evaluated. Both studies agree that use of TFP as a measurement of performance indicator need to be complemented with other factors in order to lay a positive impact on cost containment.

The following study by Barbot et al (2008) compare the productivity and the efficiency of global airlines in North America, Europe and Asia Pacific using Data Envelopment Analysis approach. In the study, the productive performance of airlines is given by the

TFP scores. The study result shows that labour influences productivity in the sample of airlines studied. This notion infers that a highly productive labour has the potential to raise the productivity growth of airlines. Specifically, North America shows a greater homogeneity in TFP scores across airlines but the opposite outcome is conveyed for airline's sample from Europe and the Asia Pacific. On top of that, LCC shows the highest DEA and TFP scores which suggests the capability of the business model in raising the operational efficiency of airlines.

Other study conducted in the same year with that of Barbot et al (2008) is by Greer (2008). The study examines productivity changes in major United States passenger airlines for the period of 2000 to 2004 using the standard DEA and Malmquist Productivity Index. The findings exhibit a significant improvement in the productivity of sample airlines studied. Furthermore, the result from the study suggests that the sample carriers have been successfully exploiting its resources by transforming labor, fuel and passenger seating capacity into available seat-miles. In addition, the study further supports the important role of efficiency change in determining the short-term productivity growth of air carriers in the United States. This is evidenced as the study shows that most of the productivity improvements came about from the efficiency laggards catching up with the efficiency leaders in the industry throughout the sample of short period observed. However, the study agrees that in the long run, adoption of new production technologies in aviation, may further enhance the productivity change of airlines in the United States.

While the literature by Barbot et al (2008) provides a more generalized outcome relating to sources of TFP growth, as the sample covers global airlines across regions, the finding in Greer (2008) requires a careful interpretation as the sample is limited to the case of United States. Hence our review suggests that labour productivity and low cost carrier determine the level of productivity change in airlines. Meanwhile, based on the sample of airlines from the United States, this review suggests that policy prescription for performance improvement has to consider the impact of time period. For example, if the management target is to solve short term problem in productivity change, it is advisable that the airlines ensure the highest efficiency in existing resource utilization. In other words, if the airline company's objective is to tackle the issue of long term productivity growth, it is appropriate for the airline to invest in a superior production technology so as to increase the productivity change in the long term.

After that, Rey et al. (2009) investigate the impact of increased competition imposed by rising entry of LCCs in Asian airline market on productivity growth for the period of 1996 to 2000. High level of competition in the air carrier market in Asia has resulted in deterioration of economic efficiency of airlines in Europe and America. The study employs both stochastic and DEA approaches in measuring the productivity change and efficiency of airlines in the sample. The findings from the study indicate that airlines from Asia such as Cathay Pacific, Singapore Airlines, Korean Air and JAL are the most efficient and productive. In contrast, airlines from American and European sample exhibits very low economic efficiencies with LUFTHANSA and SAS recorded the lowest efficiency levels. In addition, the study portrays that productivity growth for sample airlines from Asia between 1996 and 2001 was 2.9%. The finding also argues that 72 percent of productivity growth is driven by technological progress, meanwhile 28 percent is owing to technological improvement in the carriers.

In view of the significance of China's influence on the global economy, Chow (2010) assesses the association between entries of non-state owned carriers and productivity changes of Chinese airlines. In measuring the productivity change in the sample airlines, the study adopts the standard DEA Malmquist Index introduced by Fare et al. (1993). The evaluation of productivity change and efficiency is segregated into two phases, pre-entry and post entry. Pre-entry period is defined as the period between 2003 and 2000. On the other hand, post entry is given by the period between 2005 and 2007. Input variables are defined by full time employees, aircraft fuel consumption, seat capacity which is a proxied by available assets. Meanwhile outputs are defined by RPK and RTK to reflect both characteristics of services namely as passenger and cargo carried by the airlines. In addition, sample data for the study starts from 2003 to 2007. The literature concludes that operationally the non-state owned airlines perform better than state owned airlines. Of the sources of productivity changes, the finding shows that technical changes play a critical role in productivity changes among state owned airlines in China during pre and post-entries of private airlines into the air transport market in China. The finding also suggests that there is a small improvement in the efficiency of state owned airlines. On the other hand, the study reveals that improvement of productivity changes in private airlines are driven by efficiency changes.

Although the present study of Chow (2010) seems identical to that of Rey et al. (2009) in terms of their intentions to investigate the impact of competition on productivity growth in airlines, their major contrast is in terms of the sources where the competitions come from. In the later, competition is imposed by low cost carriers which offer a much lower fare due to the nature of cost structure of the airlines business model in slashing the operational costs in many ways. Meanwhile, Chow (2010) views the source of competition as entry of private carriers which raise the level of competition in the air transport market. However, the two studies agree that competitions regardless of any forms have an influential impact on airline's productivity.

The period after 2010 observes increasingly more number of studies on productivity of global airlines in various contexts. In the beginning of the period, Sjogren and Soderberg (2011) analyse the influence of market changes for instances deregulation, privatisation and membership in strategic alliances on productivity of air carriers between 1990 to 2003. The measurement of productivity change adopts the stochastic frontier approach albeit in a different way than the standard stochastic frontier model. In terms of the execution of the analysis, this study decomposes airline activities into three models: producing model, selling model and total model (aggregate model) using the translog cost function. The study argues that at the aggregated level, it is observed that deregulation increases productivity. Meanwhile, membership of airlines in strategic global alliances shows ambiguous conclusion. In addition, state ownership in the airline companies has no effect on productivity growth. Furthermore, disaggregated results confirm the productivity gain from deregulation, but rule out prior expectation on ownership and alliance. Meanwhile, selling and producing models show inconsistent results, with regards to state ownership impact on productivity growth.

Another study conducted in the same year is explained by Assaf (2011) which evaluates productivity and efficiency changes of airlines in the UK. This study employs one step advanced technique of DEA Malmquist productivity index by bootstrapping the Malmquist productivity index for a sample of 18 major UK airlines over the period of 2004 to 2007. This technique overcomes statistical issue with the use of the DEA model with regards to small sample size. The input definitions for the study are given by total operating cost including labour cost, fuel cost, and aircraft value. In addition, outputs are defined by tonnes kilometer available (TKA) and total operating revenue.

The result from the study by Assaf (2011) posits significant deterioration in productivity, efficiency, scale efficiency and technology across most airlines in the sample. Specifically, the study demonstrates significant TFP decrease for seven airlines. In addition, declining efficiency is associated with eight carriers. On the other hand, seven airlines from the sample exhibit significant pure efficiency decrease. Meanwhile, six airlines demonstrated significant scale efficiency decrease. Finally, seven airlines show significant technological decrease. Nevertheless, some airlines have observed increases in productivity and efficiency changes. Above all, the study identifies stage length, load factor and airline size as important sources of efficiency and productivity changes for the UK airline sample. The study by Sjogren and Soderberg (2011) and Assaf (2011) differ in a number of ways. Firstly, context wise the study in the former covers a large sample from international airlines across the world. Meanwhile, in the latter the focus of the study is airlines from the UK context which is carried out in quite short period of time. Secondly, both studies employ different methodological approaches to measure productivity growth. This could lead to possibility of variations in the productivity change and efficiency due to adoption of different methodological approaches.

The subsequent studies show 3 literatures relating to productivity study in the context of airlines. These studies are led by Pirez and Fernandez (2012); Chow and Fung (2012); and Assaf and Josiassen (2012). In their paper, Pirez and Fernandez (2012) provide a rigorous discussion which has not been covered by other studies. The paper adopts the Malmquist financial efficiency approach based on DEA input VRS orientation assumption to evaluate the financial efficiency of 42 publicly-held airlines from 25 countries, in 2001 (the year of the September 11 terrorist attack in the United States) and 2002. It is worth noting that year 2001 has left a significant impact on the performance of the global air transport industry. Input variables for DEA estimation are specified by financial leverage. Meanwhile, output variables are given by firm size, tangibility of assets, and intangible assets. The finding argues that level of indebtedness associates positively with profitability with the assumptions that their size, fleet and intangible assets unchanged. In addition to the debt impact on profitability of airlines, the study also pointed that companies which recorded positive productivity growth have the ability to reduce their leverage and financial risks. Besides that, companies which have productivity growth greater than 1, are able to increase their return on assets, except a few airlines such as Malaysia Airlines, Singapore Airlines and British Airways where the opposite is true. Additionally, tt is also observed that airlines which exhibit catch up levels greater than 1, usually have positive productivity growth.

Next, Chow and Fung (2012) investigate the effects of mergers on the productivity of China's airline state-owned carriers. The study employs stochastic production frontier estimation to measure the Malmquist Productivity Index using sample panel of 20 state-owned carriers in China from 1997 to 2001 before the mergers, and 10 state-owned carriers from 2003 to 2007 after the mergers took place. The input variables cover number of full time employee, quantity of fuel consumed, and seat capacity. In addition, output variables consist of passenger and freight volumes. The results show the presence of improvements in productivity change as well as technical changes in the sample corresponds to large state owned and medium state owned airlines. The literature demonstrates large state owned carriers namely as Air China, China Southern Airlines and China Eastern Airlines have benefited significantly from the merging exercise. In addition, medium sized state-owned airlines such as Sichuan Airlines, Shanghai Airlines and Shenzhen Airlines are also have benefited from the consolidation. The study finding further pointed that merger and acquisitions are partially successful in raising the technical efficiency of medium sized state airlines.

In the following paper, Assaf and Josiassen (2012) compare the efficiency and productivity of airlines from US and Europe. The authors employ the Bayesian distance frontier model subject to regularity constraints to measure efficiency in the sample airlines. Next, productivity is also estimated using parametric distance frontier approach. This study estimates both constrained and unconstrained model. Estimations of both models are vital to show the importance of monotonicity and curvature conditions of the distance function. The sample for the study consists of panel data of 31 European and American airlines including major airlines. Output variables are specified by passenger service measured in RPK and incidental revenues (non-airline revenues). In addition, inputs are given by labor, capital, fuel, and other operating inputs (all stated in quantities). The review reveals two main conclusions. First, the efficiency and productivity growths in the constrained model indicate that European airlines have slightly higher efficiency and productivity growth than U.S. airlines. Secondly, the result indicates that, low cost airlines on average, are relatively more productive and efficient than full service airlines.

In the next study, Barros and Couto (2013) analyses productivity of European airlines over the period of 11 years from 2000 to 2011 with a special focus on the impact of September 2001 tragedy. The authors employ the directional distance function and the Luenberger productivity index to assess environmental productivity of airlines in Europe. The sample of data for the study consists of balanced panel of 23 European airlines which includes both state carriers and low cost carriers. Outputs for the study are defined by RPK and RTK which characterized the types of services performed by the airlines. On top of that, inputs are given by labour costs, operational cost, and number of seats kilometers available. On one hand, the findings indicate no productivity growth in most European airlines during post September 2001 tragedy except for Austrian airlines, Finnair, Virgin Atlantic, EasyJet, Ryanair. On the other hand, the results from the regression analysis in the second stage reveal that external environment, managerial strategies, network served, and historic resource based lead to variation in the technical efficiency. In addition, comparison between the two scores of the standard Malmquist productivity index (MPI) and the Malmquist Luenberger productivity index (MLPI) demonstrates a significant different where the scores generated using the approach of the MPI is higher than the MLPI. This result pointed to the importance to consider the environmental impact in measuring the productivity of airlines.

Subsequently, Wang et al. (2014) benchmarks the productivity between Chinese airlines and other selected major airlines around the world from 2001 to 2010. The methodology for measuring productivity is TFP following the approaches in Windle and Dresner (1992), Oum and Yu (1995), Oum et al. (2005), and Homsombat et al. (2010). In addition, the study also estimates partial factor productivity (PFP) for the airlines. The data sample consists of three China big three airlines and 11 major network carriers across three continents which serve as benchmarks for Chinese airlines. The Input variables consist of labor, fuel, materials, flight equipment and ground property equipment. Meanwhile, outputs are given by passenger services, freight services, and incidental services. Although the findings showed an improvement in the productivity of Chinese airlines over the years observed, nonetheless productivity wise, airlines in China lags behind the leader like United States. The authors further argued that high profits enjoyed by Chinese carriers did not sustainable because it was driven by low labour costs. In future, labour costs may increase as the productivity of airlines in the country increases.

Another study on productivity of Chinese airlines is carried out by Cao et al. (2015). Nevertheless, this study contrasts with that of Wang et al. (2014) in terms of the measure of productivity used. The latest study adopts MPI whereas Wang et al. (2014) employ TFP and partial productivity index. In terms of length of period study, the latest study is carried out in a much shorter time span which is between 2005 and 2010 whereas the earlier study employed a much longer time period between 2000 to 2010. The study in Cao et al. (2015) uses input variables of full time employees, fuel consumed and the amount of aircrafts. Nevertheless, choice of outputs consists of total flights, revenue tonnes kilometer of both passengers and freight. The literature concludes fast improvement in the productivity efficiency of non-state owned airlines particularly during post deregulation period. However, among the state-owned airlines the study finds out that local airlines are doing better than the central airlines in terms of productivity and technical change.

Another recent study which assesses the productivity of European airlines by incorporating environmental factor is found in Scotti and Volta (2015). This study extends the study of Barros and Couto (2013) who measured the environmental productivity change using the approach of the Malmquist Luenberger Productivity Index (MLPI). However, in the present study, the biennial MLPI is introduced to counter the issue of infeasibility under the assumption of variable returns to scale, non-identification of technical regress and calculation issue with addition of new time period. In this study, the standard productivity change using biennial approach is compared with the extended biennial productivity change obtained from MLPI. On one hand, there is an average productivity increase in the sample of European airlines with or without considering for negative externalities in the production. On the other hand, the score of productivity growth is sensitive to environmental factors. The productivity growth in the model which considers negative environmental effect in the production displays a lower score than the score obtained using the standard productivity growth approach.

Besides that, the article also observes that improvements in load factor, increase in stage length and aircraft size have positive effect on productivity changes. Interestingly, the results show mitigation in the level of carbon dioxide emissions is much slower than the increase in RPK and freight tonnes kilometer (FTK). Specifically, from the score of technical change, it appears that Austrian Airlines, Air France, and Czech Airlines are innovators based on the MLPI approach. In contrast, Air France and SAS are innovators based on the standard Malmquist estimation model. There is a little departure displayed in the results of productivity change scores obtained from the present study compared to the previous study of Barros and Couto (2013) where in the previous literature the findings show the absence of productivity improvement in the sample of airlines from Europe, but the present study argues the presence of increment in the productivity change.

No doubt, literatures on airlines' productivity are slightly limited, but scope wise, it is wide in terms of the coverage of countries and regions. Geographically, the papers discussed above not only cover specific countries such as the United States, the United Kingdom, China and Indonesia but the papers also cover regions such as North America, Europe, and Asia which made the review more comprehensive. In addition, the sample of airlines in these studies also considers both developed and developing countries to ensure the findings are more generalizable. Among significant coverage, are emerging Asian countries where the demand for air transport is on the rise. Furthermore, many issues associated with productivity improvement in airlines are also discussed in the papers.

From the review of above literatures, two important points are observed. First, the methodologies or approaches employed to measure productivity change. Most studies adopt non-parametric DEA approach to estimate the productivity growth. This observation can be explained by advantages of using non-parametric approach for measuring efficiency and productivity. No requirement for assumption of functional form and feasibility of the study in terms of non-requirement of price information are among the strength of DEA methodology. A clear gap has been observed in terms of DEA model employed in measuring the productivity changes and sources of productivity change. No doubt, the above reviews have presented numerous approaches in DEA to tackle various genuine issues in the airline industry, however, to our concern, none of the studies above have attempted to specifically tackle the issue of homogeneity in technology assumption DEA, although this approach has been widely applied in benchmarking studies in various areas including agriculture, engineering, banking, hospitality, etc. It should be emphasized here that adopting an appropriate technique for measuring productivity is central to avoid biasness in the estimated results.

Secondly, the literatures above have addressed a quite comprehensive and complete scope for improvement in productivity of individual airlines. Among others, the studies have covered elements of service quality, individual airline strategies, for examples management strategy in terms of global strategic alliances (Star Alliance, Sky Team and One World), merger and acquisitions, privatization and corporate governance in terms of ownership of the airlines companies. Not only that, the reviews above also examined the impact of external factors for example liberalization and competition. Policy related to entry into air transport market and the phenomena of low cost carriers in the air transport industry have also been discussed.

The following paragraph summarizes the main empirical findings obtained from the above literatures. In general, the papers demonstrate the importance of low cost carriers as an appropriate business model in improving the productivity of airlines. This notion is true for carriers in US and Asia due to latest trend in the demand of air transportation in emerging Asian's countries. An influx of LCCs in Asia has turned air transport into a highly competitive industry thus resulting in deterioration of productivity performance of airline in the United States and Europe.

In addition, it is also concluded that deregulation, merger and acquisitions, corporate governance in the form of state ownership, and global alliances have an influence on the productivity performance of airlines in the sample observed. Next, service quality is viewed as central in order to improve productivity performance of airlines. The results after deregulation exercise in China showed improvement in non-state owned airlines. Next merging exercise in China has led to improvement in productivity changes of large and medium sized Chinese state owned airlines. Furthermore, the findings in sample of airlines from China indicate that state owned airlines are the leader in innovation meanwhile private airlines are good in cost savings by squeezing the available inputs to maximized output. Next, the conclusion from global airlines demonstrates that airlines which are good in catching up with the frontier technology are also showing positive productivity growths. Meanwhile, airlines which show positive productivity growth are also experiencing good yields (return on assets).

3.4 Outsourcing and firms' performance

There are many reasons why firms outsource part of its activities. Among others, the aspiration to gain high efficiency and cost saving have turned outsourcing as a popular strategic approach for many firms (Kakabadse & Kakabadse, 2002). The authors stress that cost reduction is an important motive for outsourcing among European firms, but best practice matters most for American's firms. In contrasts, cost reduction in the form of low wages is not pivotal for outsourcing (Deavers, 1997) but other motivation such as improving firms' focus is the main reason behind outsourcing of some activities. In this context, firms outsource in order to have an access to world class capabilities, reengineering benefits, risks sharing and the like. In addition, outsourcing has been widely viewed as a critical element of organizational strategy in order to raise the level of performance (Holcomb & Hitt, 2007).

Types of airlines' activities commonly outsourced are discussed in Al-Kaabi, Porter and Naim (2007) and Tovar and Martin-Cejas (2009). Al-Kaabi et al. (2007) suggests that line maintenance is commonly insourced activity in airline but not engine maintenance. This is attributed to criticality of the latter as it requires a close monitoring in terms of safety by the FAA. Meanwhile outsourcing of line maintenance is not common. Insourcing of line maintenance ensures improved service level and customers' satisfaction. In addition, insourcing of this activity will ensure a fast provision of services thereby reducing waiting time for customers. Meanwhile, engine maintenance is among commonly outsourced activity in the airline industry.

Outsourcing of peripheral activities is common. According to Tovar and Martin-Cejas (2009), outsourcing of non-core activities is significantly associated with higher level of firms' efficiencies. This is because, committed vendors ensure timely response to firm's demand, higher level of compliance besides mitigating liabilities and turnover costs. Activities deemed as core to the firm are likely to be provided in house. Meanwhile, activities where outside suppliers are more competent in provision of the service are laid on the hands of outside suppliers.

The tendency to outsource depends on a number of factors among others economies of scale is an important factor for consideration if one would like to embark on outsourcing. Larger firms have the tendency to carry out the activities in house (Abraham & Taylor, 1996). In contrast, smaller firms are likely to contract out their activities (Ono & Stango, 2005). This is because a smaller firm is likely to benefit from scale economies of the external suppliers as they carry the service out for many other firms. Therefore, a smaller firm enjoys lower cost by outsourcing its activities to external supplier.

Despite the importance of two main theories which are the transaction cost economics and resource based view in explaining outsourcing, (McIvor, 2009) suggests that single theory per se cannot provide a strong explanation for outsourcing. The author stresses that the combination of the two theories explanation for outsourcing best. In terms of the decision to outsource, outsourcing may not necessarily follow what the theory of transaction cost economics suggests. Findings are mixed with regards to firms' decision to outsource based on the transaction cost economics theory (Rieple & Helm, 2008). Meanwhile, some activities are in accordance with what the theory suggests. In addition, Masten (1984) suggests that transaction cost is pivotal in deciding whether to outsource or not. Although the above literatures support the importance of transaction costs in explaining outsourcing, Merkert and Cowie (2012) provide a contrast argument that transaction costs are not the main contributors to the high increase in overall costs in airlines. In fact, the study further stresses that ICT and digitalization have helped in reducing transaction costs for airlines.

There is a considerable amount of literature which discusses the relative relationship between outsourcing and firms' performance. These literatures reveal three major findings. Among others, the studies contend that outsourcing may results in: (1) increase,

(2) decrease or (3) mixed effects on firms' performances. In their studies, Quinn (1999); Ten RAA and Wolff (2001); Atef (2005); Di Gregorio et al. (2009); Bustinza et al. (2010) argue that outsourcing lead to increasing profits, productivity growth, international competitiveness, service levels, customer satisfactions, returns on investment, returns on equity, sales growth, and efficiency.

In contrast, Kotabe and Omura (1989), Siegel and Griliches (1992), Kimura (2002), Marjit and Mukherjee (2008), and Tayeb (2012) found no influence of outsourcing on performance. There is no direct influence of outsourcing on performance (Tayeb, 2012) except a negative effect on performance measure such as average aircraft utilization. Meanwhile, other measures of performance such as passenger load factor; operating profit; on-time departures; bags delayed show no association with outsourcing. Kotabe and Omura (1989) reveal that outsourcing of firms' activities through offshoring are not necessarily positively associated with higher level of firm performance. Meanwhile, according to Kimura (2002), subcontracting firms may not enjoy higher profits. On the other hand, Marjit and Mukherjee (2008) conclude negative relationships between international outsourcing and profitability of oligopolistic firms.

Other studies display mixed results associating with the impact of outsourcing on firm's performance. Among others, Jiang et al. (2006) find that outsourcing does not improve firm's productivity and profitability. However, there is evidence that outsourcing improves cost efficiency of firms in the sample. Next, Moosavirad et al. (2014) examine the impact of outsourcing on country origin of firms. The authors highlighted that outsourcing positively affect the production of international firms but negatively affect local firms' production.

A major gap in the studies above indicates that the impact of outsourcing on performance of airlines has been less researched although the industry is gaining popularity in terms of outsourcing of various activities in their attempts to streamline costs. To our knowledge there is no study thus far attempt to evaluate the impact of outsourcing on performance of airlines in the contexts of technical efficiency and productivity. Therefore, this study fills the gap in past literature on factors affecting performance of airlines.

3.5 Economic environment and firm's performance

Firms' performance does not only depend on the internal factors such as firm capability and firm capacity, but external factors which shape the operational environment where the firm operate is also matter in order to ensure high performance is met (Lusthaus, 2002, p.9).

Past literatures highlight a number of economic indicators which deemed central in influencing performance of firms, including for instance, gross domestic product (Ramanathan, 2001; Backx et al., 2002); unemployment, interest rate (Bikker & Hu, 2002), Human Development Index (Jenatabadi, 2013); inflation rate and human development index (Ismail & Jenatabadi, 2014).

Most of the reviewed literatures are in the contexts of airlines, banking industry and Australian companies. The impact of economic growth on the demand for air travel is deciphered in Vasigh and Hamzaee (1996), and Vasigh et al. (2008). In this study context, macroeconomic indicator in the form of economic growth raises the disposable income of consumers thus increasing the demand for air travel. Meanwhile, the relationship between GDP and airlines' performance is discussed in Backx et al. (2002); Gillispie (2007); Uwagwuna (2011); Jenatabadi (2013); Ismail and Jenatabadi (2014).

Backx et al. (2002) examine the relationship between ownership and airlines' performance where one of the control variables is GDP. The authors find that GDP has a positive association with performance of airlines in various dimensions viz. financial performance, organizational efficiency (labour productivity), and service performance. On the other hand, Gillispie (2007) contends that the economy, social change and government policy affects the survival of airlines in the sample examined. In addition, these external variables affect airlines decision making and performance. The effect of economic situation in the form of Human Development Index (HDI) is discussed in Jenatabadi (2013). The author asserts that HDI is a new variable yet to be considered in any attempt to model airline performance. The study shows that economic performance has a significant impact on firm's capability and firm's capacity.

Consequently, Ismail and Jenatabadi (2014) in their attempt to model airline performance found a significant relationship between economic situation representing HDI and airline's performance through mediation of internal factor such as firms' capability and capacity. The study also derives another finding, with regards to the relationship between economic situation and internal factor, where it is concluded that firm's age moderates the significant association between economic factor and internal factor in the context of airline's performance.

The impact of GDP on general transport sector is debated in Ramanathan (2001). The author stresses positive relationship between GDP and passenger revenue. However, the increase in passenger revenue and freight revenue are much faster than the increase in

GDP. This implies that 1 percent increases in GDP has the tendency to raise transport revenues by more than 1 percent. Therefore, the policy implication is that if a country would like to improve the revenues of the transport services, it is crucial to ensure that the economy of the country is doing well.

On the other hand, banking is among the industry which is influenced very much by economic environment where the firms operate. Economic environment is deemed important to ensure high performance of the banks. One of the main products offered by the bank is credit facilities besides savings and other financial products. During economic prosperity, which is indicated by high increases in GDP growth, lower inflation and unemployment rates to accommodate a conducive business environment for the bank, will attract the demand for credits.

Conversely, during downward economic cycle, banking is among the industry which is susceptible to the adverse impact of economic downturn. The demand for credit facilities which forms major financial products offered by the bank will fall. The adverse impact of economic climate faced by a country may result in even worst situations such as restructuring of the banking institutions and consolidations. There are a number of literatures which argue the positive relationship between GDP and bank performance (Mc Namara and Duncan, 1995; Demirguc-Kuhn and Huizinga, 2000; Bikker and Hu, 2002; Athanasoglou et al., 2008). In their study, Mc Namara and Duncan (1995) stress that GDP positively influences the performance of top 60 Australian firms besides other factors such as past year historical return on asset and government policy. Meanwhile, Demirguc-Kuhn and Huizinga (2000) conclude a positive relationship between macroeconomic variable and bank profitability.

Similarly, Bikker and Hu (2002) in their study using sample of banks in 26 OECD countries reveal positive relationship between GDP growth and profits. They argue that an increase of more than 2 percent in GDP results in more than 2.5 times than the increase from GDP growth below 2 percent. Another study by Anthanasoglou et al. (2008) explains the correlation between business cycle (output) and bank profitability. This study employs dynamic panel analysis using Generalized Method of Moments estimator which is more efficient, as it tackles for the issue of correlation between estimators and the error term. The findings from the study reveals that Greece commercial banks' profitability is significantly driven by output cyclical (GDP growth), bank-specific factors (managerial factors), and other macroeconomic variables. Nonetheless the study does not find any notable relationship between the structure of banks and profitability in Greece.

A quite recent attempt to model the relationship between country macroeconomic factors-GDP growth and GDP per capita is deciphered in Dietrich and Wanzenried (2014). The researchers applied the GMM Arellano and Bond estimator (1995) to estimate the connectivity between GDP growth and GDP per capita in groups of countries with different levels of income. They employ data from the Fitch-IBCA Bankscope (BSC) database. The findings showed each macroeconomic variable, GDP growth and GDP per capita recorded different results with regards to the group of countries affected. GDP growth has a positive significant effect on bank profitability in middle and high income countries. Meanwhile GDP per capita shows a significant and positive association with profitability of banks in low income countries. These findings are in line with major findings derived from main literature related to determinants of bank profitability.

While most of the above studies focused on examining the relationship between the economic indicators such as GDP growth or GDP per capita and firm's performance in the forms of profitability, labour productivity, and performance index, to date there is lacking of attempts to model the relationship between economic indicator using human development index when one knows that the index is more comprehensive measure to describe the economic performance of a country compared to GDP growth or GDP per capita which have been extensively applied in many researches. Furthermore, this study fills the research gap in past studies on airline's performance. The study attempts to investigate the interaction effect of human development index with level of institutions on airline's performance in the contexts of technical efficiency and productivity. The interaction effects of HDI with the level of institutions on technical efficiency and productivity change are absent in past literature.

3.6 Institutional factors and firm performance

As described in second proposition related to institutions outlined in the chapter 2, institutions are generally associated with variables such as political systems, business environment, and perceived business constraints, legal and regulatory framework and the judicial system. Nevertheless, common variables used in many literatures related to the study of institutions are the governance dimensions as reported in the World Governance Indicators published by the World Bank. These indicators are produced by Kaufman and Kraay in 1999 (http://info.worldbank.org/governance/wgi/index.aspx#doc). The World Bank defines governance as:

> Governance consists of traditions and institutions by which authority in a country is exercised. This includes the process by which government are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state on the

institutions that govern the economic and social interactions among them. (Kaufman & Kraay, 1999).

The governance indicators consist of voice and accountability, political stability and absent of violence, government effectiveness, regulatory quality, rule of law, and the control of corruption. The report provides aggregate and individual governance indicators for 215 countries over the period from 1996 to 2014. These aggregate indicators are formed from views of a large number of enterprises, citizen and expert survey respondents from both developed and developing countries.

External factors in the form of country characteristic may sometimes influence the performance of firms. This sub section discusses various empirical findings with regards to association of institutional factors and performance at firm level.

Institutions play an important role similar to the production factors in determining the success of firms. For instance, low institutional quality is arguably associated with low performance of firm due to high business transaction costs that were driven by low level of institutions (North, 1990; Clague, 1997; Mora-Sanguinetti and Fuentes, 2012). Good governance positively affects firms in terms of performance (Wan, 2005) and profitability (Ngoboa & Fouda, 2012). Good governance is particularly crucial in case of developing countries where institutional building is in development process. By improving the level of governance, this will ensure that firms operate at a higher performance and profit levels.

In contrast, Wan and Hoskisson (2003) examine the impact of country factors and institutions on performance of diversified firms. This study contends that institutions are negatively associated with firm performance in a conducive country environment as characterised by high level of institutions. Nonetheless, this finding needs a careful interpretation, because the impact of institutions on firm performance may not be realized in the short term. This is because institutional building is time consuming (Chan et al., 2008; Commander & Nickolosi, 2010). These studies further elaborated that the influence of institutional factors on performance of firms may not be significant in the short term, as firms need a longer time period in order to reap the spillover benefits from high country institutional quality. Not only that, the studies also added that government intervention in terms of rigid labour law and productive markets may adversely affect the productivity of firms. In general, these studies suggest that minimum government intervention on the work of free market has the potential to increase the performance of firms.

Another study by Cherchye and Verriest (2015) conclude that high institutional level deters growth of monopolist firms by raising the competition level, thus pulling down the profitability of the monopolists. Nevertheless, in this context of study, profitability of firms is not viewed as performance but more towards economic rent.

In addition, the study also stresses that diversified firms which operate in low level of institutions may not enjoy the benefit of high performance due to diversification but rather it is the firm capability which determines high performance of the firms. The impacts of legal and political institutions on growth of firms are discussed in Demirguc-Kuhn and Maksimovic (1998), Henisz (2000), and Desai et al. (2003). While Demirguc-Kuhn and Maksimovic (1998), and Henisz (2000) discuss the association of legal and political institutions on firm's growth, the latter examines the impact of institutional factors on the nature of industrial activities and dynamism. In this context, institutional quality of a country not only affects the nature of industrial activities carried out within a country but also the dynamism of firms which indicate the strength of a firm.

The role of institutions is commonly used in explaining the performance of multinational firms. The level of institutions in home country has a significant association with the performance of MNCs because institutional experiences in home country may be transferred to MNCs which operate in host countries (McGahan & Victer, 2010). Therefore, it helps in raising the performance level of MNCs in the host countries. The authors argue that institutional variables such as political norms, behaviours and customs influence performance of MNCs and local firms. In addition, the study also emphasises that country (institutions) and industry characteristics are more important in explaining variation of firm's performance in developing countries. Meanwhile corporate governance and affiliate characteristics have the tendency to shape variations of firms' performance in developed countries. The study employs panel data of global firms obtained from Compustat which are characterised by various industries and comprised firm sample from both developed and developing countries. Variable related to performance of firm is derived using variance decomposition approach.

Next, the impact of institutional level on firm's performance in host countries is discussed in Makino et al. (2004). The measure of firm performance in this study is derived using variance decomposition approach as employed in McGahan and Victer (2010). By employing the data sourced from the Trend Survey of Overseas Business Activities of Japanese owned firms across 159 industries in 79 countries, the study reveals that high institutional level of host country has a positive effect on the performance level of firms. Good governance in host country provides a conducive environment for business activities thus motivating the firms to perform better. However, the study concludes that long term profitability of the MNCs is driven by the industry's structure.

3.7 Research gaps

The above review shows a growing popularity of non-parametric approach using Data Envelopment Analysis to benchmark technical efficiency and productivity of airlines in 2000s. Therefore, various improvements have taken place in the effort to improve the standard DEA technique which contained various properties and assumptions. Extended models of DEA have been introduced in recent years to complement the standard DEA model and overcoming bias estimate of the technical efficiency scores among others including bootstrap DEA, Slack Based Model, Network DEA, and Non-oriented DEA to name a few.

With regards to productivity growth measurement approach, there have been a number of extended approaches introduced to cater for shortfalls in the standard productivity measurement technique. Among others the extended techniques are including Malmquist Luenberger Productivity Index, Biennial Malmquist Luenberger Index, Malmquist Productivity Index using Efficiency Measurement System and Bootstrap Malmquist Index. Of all the improved techniques introduced above, none of the techniques have clearly overcome the assumption of homogeneity in DEA technique. In those studies, the metafrontier technique has not been applied to the context of airlines technical efficiency and productivity. Nonetheless, the technique has been extensively applied in benchmarking of various sectors including agriculture, engineering, banking, hospitality, energy and many more. From the review related to airlines, all the studies treated the two types of business model, namely the full cost and low cost carriers as homogeneous. This implies that the calculation of an airline's technical efficiency and productivity estimates are benchmarked against a common frontier (the frontier which is formed by pooling of full cost and low cost carriers). In reality, each group of full cost carriers and low cost carriers are operating on different technologies hence, each of the group formed a separate frontier.

Secondly, having examined various factors which have the potential to influence the technical efficiency and the productivity change of airlines, the impact of outsourcing on airline's performance in the contexts of technical efficiency and productivity has received little attention despite the growing popularity of outsourcing practice in the airline industry. In addition, there is also limited study examining the impact of economic environment of a country such as human development index on technical efficiency and productivity of airlines. Therefore, these two factors are worth investigating in the context of the airline industry as it draws important policy implications for improving the technical efficiency and productivity of airline.

CHAPTER 4: METHODOLOGY OF RESEARCH

4.1 Introduction

This chapter discusses the methodologies and data adopted in measuring the technical efficiency and the productivity levels of airlines. In addition, the methodology used to investigate the effects of outsourcing on the technical efficiency and productivity change of airlines is also explained in this chapter.

The study utilizes extended Data Envelopment Analysis (DEA) models based on the DEA methodology which are the DEA metafrontier technical efficiency and metafrontier Malmquist Productivity Index as introduced by O'Donnell et al. (2008) and Oh and Lee (2010) to measure the technical efficiency and productivity change across different airlines business models namely full cost and low cost carriers. Next, in the second stage, relevant variables which are the extent of outsourcing and economic development level of the countries where the airlines operated from are regressed upon the technical efficiency and productivity growth scores obtained from first stage DEA analysis by adopting the Generalized Method of Moment approach (GMM) called the System GMM. The purpose of executing second stage analysis is to investigate the determinants of technical efficiency and productivity change in airlines.

4.2 Data Envelopment Analysis (DEA)

Principally, in the production process, technical efficiency estimates of a firm can be measured using two approaches viz. parametric and non-parametric. The parametric approach utilizes the Stochastic Frontier Analysis (SFA) which requires the researcher to estimate the cost function or the production function of firm and random errors. In a way, the parameters have to be statistically estimated in parametric study related to efficiency.

On the other hand, the non-parametric approach does not require one to know the production function shape. DEA method also enables efficiency to be calculated despite a small sample size, provided that the DMUs meet certain level for minimum DEA convention which is a limitation for SFA method as it demands a large sample size in order to give reliable efficiency estimates.

While DEA has been known as viable in working with small sample size data, other propositions that support the application of the non-parametric approach present a statistical advantage of the DEA, in terms of less sensitivity to misspecification issue compared to SFA, because one needs to assume a specific functional form (Singh et al, 2000). On top of that, DEA is not subject to unit sensitivity as one can use different units in inputs and outputs to run DEA analysis. Besides that, DEA is convenient to measure efficiency because it has the ability to handle multiple inputs and multiple outputs at one time using linear programming. Not only that, DEA is also convenient as it works well with different measurement units of input and output (Ramanathan, 2003). For an example, one output variable which is operating revenue may be measured in money unit but the other may be measured in quantity, such as number of passenger or revenue passenger kilometer.

Despite no statistical requirements, DEA also provides a comparable analysis, as other tools in econometric analysis, where the efficiency score estimated is objective using numerical data. Missing price information is a major issue in some countries where data on prices are treated as confidential. However, DEA can dismiss price information in calculating the technical efficiency and productivity change. These explanations make DEA a popular approach when compared to parametric.

Despite the convenience in measuring efficiency of DMU, there are several disadvantageous associated with DEA. Ramanathan (2003) outlined the following disadvantage of DEA, among others: Because DEA is based on point measurement, it reacts largely to small errors found in the data. This requires determination of appropriate inputs and outputs to give a more reliable result of efficiency estimates; secondly, DEA assumes positive values of inputs and outputs, which means that it cannot work in a situation where the value of inputs and outputs are negative. This notion limits the power of DEA for application to various cases. Thirdly, the standard DEA technique assumes homogeneity in inputs and outputs. The standard DEA model cannot give a correct picture of efficiency if the firms are characterized as heterogeneous.

4.2.1 Standard Data Envelopment Analysis model

The original idea of frontier estimation using the piece-wise linear convex hull approach, is first introduced by Farrell (1957) followed by the introduction of mathematical programming approach, to conduct frontier estimation as found in Boles (1966); Shephard, (1970); and Afriat (1972). However, frontier estimation has not received wide acceptance among scholars in performance study until the introduction of the Data Envelopment Analysis by Charnes, Cooper and Rhodes (1978). Basic output orientation DEA model, introduced by Charnes et al. (1978) or later called CCR constant return to scale model, allows each DMU to select optimal weights of input and output using mathematical programming which takes the basic form as follows:

$$\text{Max}_{u,v} \left\{ \delta_0 = \frac{u' q_i}{v' x_i} \right\} \tag{4.1}$$

(the objective is to find optimal values of weights, u and v in order to maximize the efficiency measure of the jth DMU).

Subject to:

$\frac{u' q_j}{v' x_j} \leq 1$; where, $u_r, v_i \geq 0$ and, $j=1,2,3,\ldots I$

(take note that all the efficiency constraints must be less or equal to one)

Where:

q is vector of outputs; x is vector of inputs; u' is the weight given to output q which is an *MxI* vector of output weights; v_i is the weight given to input v which is a *NxI* vector of input weights.

The DEA form (ratio form) in equation (4.1) is confounded with the issue of infinite number of solutions, therefore to avoid this, an additional constrain, $v'x_i$ may be imposed to the equation to get the multiplier form:

$$max_{u,v}(\mu' q_i) \tag{4.2}$$

Subject to: $v'x_i$=1,

$\mu' q_j - v' x_j \leq 0$, $j=1,2,\ldots,I$.

$\mu, y \geq 0$,

Equation 4.2 is a different linear programming problem where the symbols for weights of output and input have been changed from u and v to μ and v respectively.

Taking the duality in linear programming in (4.1), we obtained the following envelopment form of input orientation based on Charnes, Cooper and Rhodes (1978), later on called the CCR model with an assumption of constant return to scale (CRS).

$$\mathrm{Min}_{\Theta,\lambda} \quad \Theta \tag{4.3}$$

Subject: $-q_i + Q\lambda \geq 0,$

$\Theta x_i - X\lambda \geq 0,$

$\lambda \geq 0$

Θ is a scalar, and λ is a Ix1 vector of weights or constants.

On the other hand, an output orientation, constant returns to scale model is written as:

$$Max_{\phi,\lambda} \ \phi \tag{4.4}$$

Subject to:

$-\phi q_i + Q\lambda \geq 0,$

$x_i - X\lambda \geq 0,$

$\lambda \geq 0$

Where, $1 \leq \phi \leq \infty$, and $\phi - 1$ is the proportional increase in output achievable by the i-th firm, holding that input quantities are constant and,

λ is a I x1 vector of weights.

Intuitively,

The problem in LP (4.3) implies that *ith* number firms seek for a radial contraction of input vectors x_i to the maximum while still restricted within the feasible input set. The radial contraction of the input vector, x_i produces a projected point (Xλ, Qλ), on the surface of this technology. In addition, the constraints ensure that the projected point cannot lie outside the feasible set. (Coelli et al., 2005, p163)

The linear programming in equation (4.3) is the preferred form to solve in many studies related to DEA because it is much simple than the multiplier form as well as it has fewer constraints than the multiplier form. In addition, the technology of this form of LP satisfies the axioms of convexity, constant return to scale and strong disposability (Fare et al., 1994).

While constant returns to scale assumption is ideal in DEA, however in practice, not all firms are operating at optimal scales. To account for this issue, Banker et al. (1984) came out with the BCC model by introducing variable returns to scale (VRS) assumption in DEA.

The form of problem in the VRS model is analog to that of the CRS model except in the VRS where an additional constraint is imposed that is the convexity constraint, I1'λ=1. This constraint ensures that an inefficient firm is only benchmarked against firms of a similar scale.

In the event of an assumption of variable return to scale, one can apply equation (4.3) by adding an additional constraint that is convexity constraint to form DEA with VRS assumption. Assuming that group k consists of information on L_k firms and there are T periods, an output orientation and variable returns to scale DEA model is rewritten in an envelopment form in equation 4.5 as follows:

$$Max_{\emptyset,\lambda}\ \phi \tag{4.5}$$

Subject to:

$-\phi q_i + Q\lambda \geq 0,$

$x_i - X\lambda \geq 0,$

$I1'\lambda = 1$

$\lambda \geq 0$

Where I1 is an *I*x1 vector of ones, which form a convex hull of intersecting planes that envelope the data points more tightly than the constant returns to scale assumption. Therefore, VRS assumption provides the scores of technical efficiency which are larger than CRS.

Where, $1 \leq \phi \leq \infty$ and; $\phi - 1$ is the proportional increase in output achievable by the *i-th* firm, assuming that input quantities are constant. Meanwhile, the technical efficiency score is given by $1/\phi$. The notations I1 and λ are *I* x 1 vector of ones, for *I* number of airlines and *I* x1 vector of constants (weights) respectively.

Nevertheless, for both the technical efficiency DEA and Malmquist DEA analysis in this study, constant returns to scale technology is assumed. A separate examination using variable returns to scale assumption has been executed as suggested in Dyson et al. (2001) and the results showed that there are very few airlines facing fully scale efficient. Furthermore, changing the capacity or size of operation in the short run is impossible (Schefczyk, 1993). There is strong empirical evidence advocating the airline industry as facing constant returns to scale. For example, White (1979), Caves et al. (1984; 1985), McShan and Windle (1989), Sickles et al. (2002), and Greer (2009). This evidence is further supported by the fact that small and large carriers coexist over extended periods of time in the industry indicate existence, thus strengthening our assumption that the airline industry is facing CRS technology. In addition, an application of CRS technology is reasonable, to avoid the issue of high number of fully efficient scores, due to variable returns to scale assumption. The implication of applying, variable returns to scale assumption in our case, may bias estimate the score of technical efficiencies due to its low discriminatory power. This is because the value of technical efficiency scores calculated under an assumption of the VRS technology is usually higher than the CRS technology.

In addition, this study further assumes output orientation envelopment DEA. This option is appropriate in the context of the airline industry, because important inputs may be beyond the control of an airline company. For example, fuel price is fluctuating and determined by the market interaction. Therefore, here it is assumed that the objective of airline companies is to maximize output given the available resources.

In the second analysis, the metafrontier Malmquist productivity index is measured based on the approach of Oh and Lee (2010), which is an extension of global Malmquist

Productivity Index of Pastor and Lovell (2005). Since both approaches assumed CRS, the assumption of CRS is applied in the calculation of MPI in the second analysis. Besides that, the decision to choose constant returns to scale technology is also supported by MPI decomposition in the standard model of Fare et al. (1992) which also assumed CRS technology. This reasoning plus the examination performed on VRS technology have led to an adoption of constant returns to scale technology in the metafrontier Malmquist model estimated in this study.

4.2.2 Metafrontier model based on DEA methodology

The idea of metafrontier is originated from Hayami and Ruttan (1970) which is related to the concept of metaproduction function. According to these authors, a metaproduction function is regarded as the envelope of the neoclassical production functions. This concept was later on extended by Battese and Rao (2002), Battese et al. (2004), and O'Donnell et al. (2008) in which they came out with the metafrontier model to estimate the technical efficiency of firms which belong to different groups.

In the traditional DEA model, each firm is treated as homogenous, thus assuming that each firm is facing a similar production frontier. This implies that measurement of a firm's technical efficiency is obtained by comparing the efficiency of a firm against a frontier for all firms irrespective of which group they belong to. Benchmarking the technical efficiency using this approach is inappropriate as the firms are heterogeneous in many aspects, because they are facing different frontiers.

Full cost and low cost carriers are operating on different production technology due to restrictions in terms of access to resources as well as the environment where the carrier operates. For example, due to the nature of the services rendered by full cost carriers and low cost carriers, they employ different aircraft types in their operations. Low cost carriers which offer point to point, short and medium haul services usually utilize a single type of aircraft in their operation. However, for full cost carriers which offer both domestic and international services, and distributing traffic based on hub and spoke strategy, usually use different type of aircraft to meet the capacity requirements of each type of service. Other restrictions such as accessibility to capital, quality of labour, economic infrastructure, resource endowments, and other factors such as physical, social and economic environment may also result in airlines facing different technologies in their productions (O'Donnell et al., 2008). Therefore, it is common to observe studies on technical efficiency which constructs separate frontiers for different groups in airlines or what is called as clustering approach found in Anthanassopoulos et al. (1995) or find the metafrontier after clustering as done in Battese, Rao and O'Donnell (2004, p.3). Given these solutions, all these past approaches are not appropriate as it maintains the assumption of homogeneity. However, comparing the technical efficiency of a firm in one group to a firm in other group is impossible if the firms do not have identical frontiers due to heterogeneity issues as discussed earlier. Therefore, comparing the technical efficiency of firms which belong to different groups using the traditional DEA concept may provide misleading results for policy implication.

The concept of metafrontier based on DEA has been widely applied to measure the technical efficiency in various fields. O'Donnell, Rao and Battese (2008) investigate the efficiency of agricultural performance in 97 countries. The efficiency of banks in four MENA countries was carried out by Naceur, Ben-Khedhiri, and Casu (2011). Meanwhile, Kontolaimou and Tsekouras (2010) benchmarked the productive performance of European co-operative banks against commercial and savings banks. The application of metafrontier technique based on DEA has also been applied in the sports sector, for example Tiedmann, Frankson, and Lohmann (2011) who assess the efficiency of football players. The popularity of metafrontier technique is not only limited to benchmarking in banking and sport's sector but also, more than that, it has gained popularity in the field of engineering as indicated in the study by Sala-Garrido, Molinos-Senante, and Hernández-Sancho (2011) who evaluate the efficiency of waste water treatment technologies. The technique continued to receive overwhelming support where it has been applied in assessing the efficiency of small franchise enterprises as studied by Sala-Garrido, Molinos-Senante, and Hernández-Sancho (2011).

The scenario for performance benchmarking based on productivity approach is similar to that of technical efficiency where the metafrontier technique has received a wide acceptance for assessment in various fields. Among the earliest study which applies the metafrontier concept of DEA in measuring the productivity growth is found in Rambaldi, Rao and Dolan (2006) who compare the productivity growth of countries in different geographical regions. Based on the framework introduced in the study of Rambaldi, Rao and Dolan (2006), Krishnasamy and Ahmed (2009) employed the metafrontier Malmquist Productivity Index to compare technology catch up between countries in OECD. Subsequently, based on similar framework in their study done in 2009, Ahmed and Krishnasamy (2013) analyses the technology gap and catch up level of three regions in Asia namely Southern Asia, East Asia, and ASEAN-5 regions. Recently Arsana (2014) assesses the productivity growth of different levels of development in Indonesian regions by applying the metafrontier concept of Malmquist productivity index. Despite a wide acceptance of the metafrontier technique in various areas of studies, the technique so far has not been applied in evaluating the technical efficiency and productivity growth in the field of aviation. Hence, this study attempts to fill this gap in past researches by applying the metafrontier model developed by O'Donnell et al. (2008) and Oh and Lee (2010) to estimate the technical efficiency and productivity change in a selected worldwide sample of airlines to account for heterogeneity nature of technology in production among full cost and low cost carriers.

The heterogeneeous nature of firms can be further confirmed scientifically using non-parametric test of the Mann-Whitney U test, to test whether the sample variables belong to identical population or the other way around. This approach to confirm the heterogeneity nature of the sample has been used in metafrontier studies, for example Sala-Garrido, Malinos-Senante, and Hernandez-Sancho (2011); and Medal-Bartual, Gartia-Martin and Sala-Garrido (2012). The empirical results of this test with respect to the case of airlines are presented in chapter 5 of this report.

4.2.2.1 The metafrontier technology for measuring DEA technical efficiency

Assumes that we have x and y non-negative real input and output vectors of dimension Mx1 and Nx1 respectively. Therefore, the meta-technology set is given as follows:

$$T = \{(x, y){:}x>0,\ y>0;\ x \text{ can produce } y\} \tag{4.6}$$

The input and output sets associated with the meta-technology set, T are specified as follows:

$$P(x) = \{y: (x, y) \epsilon\, T \tag{4.7}$$

This output set is also called the output metafrontier. The output set must meet the standard regularity properties discussed in Fare and Primont (1995).

Therefore, the output meta-distance function is given as:

$$D(x,y) = inf_{\theta}\{\theta > 0: \frac{y}{\theta} \in P(x)\} \tag{4.8}$$

The output meta-distance function above implies that a firm can radially expand its output vector given the inputs that it has. Therefore, the input and output vectors are said to be technically efficient if $D(x,y) = 1$.

4.2.2.2 The group frontier technology

Assumes that firms take a number of K(>1) groups. It is also assumed that differences in access to resources, regulatory and other environmental constraints result in the firms' inability to access meta-technology production set, T. Hence the group specific technology set available to *k-th* group of firms is given by:

$$T^k = \{(x,y): x \geq 0; y \geq 0; x \text{ input } is\ used\ to\ produce\ y \text{ output } by\ group\ k$$

(4.9)

The output sets and output distance function with respect to group k is defined as:

$$P^k(x) = \{y: (x,y) \in T^k\}, where\ k = 1,2, \ldots, K;\ and \tag{4.10}$$

$$D^k(x,y) = inf_{\theta}\left\{\theta > 0: \left(\frac{y}{\theta}\right) \in P^k(x)\right\}, k = 1,2 \ldots\ldots, K \tag{4.11}$$

The boundaries of group specific output set are also called the group frontiers. If the output set $P^k(x), k = 1,2 \dots, K$ satisfies the standard properties, then the distance functions, $D^k(x, y), k = 1,2 \dots . K$, also satisfy the standard properties. It is clear that

R.1 If $(x, y) \in T^k$ group technology set for any k, then $(x, y) \in T$;

R.2 If $(x, y) \in T$ then $(x, y) \in T^k$ for some k;

R.3 If $T = \{T^1 \cup T^2 \cup \dots \cup T^k\}$; and

R.4 If $D^k(x, y) \geq D(x, y)$ for all k=1,2….,K.

R.5 Convex in unrestricted output set, $P(x)$ does not necessarily follow by convex group output set, $P^k(x), k = 1,2 \dots, K$

From these rules, it is concluded that the group specific output sets $P^k(x), k = 1,2 \dots, K$ are subsets of the unrestricted output set, $P(x)$.

4.2.2.3 Technical efficiency and technology gap ratio

This sub-section provides the definitions for technical efficiencies with respect to group frontier, metafrontier, and technology gap ratio.

An output orientated estimate of the technical efficiency with respect to group k technology for pair of input x and output y is defined as:

$$TE^k(x, y) = D(x, y) \tag{4.12}$$

Meanwhile, an output orientated estimate of the technical efficiency with respect to the metafrontier technology is defined as

$$TE(x, y) = D(x, y) \tag{4.13}$$

Hence, the output orientated technology gap ratio for group k firms is defined as

$$TGR^k(x, y) = \frac{D(x,y)}{D^K(x,y)} = \frac{TE\ (x,y)}{TE^k(x,y)} \tag{4.14}$$

This is depicted in figure 4.1 below.

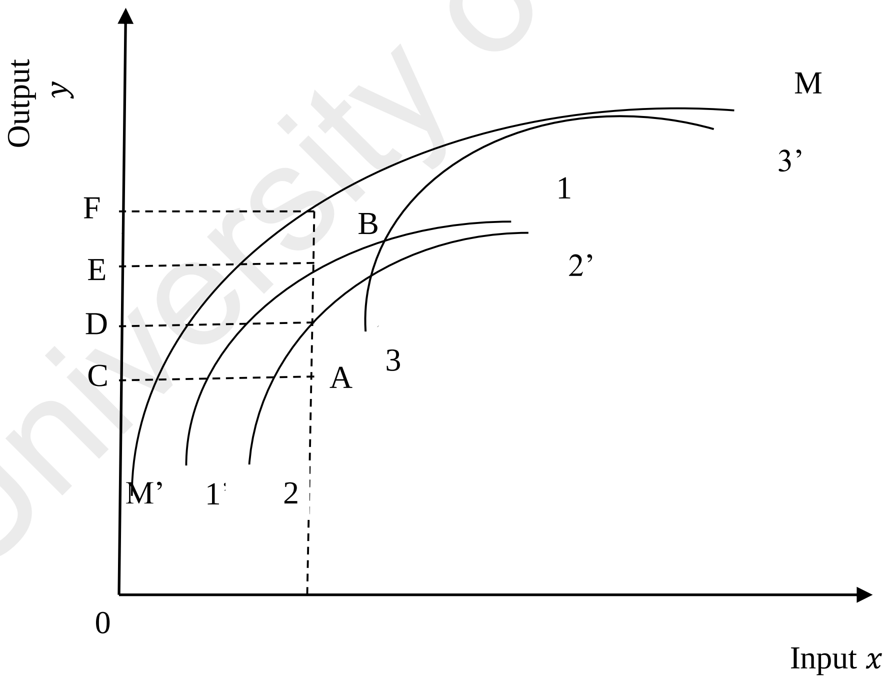


Figure 4.1: Group frontier and metafrontier technologies

Source: O’Donnell et al. (2008)

Figure 4.1 shows the construction of metafrontier technical efficiency. The curves labeled 11', 22' and 33' are referring to frontiers with respect to group 1, 2, and 3. Meanwhile, the wider frontier labeled as MM' refers to the metafrontier. In this case, the metafrontier MM' enveloped all the 3 groups of firms.

Assuming a convex metafrontier as labeled by MM', the technical efficiency for group 1 (TE^1) frontier using input and output combination at point A is calculated as:

$$TE^1(A) = OC/OE \tag{4.15}$$

Meanwhile, the metafrontier technical efficiency, TE(A) for group 1 using input and output mix at point A when benchmarked upon the metafrontier MM' is given by:

$$TE(A) = OC/OF \tag{4.16}$$

Hence, the technology gap ratio (TGR) for group 1 at point of input and output labeled A is given by:

$$TGR^1 = \frac{TE(A)}{TE^1} = \frac{OC/OF}{OC/OE} \tag{4.17}$$

4.2.3 Malmquist Productivity Index

The Malmquist Productivity Index (MPI) was first introduced by Caves, Christensen and Diewert (1982). They defined the TFP index using Malmquist input and output distance function. Next, Fare, Grosskopf, Norris and Zhang (1994) decomposed the Malmquist total factor productivity change (TFP) into technical efficiency change and technical change. The MPI measures productivity change with respect to period t and period $t+1$technologies. Based on Fare et al. (1994), assuming there are *i* panel of firms denoted by $i = 1, \dots, K$ firms. The number of periods observed are $t = 1, \dots., T$ periods. Assumes that each firm uses N inputs, $x \epsilon R_{+}^{N}$ to produces M outputs, $y \epsilon R_{+}^{M}$. The production possibility set which defines the technology applied in this case is given by:

P = {(*x*,*y*)| *x* can produce *y* } with λP = P,λ>0. It is also assumed that there are *J* different groups in the panels which use different technologies.

Based on Oh and Lee (2010), the metafrontier Malmquist Productivity Index can be decomposed into three technology sets, namely contemporaneous benchmark technology, intertemporal benchmark technology, and global benchmark technology. The last technology set is also known as the metafrontier Malmquist productivity index.

4.2.3.1 Contemporaneous benchmark technology

The production possibility set for a contemporaneous benchmark technology for group R_J is given by $P_{R_J}^{t}$ ={(x^t ,y^t) | x^t can produce y^t}, where $\lambda P^t = P^t$, and t= 1,…,T and λ>0. In a way, the contemporaneous technology develops a reference production set for each point in time period *t* (Pastor & Lovell, 2005).

Basically, the contemporaneous benchmark technology introduced by Caves et al. (1982) is not circular hence is prone to infeasibility issue in the linear programming technique used to compute and decomposed the index (Pastor & Lovell, 2005). In contemporaneous Malmquist productivity index, an output oriented MPI with respect to period *t* technology is defined as

$$M_t = \frac{D_t(x_{t+1},y_{t+1})}{D_t(x_t,y_t)} \tag{4.18}$$

and if period t+1 is chosen as the reference technology, the output oriented MPI is given by

$$M_{t+1} = \frac{D_{t+1}(x_{t+1},y_{t+1})}{D_{t+1}(x_t,y_t)} \tag{4.19}$$

Due to difficulty in choosing between period t and t+1 as the reference period, the output orientated MPI takes the form of geometric mean which is defined as follows:

$$M_{t,t+1}(x_t, y_t, x_{t+1}, y_{t+1}) = \left[\frac{D_t(x_{t+1},y_{t+1})}{D_t(x_t,y_t)} X \frac{D_{t+1}(x_{t+1},y_{t+1}}{D_{t+1}(x_t,y_t)}\right]^{1/2} \tag{4.20}$$

This form of MPI can be dissected into components of technical efficiency change and technical change as defined below. The MPI index is computed by solving 6 linear programming as indicated below.

$$M_{t,t+1}(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{D_{t+1}(x_{t+1},y_{t+1})}{D_t(x_t,y_t)} \left[\frac{D_t(x_{t+1},y_{t+1})}{D_{t+1}(x_{t+1},y_{t+1})} X \frac{D_t(x_t,y_t}{D_{t+1}(x_t,y_t)}\right]^{1/2} \tag{4.21}$$

= EC x TEC

Where, the first fraction from the left-hand side refers to technical efficiency change, while the second fraction on the right refers to technical change.

The output distance function for $K' \in R_j$ in this study is calculated using a linear programming approach which is outlined below. The productivity of producer K' between time period t to $t+1$ is given by the distance function:

$$\left[D^s(x^{k',s}, y^{k',s}\right]^{-1} = \max \phi_c^{k',s} \tag{4.22}$$

Subject to

$$\sum_{k \epsilon R_J} \lambda^k y_m^{k,s} \geq \phi_c^{k',s} y_m^{k',s} \quad , \qquad m = 1, \ldots., M$$

$$\sum_{k \epsilon R_J} \lambda^k x_n^{k,s} \leq x_n^{k',s} \quad , \qquad n = 1, \ldots., N$$

$$z^{k,s} \geq 0$$

Where λ^k, which refers to the intensity of an airline activity, is utilized in production.

4.2.3.2 Intertemporal benchmark technology

The intertemporal benchmark technology can be defined by the production productivity set as $P_{R_J}^I = \text{conv}\{P_{R_J}^1 \cup P_{R_J}^2 \cup \ldots. \cup P_{R_J}^T$. It refers to a technology frontier which is composed by the whole observations set throughout the entire time period for group R_J (Tulkens & Vanden Eeckaut, 1995). In this case, there are J different intertemporal benchmark technologies depending on the number of groups that the firms have. Each firm can only access to its own intertemporal technology. Access to other intertemporal technologies by each group is difficult.

The intertemporal Malmquist productivity index for group R_J is defined in distance function form as

$$M^I(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D^I(x^{t+1}, y^{t+1})}{D^I(x^t, y^t)} \tag{4.23}$$

Where, the output distance function is defined on the intertemporal technology set as $D^I(x,y) = \inf\{\phi{>}0 \mid (x, y/\phi) \in P^I_{R_J}\}$.

Based on Pastor and Lovell (2005), the intertemporal Malmquist productivity index for group R_J can be decomposed into efficiency change and best practice change as follows:

$$M^I(x^t, y^t, x^{t+1}, y^{t+1}) \tag{4.24}$$

$$= \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \text{ x} \left\{ \frac{D^I(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})} \text{ x} \frac{D^t(x^t, y^t)}{D^I(x^t, y^t)} \right\}$$

$$= \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \text{ x} \left\{ \frac{D^I(x^{t+1}, y^{t+1}/D^{t+1}(x^{t+1}, y^{t+1}))}{D^I(x^t, y^t/D^t(x^t, y^t))} \right\}$$

$$= \frac{TE^{t+1}}{TE^t} \text{ x } \frac{BPG^{I,t+1}}{BPG^{I,t}}$$

$$= EC \ X \ BPC$$

Where TE^s is the level of technical efficiency, and $BPG^{I,s}$ is the best practice gap. The terms *EC* and *BPC* denote the efficiency change as explained in Fare et al. (1994) and best practice gap change between $P^I_{R_J}$ and $P^s_{R_J}$ measured along rays (x^s, y^s), where s refers to periods *t* to *t+1*. When *BPC>1*, it indicates that the contemporaneous benchmark technology in period *t+1* in the region $[x^{t+1}, y^{t+1}/D^{t+1}(x^{t+1}, y^{t+1})]$ is approaching to the intertemporal benchmark technology than is the benchmark technology in period *t* in the region of $[(x^t, y^t/D^t(x^t, y^t))]$. Meanwhile, the opposite holds true when *BPC<1*.

Note that BPC gives the value of technical change within a group (Pastor and Lovell, 2005). Therefore, BPC >1 shows technical progress and BPC <1 indicates technical regress.

Solving the Malmquist productivity index in the simple case of single input and output is easy. However, when the problem becomes complicated with multiple inputs and multiple outputs, linear programming is applied to solve the problem.

The linear programming model to compute the output distance function for the intertemporal benchmark technology which is $D^I(x^{k',s}, y^{k',s}/D^{k',s}(x^{k',s}, y^{k',s}))$, where s refers to period *t* and *t+1* is given as follows:

$$\left[D^I(x^{k',s}, y^{k',s}/D^{k',s}(x^{k',s}, y^{k',s}))\right]^{-1} = \max\phi_I^{K'} \tag{4.25}$$

Subject to

$$\sum_{k\epsilon R, S\epsilon\tau} \lambda^{k,s} y_m^{k,s} \geq \phi_I^{k'} \hat{\phi}_I^{k',s} y_m^{k',s}$$

$$\sum_{k\epsilon R, S\epsilon\tau} \lambda^{k,s} x_n^{k,s} \leq x_n^{k',s}$$

$$z^{k,s} \geq 0 \ ,$$

where $\tau = \{1,2, \ldots, T\}$, *m*= 1,…,*M*, and *n* =1,….,*N*

4.2.3.3 Metafrontier Malmquist Productivity Index

In the study by Oh and Lee (2010), the metafrontier Malmquist productivity index is also known as the global benchmark technology approach as introduced in Pastor and

Lovell (2005). Basically, Oh and Lee (2010) extends the global Malmquist model of Pastor and Lovell by incorporating the intertemporal technology frontier or what is called as group frontier in O'Donnell et al. (2008) in their new model. The production technology exhibited by the global benchmark technology is defined as the production productivity set, $P^G = conv(P^I_{R_1} \cup P^I_{R_2} \cup \ldots \cup P^I_{R_J})$. In this respect, the global benchmark technology formed a single reference production set from the observation made all over the observations and time periods throughout all groups. In a way, the global benchmark technology enveloped all the intertemporal technology frontiers for all the groups across the entire time period. To simplify our analysis, it is assumed that all producers have access to the global technology frontier, unlike other technology frontiers where their access are limited due to some obstacles.

An output distance function of the metafrontier Malmquist productivity index is defined as

$$M^G(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D^G(x^{t+1}, y^{t+1})}{D^G(x^t, y^t)} \tag{4.26}$$

Take note that the output distance function denoted by $D^G(x, y) = \inf\{\phi > 0 | (x, y\ /\phi \epsilon P^G\}$ is defined in the global technology set. The decomposition of the metafrontier Malmquist productivity index into sources of productivity growth is explained as follows:

$$\mathrm{M^G}(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{\mathrm{D^G}(x_{t+1}, y_{t+1})}{\mathrm{D^G}(x_t, y_t)} \left[\frac{D^*_t(x_{t+1}, y_{t+1})}{D^*_{t+1}(x_{t+1}, y_{t+1})} X \frac{D^*_t(x_t, y_t)}{D^*_{t+1}(x_t, y_t)}\right]^{1/2} \tag{4.27}$$

$$= \frac{D^{G}(x_{t+1}, y_{t+1})}{D^{G}(x_t, y_t)}$$

$$= \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t}(x^{t}, y^{t})} \text{ x} \left\{ \frac{D^{t}(x^{t}, y^{t})}{D^{t+1}(x^{t+1}, y^{t+1})} \text{ x} \frac{D^{G}(x^{t+1}, y^{t+1})}{D^{G}(x^{t}, y^{t})} \right\}$$

$$= \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t}(x^{t}, y^{t})} \text{ x} \left\{ \frac{D^{t}(x^{t}, y^{t})}{D^{t+1}(x^{t+1}, y^{t+1})} \text{ x} \frac{D^{I}(x^{t}, y^{t})}{D^{I}(x^{t}, y^{t})} \right\} \text{ x } \left\{ \frac{D^{I}(x^{t}, y^{t})}{D^{I}(x^{t+1}, y^{t+1})} \text{ x} \frac{D^{G}(x^{t+1}, y^{t+1})}{D^{G}(x^{t}, y^{t})} \right\}$$

$$= \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^{t}(x^{t}, y^{t})} \text{ x } \frac{D^{I}(x^{t+1}, y^{t+1}/D^{t+1}(x^{t+1}, y^{t+1}))}{D^{I}(x^{t}, y^{t}/D^{t}(x^{t}, y^{t}))} \quad \text{ x } \frac{D^{G}(x^{t+1}, y^{t+1}/D^{I}(x^{t+1}, y^{t+1}))}{D^{G}(x^{t}, y^{t}/D^{I}(x^{t}, y^{t}))}$$

$$= \frac{TE^{t+1}}{TE^{t}} \text{ x } \frac{BPG^{I,t+1}}{BPG^{I,t}} \text{ x } \frac{\mathrm{TGR}^{t+1}}{\mathrm{TGR}^{t}}$$

$$= EC \text{ x } BPC \text{ x } TGC$$

In MaxDEA programme, the computation of metafrontier Malmquist productivity index is given by the following linear programming:

$$\left[D^{G}(x^{k',s}, y^{k',s}/D^{k',s}(x^{k',s}, y^{k',s}))\right]^{-1} = \max \phi_G^{k'} \tag{4.28}$$

Subject to $\sum_{k \epsilon R, S \epsilon \tau} z^{k,s} y_m^{k,s} \geq \phi_G^{k'} \hat{\phi}_I^{k',s} y_m^{k',s}$; $\sum_{k \epsilon R, S \epsilon \tau} z^{k,s} x_n^{k,s} \leq x_n^{k',s}$

$z^{k,s} \geq 0,$

where $R = R_1 \cup R_2 \cup \dots . R_J$, $\tau = \{1,2, \dots, T\}$, m= 1,…,M, and n =1,….,N

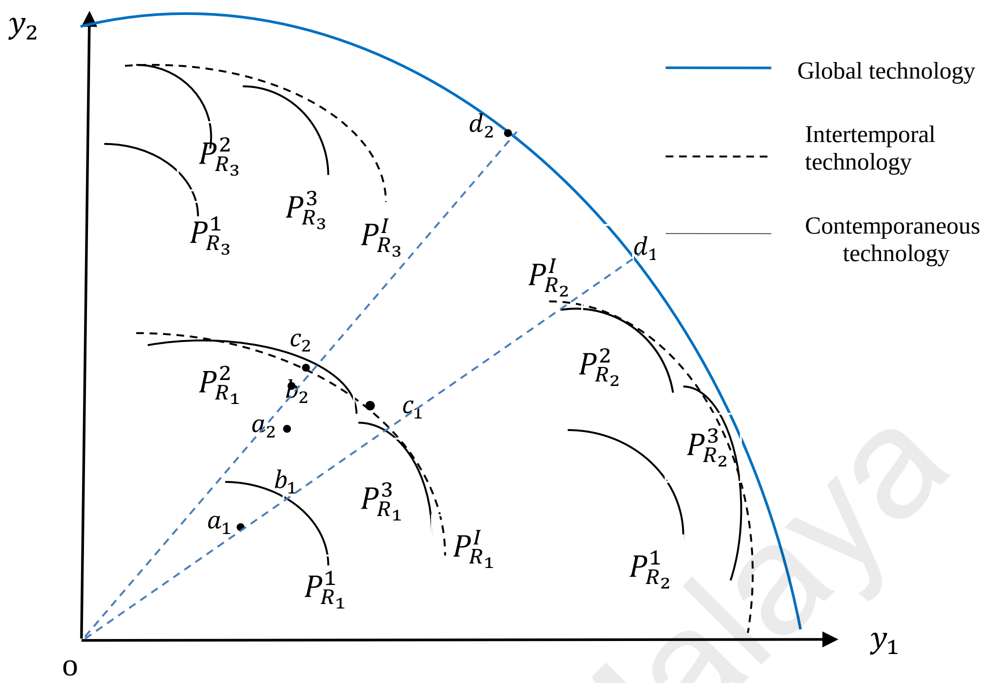


Figure 4.2: The Metafrontier concept of Malmquist productivity index

Source: Oh & Lee (2010)

Figure 4.2 illustrates conceptually how the metafrontier Malmquist productivity index is derived. Basically, there are two types of technologies involved in the computation of the metafrontier Malmquist productivity index. First, is the contemporaneous benchmark technology, which is also referring to Fare et al. (1994) concept of Malmquist productivity index. Let us assumes that there are three time periods involved, namely time period 1, 2 and 3. Let us also assume that there are three groups of firms involved, namely groups 1, 2 and 3. The smallest curves, which convex to the origin in the diagram refer to the contemporaneous technology frontier. The output distance function for contemporaneous benchmark technology is measured by the distance. Meanwhile, the medium size curves which envelope all the three period of contemporaneous technology frontier is called the intertemporal technology frontier. Points denoted by $a_1, b_1, c_1, and\ d_1\ and\ a_2, b_2, c_2\ and\ d_2$ refer to production points for the firms. For instance, the output distance function for a production activity at point a_1 with reference to the contemporaneous technology frontier $P_{R_1}^1$ in time period 1 is given by $Oa_1/\ O_{b_1}$. Meanwhile, the output distance function for a production activity at point a_2 with reference to contemporaneous technology frontier $P_{R_1}^2$ in time period 2 is given by $0a_2/0b_2$. The output distance function for a production activity at point a_1 with reference to the intertemporal benchmark technology in period 1 is given by $Oa_1/\ O_{c_1}$. For period 2, the output distance function with reference to intertemporal technology at production activity in point a_2 is calculated as $0a_2/0c_2$. The output distance function with reference to the global benchmark technology in period 1 and period 2 are calculated as $Oa_1/\ O_{d_1}$ and $0a_2/0d_2$ respectively.

With reference to figure 4.2, the metafrontier Malmquist productivity index and its decompositions into contemporaneous, intertemporal and global technologies can be computed using distances approach as follows:

$$\mathrm{M}^{\mathrm{G}}(x_t, y_t, x_{t+1}, y_{t+1}) \tag{4.29}$$

$$= \frac{0a_2/0d_2}{Oa_1/\ O_{d_1}}$$

$$= \frac{0a_2/0b_2}{Oa_1/\ O_{b_1}} \text{ x } \left\{\frac{0a_1/0b_1}{Oa_2/\ O_{b_2}}\ x\ \frac{0a_2/0d_2}{Oa_1/\ O_{d_1}}\right\}$$

$$= \frac{0a_2/0b_2}{Oa_1/\ O_{b_1}} \text{ x } \left\{\frac{0a_1/0b_1}{Oa_2/\ O_{b_2}} \text{ x } \frac{0a_2/0c_2}{Oa_1/\ O_{c_1}}\right\} \text{ x } \left\{\frac{0a_1/0c_1}{Oa_2/\ O_{c_2}} \text{ x } \frac{0a_2/0d_2}{Oa_1/\ O_{d_1}}\right\}$$

$$= \frac{0a_2/0b_2}{Oa_1/\ O_{b_1}} \text{ x } \left\{\frac{\frac{0a_2/0c_2}{Oa_2/\ O_{b_2}}}{\frac{0a_1/0c_1}{Oa_1/\ O_{b_1}}}\right\} \text{ x } \left\{\frac{\frac{0a_2/0d_2}{Oa_2/\ O_{c_2}}}{\frac{0a_1/0d_1}{Oa_1/\ O_{c_1}}}\right\}$$

$$= \frac{0a_2/0b_2}{Oa_1/\ O_{b_1}} \text{ x } \frac{0b_2/0c_2}{Ob_1/\ O_{c_1}} \text{ x } \frac{0c_2/0d_2}{Oc_1/\ O_{d_1}}$$

4.3 Econometric approach for modeling dynamic relationships in airline's efficiency and productivity change.

The efficiency and productivity growth scores obtained from the DEA metafrontier models are important for evaluation of efficiency and productivity growth scores between airlines in the full cost and the low cost business models. However, the efficiency and productivity growth estimates will be more meaningful if we are able to understand the drivers of improvements in the efficiency and productivity growth levels. This analysis is worth pursuing particularly if the objective of efficiency and productivity measurements are meant for policy recommendations to improve performance of airlines.

The objective is materialized using the two stage procedures. First, is to evaluate the efficiency and productivity growth scores for each airline in the sample. Secondly the efficiency and productivity growth variations obtained from the first stage analysis are regressed upon variables which are not directly observed in the efficiency and productivity growth calculations to examine the sources of efficiency and productivity change across time using linear econometric model: the dynamic panel Generalized Method of Moments (GMM) estimator. These variables are extent of outsourcing and economic development levels of the countries where the airline companies are originated from. In addition, we include other variables such as passenger load factor, available seat kilometer, and revenue passenger kilometer to control for quality, capacity and size of the respective airlines.

It is argued that airlines' output in deregulated market is affected by endogeneity problem, where decisions on output prices are determined by costs in past periods (Creel

& Farell, 2001). Furthermore, investment in modern aircraft with the state of the art technology is important to raise the performance of airlines through the increase in seating capacity, speed, and fuel efficiency. However, this kind of investment usually involves high capital cost which is a common problem faced by airlines in developing countries (Smyth & Pearce, 2007 July). As reported by IATA, for many years, investments made by airlines have constantly met with low returns which are below the cost of capital (CAPA, 2013 July 5). Due to the nature of high capital cost faced by the aviation industry plus slow return from the capital investment, it is likely that there is a delay in performance improvement. There is a tendency for present inefficiency and low productivity in airlines be influenced by past inefficiency and low productivity record. Therefore, it is reasonable to suspect the presence of endogeneity issue in our data. Hence, the application of GMM estimator is an ideal solution as one can add lag dependent variable to overcome endogeneity issue.

Furthermore, there are a number of studies at firm level which adopt GMM estimator. For example, Elsayed and Paton (2005) examine the impact of environmental performance on firm performance. Subsequently, E. Souza and Gomes (2015) investigate the influence of intensity of partnership and revenue generation on the technical efficiency of an agricultural research centre in Brazil. Next, Al-Gasaymeh (2015) studies the association of country risk with the concentration on bank efficiency in Gulf Cooperation Council Countries. These studies believe that past performance of firm has the influence on present performance. Hence, application of GMM estimators is suitable to tackle the issue of endogeneity in the study.

4.3.1 Solving for endogeneity issue in static panel data models

i. Instrumental variable (IV)

Consider the following static model of panel data which includes the lag dependent variable Y_{it-1} as shown in the following equation 4.30.

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Y_{it-1} + [\lambda_i + \mu_i + v_{it}] \tag{4.30}$$

Since Y_{it} and Y_{it-1} are correlated, these variables are also correlated with the error terms on the right-hand side of the equation which lead to endogeneity problem in this estimator. Therefore, modeling such panel data using OLS or GLS estimators (fixed effect and random effect models) cannot solve the endogeneity problem. The fixed effect model based on OLS estimator is said to be biased downward. Meanwhile the random effect model which is solved using the GLS estimator by quasi-demeaning the all the variables also does not remove out the individual effect hence, does not solve this issue. In addition, the random effect model is also said to be both downward and upward bias. Next, Anderson and Hsiao (1981) derive a solution, which introduces the Instrumental Variable (IV) estimator to solve the inefficiency issue of the static models discussed above. The IV estimation approach tends to solve the endogeneity issue by first differencing the equation to eliminate the individual effects. The estimation approach makes use of all the past information of Y_{it} for instruments and structures the error terms to get consistent estimates. In the next step, twice-lagged instrumental variable is included which applies the 2SLS technique, thus leading to the formation of the following instrument matrix in equation 4.31:

$$Z_i = \begin{bmatrix} y_{i,1} \\ \vdots \\ y_{i,T-2} \end{bmatrix} \tag{4.31}$$

In a way, the IV estimation approach tries to identify the best candidates for Z which are the moment condition. The best candidate or instrument in this respect may come from the dependent variable itself which is lag 2 or simply y_{it-2} as an instrument for $\Delta_{i,t-1} = (y_{i,t-1} - y_{i,t-2})$. Therefore, this instrument will not correlate with the error term $\Delta v_{it} = v_{it} - v_{i,t-1}$ as long as there is no serial correlation in v_{it}. The instrument variable in this context, plays a key role to eliminate the issue of endogeneity in the estimation. Hence, the IV estimator is consistent, but not necessarily efficient estimate, because it only provides one instrument. In this respect, one moment condition proposed in the IV estimator does not consider the different structure of the residual disturbances, which are Δv_{it}, in order to solve the endogeneity problem. Therefore, it does not fully utilize all the available moment conditions (Ahn & Schmidt, 1995).

4.3.2 Generalized Method of Moments (GMM)

In order to overcome the issue of limited moment condition highlighted in the IV estimation, Arellano (1989) suggests that the simple dynamic error component model which utilizes the first different form of lag 2, which is, $\Delta y_{i,t-2}$ as the instrument instead of the level form which is $y_{i,t-2}$ that has a singularity point and large variances. Hence, first difference form of $y_{i,t-2}$ is suggested as the instrument due to non-singularity and much lower variances. The GMM model is advantageous over the earlier Instrumental Variables (IV) approach introduced by Anderson and Hsiao (1981), as the IV model does not fully utilize past information available in the sample (the moment conditions).

The first approach in the dynamic panel data, Generalized Method of Moments (GMM), is the first difference GMM estimator. This approach, which is introduced by Arellano and Bond (1991) and Arellano and Bover (1995), actually popularized the work of Eakin, Newey and Rosen (1988). In the Arellano and Bond estimations, a generalized method of moments is set where the model is specified as a system of equations, one for each time period. For this purpose, the instruments for each equation differ. The additional moment of conditions is expressed in the following matrix reflected in equation 4.32.

$$Z_i = \begin{bmatrix} y_{i1} & 0 & 0 & \dots & 0 & \dots & 0 \\ 0 & y_{i1} & y_{i2} & \dots & 0 & \dots & 0 \\ . & . & . & \dots & . & \dots & . \\ 0 & 0 & 0 & \dots & y_{i1} & \dots & y_{i,T-2} \end{bmatrix} \tag{4.32}$$

In the above matrix, Z_i, each row is associated with the first different equation for the period t=3,4,T, thus exploiting the moment condition $E[Z_i' \Delta v_i] = 0$. Where *i=1,2,…,N*. As stresses in (Hansen, 1982), an advantage of the GMM estimator is that it minimizes the difference between the sample moments and their values in probability.

Consider the following simple AR (1) model:

$$Y_{it} = \beta_0 + \beta_1 Y_{it-1} + [\lambda_i + \mu_i + v_{it}] \tag{4.33}$$

In equation 4.33, Y_{it-1} where the independent variable correlates with the specific effect μ_i thus leading to what is commonly called as endogeneity problem. Anderson and Hsiao (1981); Arellano and Bond (1991); and Arellano and Bover (1995) tackle this issue by first differencing the variables which removes λ_i as shown in the following equations.

$$\Delta\varepsilon_{it} = \Delta v_{it} = v_{it} - v_{it-1} \quad (4.34)$$

$$Y_{it} - Y_{i,t-1} = \beta_1\left(Y_{i,t-1} - Y_{i,t-2}\right) + \left(v_i - v_{i,t-1}\right) \quad (4.35)$$

Transformation of the regressors into first difference, form eliminates inefficiency, in the estimation, due to omitted variables and fixed country specific effects. An alternative approach for transformation besides first difference is forward orthogonal deviations as proposed in Arellano and Bover (1995) who preserve the sample size in panels with gaps. The purpose is to fine tune the instrumental variables in the instrument matrix. Since lags are used as instruments in difference GMM, Arellano and Bond (1991) offer a diagnostic test to confirm the absence of second order serial correlation in the disturbances because the consistency of the GMM estimator depends on whether $E\left[\Delta v_{it}\Delta v_{i,t-2}\right] = 0$.

The moment conditions used in Difference GMM estimator are expressed in the following equations 4.36 and 4.37 respectively.

$$E\left[y_{i,t-s}\left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \; for \; s \geq 2; t = 3, \ldots., T \quad (4.36)$$

$$E\left[X_{i,t-s}\left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0; for \; s \geq 2; \; t=3, \ldots., T \quad (4.37)$$

Nevertheless, the main issue with difference GMM is associated with weak instrument due to the use of lagged levels of y_{it} as instruments for equations in the first difference GMM estimator which was highlighted in Nelson and Starts (1990) and Staiger and Stock (1997). To overcome this problem, Blundel and Bond (1998) who extended the idea of Arellano and Bover (1995) suggests a system consists of two equations called System GMM. In order for System GMM to hold valid, a further assumption is required, which suggests that there is no correlation between the first difference instrument variables and the fixed effects. In System GMM, the choice of instruments increases where additional instruments which are the lagged differences of y_{it} are used as instruments for equations in levels to complement the instruments in the form of lagged levels of y_{it} which are used as instruments in the equations at first difference. These additional moment conditions in System GMM are expressed in the following equations 4.38 and4.39.

$$E\left[(y_{i,t-s} - y_{i,t-s-1})(\lambda_i + \varepsilon_{i,t})\right] = 0; \text{ for s=1} \tag{4.38}$$

$$E\left[(X_{i,t-s} - X_{i,t-s-1})(\lambda_i + \varepsilon_{i,t})\right]=0; \text{ for s=1} \tag{4.39}$$

The System GMM is basically a combination of the equations at levels and first difference. In a way, in System GMM the number of moment conditions are larger than that found in the first difference GMM which may increase the efficiency gains when compared to the difference GMM estimator. These improvements particularly work when the period of data observation is short and persistent or following random walk. Despite the improvement in the precisions of the estimator, System GMM also tackles the problem of finite sample bias. A careful examination of System GMM can overcome many loopholes found in the standard GMM estimators (Blundell, Bond & Windmeijer, 2000). In addition, Hahn (1999) evidenced that efficiency gains from System GMM is high.

The GMM estimators come in two variants, one step and two steps. Theoretically, the two steps estimator is more efficient than the one step estimator as it applies optimal weighting matrices. The two-step estimator involves correction for the two step covariance matrix to deal with finite sample bias (Windmeijer, 2000). Nonetheless, empirical studies show that two steps GMM estimator may lead to inaccurate estimates (Bond & Windmeijer, 2002).

4.3.3 Diagnostic tests for validity of instruments in GMM model

The reliability and consistency of the GMM estimators discussed above in the difference and system GMM estimators depend upon the outcomes from three important statistical tests, namely serial correlation tests in disturbances proposed in Arellano and Bond (1991); Sargan test of over-identifying restrictions (Sargan, 1958) and Hansen (1982) J-test Statistics. It is important to note that the validity of the instruments used in the GMM estimators can be examined from the degree of serial correlation of idiosyncratic disturbances of the error term, ε_{it} . Based on this test, there are two orders of autocorrelation namely AR(1) and AR(2) respectively. The null hypothesis for both AR(1) and AR(2) serial correlation test is that the disturbances are not serially correlated. In practice, AR(2) is closely monitored and the hypothesis should not be rejected. Meanwhile, AR(1) should be rejected as the disturbances are serially correlated based on AR(1) test.

Next, due to the issue of instrument proliferation as the size of time period, T grows, it is crucial to examine validity of the instruments used in the selected GMM estimators. For this purpose, Arellano and Bond (1991) suggest Sargan (1958) test for identifying restrictions which is given in difference GMM as indicated in equation 4.40 below:

$$m = \Delta\widehat{v}'W\left[\sum_{i=1}^{N} W_i'(\Delta\widehat{v}_i)(\Delta\widehat{v}_i)'W_i\right]^{-1} W'(\Delta\hat{v}) \sim X^2_{p-K-1} \qquad (4.40)$$

Where p refers to number of columns of matrix instruments, (W) while, $\Delta\hat{v}$ refers to the residuals from the Two Step, difference GMM estimator. In One Step, GMM estimators, Sargan test statistics is reported. As for the two step GMM estimator, Hansen J test statistic is reported. Both the Sargan test statistic and Hansen J test statistic are given by the chi square values. A high value of chi square indicates the non-rejection of the null hypothesis thus denoting that over-identifying restriction are valid. Therefore, all the instruments are valid and the models are correctly specified. Meanwhile, the rejection of the null hypothesis signifies that some of the instruments are indeed invalid thus leading to misspecification of the model. We report the Sargan test statistic when disturbances are homoscedastic, but the Hansen-*J* test statistic when disturbances are not homoscedastic.

Having discussed the process of development of GMM estimator which leads to the selection of the System GMM estimator, it is of particular important to highlight the general conditions where the two estimators should be applied.

i. The nature of the data is characterised by short time period *T*, and large cross section or individuals (n).
ii. Linear functional relationship;
iii. A dynamic single left hand side variable which depends on its own past values or lags;
iv. The presence of fixed individual effect which implies the presence of unobserved heterogeneity;
v. Heteroscedasticity and autocorrelation within individual unit' errors but not across them;
vi. Independent variables, which are denoted by vector X_{it} are predetermined, though not strictly exogeneous.

4.4 Data descriptions for technical efficiency and productivity growth analysis

In economics' theory of production, firms utilize inputs to generate outputs. The term "input" is used interchangeably with other terminologies such as resources, or factors of productions. All the three terminologies are common terminologies found in economics textbooks and other writings related to economics. These terminologies are similar in meaning. However, in this study, the term “input” will be used because the term is also commonly applied in DEA which is chosen as the main methodology used in calculating technical efficiency and productivity of airlines. Basic theory of production classifies factors of production as they consist of land (natural resources), labour and capital (Heathfield, 1971; Salvatore, 2009). These general classifications of inputs formed the basis for selection of input categories to be used in evaluations of technical efficiency and productivity change based on DEA.

Input variables, in this study, are based on major functional costs incurred by airlines as specified in James (1982). According to this specification, flying operations forms the largest portion of airline costs. Hence, input variables in this study, include those inputs which are significantly used in the operation of an airline company. Based on James (1982) specification of inputs, it is decided that input variables consist of total operating costs and number of operating fleet. Meanwhile, output variables for this study are proxy by total operating revenues and revenue passenger kilometer (RPK). Measurements of input and output variables in this study follow the measures specified by the International Civil Aviation Organization (ICAO). For more detail of definitions with respect to each input and output variables for DEA estimations of technical efficiency and productivity change in this study, please see ICAO (2002) on “Reporting Instructions for Financial Data in Form EF of the ICAO Digest of Statistics”.

The list of inputs and outputs used for the DEA estimations of technical efficiency and productivity change are portrayed in table 4.1. Next, table 4.2 gives a picture of the characteristics of inputs and outputs variables for full carriers and low cost carriers in the sample of study throughout the period 2002 to 2011. Most of the financial data can be obtained from ICAO Digest of Statistics and are reported in US dollar. Some airlines do not consistently report their financial statistics data for examples labour cost, fuel cost and total operating revenues to ICAO, thus leading to missing data for certain years of observations. In order to supplement these missing data, we have to depend on annual reports to provide the data. However, annual reports only present data in the national currency thus leading us to no choice but to convert the data from local currency to US dollar. The conversion of local currency to US dollar is done using the purchasing power parity index which is obtained from the Penn World table as applied in Assaf and Josiassen (2012). The PPP index overcomes the problem associated with changes in exchange rate and real price level (Oum & Yu, 1995). The table exhibits that on average, full cost carriers consumed considerable inputs which are translated into larger outputs compared to low cost carriers which utilized much lower inputs, thus producing a lower level of outputs as well.

Table 4.1: List of inputs and outputs, unit measurements and symbols for DEA technical efficiency and productivity change analyses

Variable	Unit measurement	Symbol
Operating cost	million US dollar	OPCOST
Operating fleets	Number of fleets	OPFLEET
Operating revenues	million US dollar	OPEREV
Revenue passenger kilometer	'000 RPK	RPK

Table 4.2: Descriptive statistics for 56 sample of world airlines, 2002-2011 (in million US dollar except for OPFLEETS)

Groups	Number of airlines		OPCOST (million US dollar)	OPFLEETS	OPEREV (million US dollar)	RPK
Full cost Carrier	43	Mean	2876.8	143	6158.1	58119
		Minimum	30.7	7	74.6	794
		Maximum	22135.0	806	35230.0	425640
		Standard Deviation	3166.9	145.3	6068.9	67708
Low Cost Carrier	13	Mean	1059.3	106	2148.6	25341
		Minimum	9.1	3	22.2	130
		Maximum	10015.0	564	15658.0	157040
		Standard Deviation	1536.8	123.11	2542.0	29594

Note: OPFLEETS = Operating fleets; OPEREV = operating revenues; RPK= Revenue Passenger Kilometer; OPCOST=operating costs

The input and output variables used in this study are defined as follows:

Operating costs in this study are defined as the sum of fuel costs and labour costs stated in the local currency of country origin of the airline. The rationale of combining the two types of costs is because fuel costs and labour costs comprises of about 50 % of the total operating cost of airlines (Doganis, 2006).

Fuel costs refer to jet fuel costs incurred by an airline company for one year provision of passenger or freight services measured in the currency of the respective airline's country of origin. These costs include throughput chargers, non-refundable duties, and taxes for providing the jet fuel to end user which is the airline company. These costs can differ significantly from other airline companies depending on their management ability to gain from hedging of fuel price.

Labour costs are defined as the total costs of full time employment incurred by an airline company for one year financial period measured in the local currency of the respective airline's country of origin. These costs included bonus payment, other remunerations, and pensions.

Operating fleets refer to the total number of aircraft assets that the company has in its fleet for one-year financial period including aircrafts where the airline company have ownership and those leased from other parties. Operating fleet also reflects the major capital input which is very important for the provision of passenger or freight services. This type of capital is very important as it involves main input used in the production process of passenger or cargo outputs.

Operating revenue is defined as the total revenue received by an airline company in one annual financial period stated in the local currency of the airline company. Those revenues comprise of the sum of revenues generated by scheduled, non-scheduled services, and other operating revenues which relate to non-core transport related activities.

Revenue passenger kilometer (RPK) refers to an annual total product of the number of passengers carried on each flight stage and stage distance (kilometer flown). RPK is obtained by multiplying the total number of passenger in each flight stage by the distance flown in each flight stage. This indicator shows the annual travel distance (in kilometre) by all passengers. This variable is stated in the non-financial form.

Outputs for the study are proxy by total operating revenues and revenue passenger kilometer (RPK) as discussed above. The former refers to common outputs employed in many DEA studies related to airlines for instances Good et al. (1993); Wong and Chen (2005); Assaf and Josiassen (2009); Assaf (2011); Min and Joo (2016) as they reflect both passenger and cargo outputs which are among the characteristics of airlines in the sample of this study. Meanwhile the latter type of output has been extensively applied in many studies using DEA to benchmark airline efficiency and productivity, for instance Fethi and Jackson (2000); Scheraga (2004a); Assaf and Josiassen (2012); Scotti and Volta (2015); Tavassoli et al. (2016); Duygun et al. (2016). Despite acknowledging that airlines' revenues can be decomposed into passenger and freight revenues, in this study the aggregated revenues which comprised total passenger and freight revenues is used because the sample in this study comprised both full service (which carries both passenger and freight) and low costs carriers which considerably focus on the passenger business. In the case of low cost carriers, freight revenue is not reported as single item in the income statement of the respective airlines but rather it is grouped with other forms of revenues in the annual report due to its insignificant contribution to the share of total operating revenues. Due to inconsistency in reporting revenues between full cost and low cost carriers, total operating revenue is used as an alternative measure to specific outputs related to passenger and freight operations.

Hence, this study employs two inputs and two outputs to generate the technical efficiency and productivity change scores using the DEA and the Malmquist Productivity Index approaches. The total number of inputs and outputs are restricted to 4 so as to maintain a certain degree of discretionary power (Coelli, 1996d). The inputs and outputs variables for estimating the technical efficiency and productivity growth of airlines in this study comprises both data types-operational (traffic) and financial data of scheduled operations of selected airlines across all regions in the world spanning from 2002-2011.

The total sample of airlines in this study is 56 which consists of airlines from two business models namely full cost carriers and low cost carriers. The sample of full cost carriers comprises of 43, whilst the sample of low cost carriers comprises of 13. Full cost carriers in this sample of study carry mostly passengers and a certain portion of freights. Whereas low cost carriers mostly carry passengers. Freight is rarely carried by low cost carriers and if they offer the service, the proportion of freight carried is very low compared to passenger output. Cargo airlines are not included in this study because it is a totally different business model which belongs to neither type of the two carriers. Other characteristic of airlines in the sample including operates of both domestic and international business segments. The airlines in the sample also consisted of multiple scales of operation ranging from an airline with operating revenue as low as USD$222.4 million to an airline with operating revenues as large as USD$ 35.2 billion. The number of airlines in the sample used for the study is 56 and the sample is observed for the period of 10 years. Although the number of sample airlines in the study is 56 which is far less than total 437 airlines in Air Transport World membership, however the number is justifiable as the total sample represents about 75 percent of the total operating revenue of airlines which are members of Air Transport World in 2011.

In addition, the total sample of airlines used for this study is more than sufficient for the DEA methodology to provide a high degree of discretionary power in the efficiency and productivity scores when using the combination of 2 inputs and 2 outputs variables.

The sample size is justifiable in order for the DEA estimator to perform efficiently because it meets the requirement as stated in Ramanathan (2003) where the minimum number of decision making units (airline companies) have to be at least two times larger the sum of inputs and outputs. Even if common DEA convention is prescribed which argues that minimum number of decision making units shall be three times larger than the total input and output (Dyson et. al., 2001; Raab and Lichty, (2002); Barros and Peypoch, (2009); Lee and Worthington (2014), the sample size employed is still sufficient and efficient for employing the DEA technique. The total observations for full cost carriers are 430> 3(2+2), and low cost airlines are 130>3(2+2) respectively which meet the requirement that the total sample is 3 times larger than the sum of input and output. The airline sample in this study is selected based on availability and accessibility of data or what is known as convenience sampling in statistics. Major sources of input and output variables for the study are obtained from the annual reports of various years for individual airlines from 2002 to 2011, International Civil Aviation Organization (ICAO) Digest of Statistics (printed and online version), and Air Transport World (ATW) Financial Reports. The process of estimations of technical efficiency and productivity growth scores and related input and output variables involved are clearly presented in figure 4.1 below.

Figure 4.3 shows the framework involved in the first stage analysis to estimate the technical efficiency and productivity change of 43 full cost carriers and 13 low cost carriers. Using the metafrontier Data Envelopment Analysis (DEA) framework, each airline utilizes 2 type of inputs comprising operating costs and operating aircraft (capital) to generate 2 outputs which are revenue passenger kilometer (RPK) and operating revenue to generate technical efficiency and total factor productivity estimates. The technical efficiency score is estimated by using the 1-Stage DEA model, whilst the total factor productivity scores are generated by running the metafrontier DEA-Malmquist productivity index model.

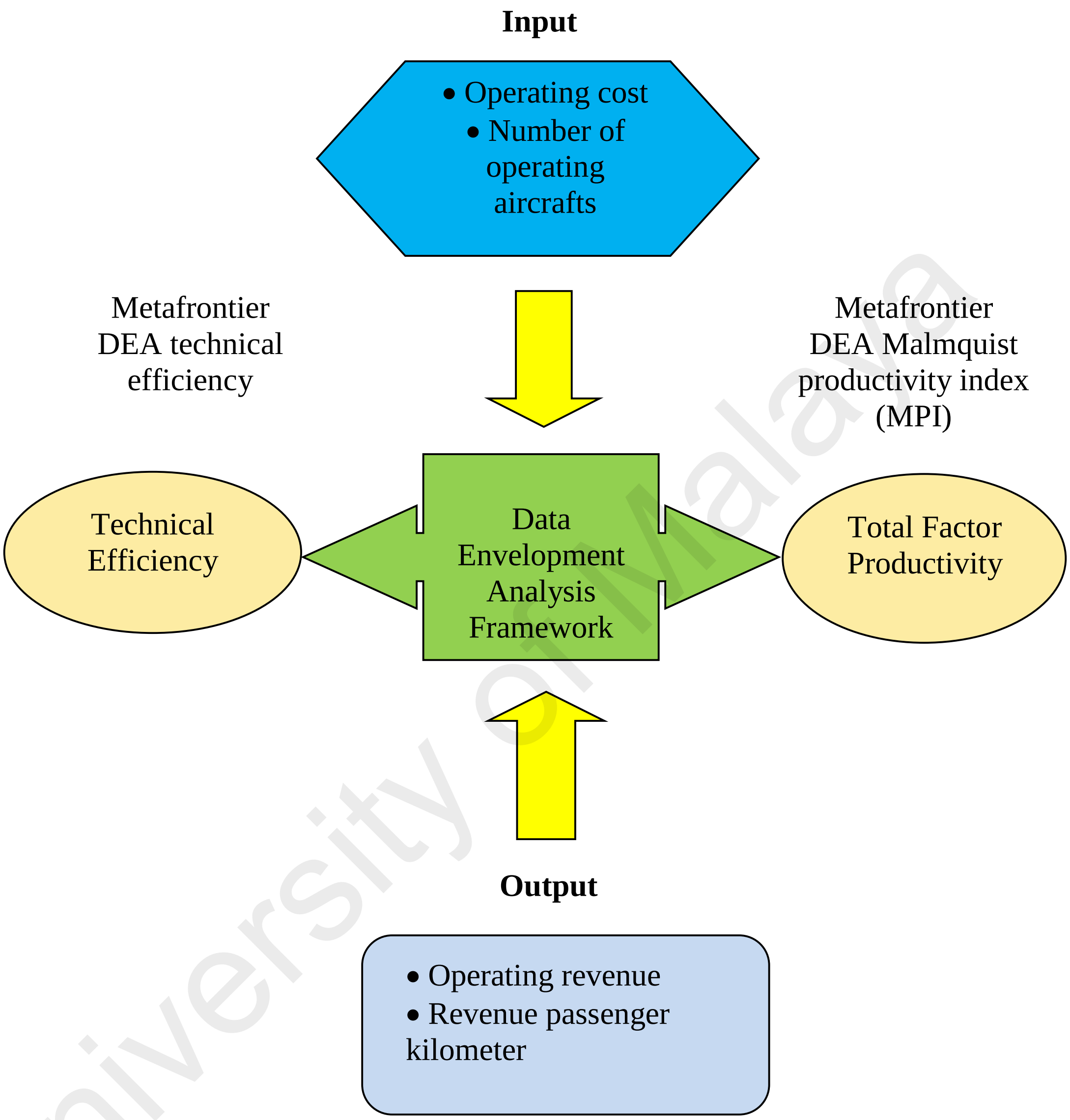


Figure 4.3: Illustration of DEA process to calculate the technical efficiency and productivity growth

Source: Adapted from Mandl et al. (2008)

4.5 Data descriptions for dynamic panel data GMM estimations

This section aims to investigate the influences of extent of outsourcing and economic development levels on technical efficiency and productivity change in selected global airline companies. Table 4.3 indicates the details of variables such as unit measurements, and symbols used in the GMM estimations. Meanwhile, the descriptive statistics summary of the data for GMM estimations are presented in table 4.4.

Table 4.3: List of variables, measurements and symbols for the GMM estimations

Variable	Unit measurement	Symbol
Technical efficiency score	Percentage (0-1)	MTECHEFF
Productivity change score	>0	GMMPI
Passenger load factor	Percentage (0-1)	PLF
Available seat kilometer	‘000 ASK	ASK
Revenue passenger kilometer	‘000 RPK	RPK
Extent of outsourcing	USD ‘000	OSRC
Economic development level	Percentage (0-1)	HDI
Control of corruption	-2.5 to 2.5	GOV1
Government effectiveness	-2.5 to 2.5	GOV2
Political stability and absence of violence/terrorism	-2.5 to 2.5	GOV3
Regulatory quality	-2.5 to 2.5	GOV4
Rule of law	-2.5 to 2.5	GOV5
Voice and accountability	-2.5 to 2.5	GOV6

Table 4.4: Descriptive statistics of data for 53 airlines used the GMM estimations, 2003-2011

Year	Variable	Mean	Standard Deviation	Min	Max
2003	MTECHEFF	0.558	0.180	0.202	0.905
	GMMPI	1.070	0.391	0.636	3.125
	PLF	0.712	0.058	0.577	0.845
	ASK (‘000)	55400	75000	989	354000
	RPK (‘000)	40400	56000	703	270000
	OSRC	0.229	0.094	0.040	0.414
	HDI	0.808	0.127	0.320	0.920
	GOV1	1.160	1.005	-0.960	2.480
	GOV2	1.207	0.825	-0.870	2.264
	GOV3	0.193	0.845	-2.118	1.664
	GOV4	1.058	0.803	-1.175	1.935
	GOV5	1.033	0.866	-0.933	1.964
	GOV6	0.720	0.914	-1.541	1.565
2004	MTECHEFF	0.573	0.184	0.209	1.000
	GMMPI	1.064	0.202	0.717	2.066
	PLF	0.721	0.059	0.579	0.861
	ASK (‘000)	60000	79000	1546	376000
	RPK (‘000)	44400	60700	896	298000
	OSRC	0.221	0.087	0.029	0.409
	HDI	0.812	0.125	0.330	0.930
	GOV1	1.164	1.032	-1.059	2.527
	GOV2	1.276	0.860	-0.732	2.210
	GOV3	0.108	0.839	-1.869	1.590
	GOV4	1.084	0.808	-0.958	1.991
	GOV5	1.012	0.847	-0.864	1.988
	GOV6	0.812	0.929	-1.455	1.807
2005	MTECHEFF	0.566	0.181	0.195	1.000
	GMMPI	0.994	0.143	0.596	1.325
	PLF	0.742	0.052	0.622	0.876
	ASK (‘000)	64100	79200	1545	364000
	RPK (‘000)	48700	62500	960	297000
	OSRC	0.204	0.083	0.022	0.399
	HDI	0.818	0.124	0.339	0.935
	GOV1	1.054	0.965	-1.040	2.350
	GOV2	1.175	0.804	-0.885	2.158
	GOV3	0.166	0.839	-1.760	1.590
	GOV4	1.081	0.772	-1.107	1.854
	GOV5	1.018	0.863	-0.905	1.954
	GOV6	0.771	0.909	-1.496	1.700
2006	MTECHEFF	0.548	0.164	0.163	0.936
	GMMPI	0.983	0.104	0.655	1.208
	PLF	0.877	0.915	0.607	7.405
	ASK (‘000)	66600	78500	1543	371000
	RPK (‘000)	51700	62700	1025	304000
	OSRC	0.195	0.075	0.023	0.401
	HDI	0.823	0.121	0.356	0.938
	GOV1	1.022	0.947	-0.849	2.553
	GOV2	1.205	0.776	-0.574	2.176
	GOV3	0.336	0.844	-2.040	1.496
	GOV4	1.100	0.796	-0.967	1.955
	GOV5	1.059	0.883	-0.931	1.960
	GOV6	0.644	0.928	-1.682	1.603

‘Table 4.4 continued’

Year	Variable	Mean	Standard Deviation	Min	Max
2007	MTECHEFF	0.554	0.164	0.204	0.952
	GMMPI	1.033	0.128	0.434	1.443
	PLF	0.763	0.055	0.613	0.874
	ASK (‘000)	70100	78300	1768	367000
	RPK (‘000)	55000	63700	1186	304000
	OSRC	0.227	0.240	0.021	1.851
	HDI	0.828	0.117	0.378	0.938
	GOV1	1.025	0.956	-0.950	2.471
	GOV2	1.230	0.752	-0.462	2.373
	GOV3	0.283	0.869	-2.426	1.495
	GOV4	1.074	0.773	-0.909	1.996
	GOV5	1.054	0.881	-0.949	1.959
	GOV6	0.643	0.919	-1.662	1.582
2008	MTECHEFF	0.534	0.141	0.201	0.800
	GMMPI	0.999	0.255	0.694	2.686
	PLF	0.763	0.055	0.647	0.870
	ASK (‘000)	73200	78300	2056	352000
	RPK (‘000)	57000	63100	1349	285000
	OSRC	0.182	0.070	0.030	0.358
	HDI	0.832	0.116	0.394	0.937
	GOV1	1.023	0.977	-1.050	2.411
	GOV2	1.200	0.757	-0.700	2.430
	GOV3	0.317	0.886	-2.571	1.446
	GOV4	1.077	0.801	-0.843	1.976
	GOV5	1.063	0.891	-0.977	1.957
	GOV6	0.654	0.923	-1.644	1.584
2009	MTECHEFF	0.540	0.128	0.195	0.857
	GMMPI	1.002	0.139	0.800	1.377
	PLF	0.757	0.059	0.606	0.874
	ASK (‘000)	71700	72700	1886	318000
	RPK (‘000)	55800	59000	1193	261000
	OSRC	0.200	0.076	0.040	0.381
	HDI	0.833	0.113	0.403	0.937
	GOV1	0.964	0.990	-1.088	2.303
	GOV2	1.141	0.748	-0.779	2.281
	GOV3	0.231	0.861	-2.627	1.425
	GOV4	1.019	0.768	-0.916	1.853
	GOV5	1.067	0.869	-0.842	1.974
	GOV6	0.650	0.912	-1.657	1.579
2010	MTECHEFF	0.562	0.138	0.201	0.830
	GMMPI	1.055	0.103	0.847	1.368
	PLF	0.780	0.056	0.610	0.892
	ASK (‘000)	78000	88100	1843	505000
	RPK (‘000)	62700	74000	1226	424000
	OSRC	0.197	0.072	0.037	0.350
	HDI	0.837	0.112	0.409	0.939
	GOV1	0.962	0.988	-1.071	2.319
	GOV2	1.166	0.763	-0.759	2.255
	GOV3	0.255	0.839	-2.673	1.393
	GOV4	1.038	0.775	-0.852	1.908
	GOV5	1.092	0.883	-0.768	1.977
	GOV6	0.658	0.916	-1.632	1.637

‘Table 4.4 continued’

Year	Variable	Mean	Standard Deviation	Min	Max
2011	MTECHEFF	0.541	0.129	0.215	0.763
	GMMPI	1.008	0.123	0.639	1.435
	PLF	0.785	0.085	0.604	1.206
	ASK (‘000)	83300	89600	1933	513000
	RPK (‘000)	66900	74100	1219	426000
	OSRC	0.190	0.080	0.040	0.490
	HDI	0.841	0.110	0.422	0.941
	GOV1	0.955	0.971	-1.052	2.222
	GOV2	1.147	0.753	-0.811	2.258
	GOV3	0.338	0.860	-2.812	1.375
	GOV4	1.043	0.776	-0.987	1.913
	GOV5	1.073	0.875	-0.909	1.956
	GOV6	0.660	0.907	-1.578	1.673

Data on extent of outsourcing which will be used in the regression analysis is obtained from annual reports of individual airlines and ICAO database. In this study context, extent of outsourcing is measured by the ratio of labour costs (US dollar) to total operating costs incurred by an airline company for one year according to the financial period for each airline company. It is worth revealing that secondary data on the actual amount of activities outsourced is limited and confidential based on the researcher’s experience in collecting actual data from the individual airline company. It is also agreed that the degree of airline outsourcing is difficult to measure based on published data (Morrison & Mason, 2007). It is also not known, if there is any initiative from consulting company to compile data on outsourcing at a global scale. Even if there is any, it would be costly to secure the data. Due to these limitations, this study utilizes common proxy for measuring the extent of outsourcing by taking the ratio of labour cost to total cost as applied in past studies for example Morrison and Mason (2007); Walter[2], (2007); and Tayeb (2012). A higher proportion of labour cost over total costs indicates that the company outsources less of its

[2] In this research, the author used costs of material outsourcing to reflect the intensity of outsourcing in Germany public transports. However, in the case of airlines, many companies do not publish specific data on material costs annually, thus leaving the researcher with the only available data on labour costs.

operations. Whereas, a lower proportion of labour cost signifies that the company is likely to outsource its operations.

Meanwhile, Human Development Index (HDI) which is the proxy for economic development level is obtained from the United Nations Human Development Report of various years. The index has been introduced in 1990 to replace a relatively weak yet common indicator of development by using GDP per capita per se. HDI is an indicator of development level of a nation which is formed from the composite of three components of important indicators to development which are (i) life expectancy (measured by life expectancy at birth), (ii) adult literacy (measured by expected years of schooling and mean years of schooling) and (iii) Per capita GNI, expressed in Purchasing Power Parity. The HDI index provides inter country development level in comparison. For detail computation and formulation of HDI and its components, one may refer the formulas provided in Nafziger (2005).

Next, the quality of institution is introduced as one of the variables to be interacted with HDI. In this respect, quality of institution variable is proxied by governance indicators of the respective country where the airlines are originated from which were produced by Kaufmann et al. (2008) and publishes by the World Bank annually in the World Governance Indicators (WGI) database. Governance indicators have been widely applied as the proxy for the quality of institution in many studies in the fields of economics among others Ott (2010); Debnath and Shankar (2014); Naghvi and Lau (2014) to name a few. Furthermore, according to Kaufmann, Kraay and Masttuzzi (2005), the precision of the governance indicators provided in the WGI databased have been improved by the increase in the number of independent data sources. In addition, availability of the data on annual basis reflects the time varying characteristic of the indicators which is useful for panel data analysis. The World Bank defines governance as the exercise of power in managing the economy and the resources. In addition, Kaufmann, Aart, and Massimo (1999) and Kaufmann, Kraay, and Mastruzzi (2008) defines governance as traditions and institutions by which authority in a country is exercised. In this study, the quality of governance is measured by each six key elements in the governance indicators produced by Kaufmann et al. (2008) including voice and accountability, political stability and lack of violence, government effectiveness and regulatory quality, rule of law and control of corruption.

The aggregate data for six dimensions stated above reflect the views of broad groups of enterprise, citizen and expert survey respondents in both developing and industrial countries. The data mentioned above are obtained from 30 individual data sources including those provided by survey institutes, think-tanks, non-governmental and international organizations and private sector firms. The score for each dimension ranges from -2.5 to 2.5, a higher value which indicates better governance level.

Voice and accountability reflect the extent of participation of a country's citizen government selection process, freedoms in expression of voice, association and media. Next, political stability and absence of violence refer to potentiality for destabilizing of government and administration resulting from unconstitutional and violent practices including domestic violence and terrorism. Meanwhile, government effectiveness refers to the qualities of public and civil services, policy formulations implementations and the extent of independency from political influences. Regulatory quality, on the other hand, measures how capable the government, in terms of formulating and implementing sound policies, thus, promoting the private sector development.

In addition, next dimension which is captured by rule of law pictured the society's confidence and obedience over the rules in the country, particularly respect in institutions such as police, courts and safety aspects of the country in terms of being free from crime and violence. Finally, control of corruption is defined as misuse of public power for personal gain including petty[3] and grand[4] forms of corruptions.

It is also crucial to introduce the interaction variables which will be used in the GMM estimations to indicate how outsourcing and economic development level can improve the technical efficiency and productivity change in the sample of airlines studied. Therefore, for this purpose, revenue passenger kilometer which was defined in section 4.3 is used as an interaction variable for the extent of outsourcing in airlines. Revenue passenger kilometer in the GMM estimation is used to indicate the size of airline companies which is reflected by total revenue generated from the core business of airline companies, which in this study context, is passenger revenues. Median score for revenue passenger kilometer is calculated from the data of samples of 53 airlines. From the median score, the airline samples are grouped into small and large scale. The RPK values which are less than the median score, are considered as small size airlines, whereas, RPK values which exceed the median score are categorized as large scale.

[3] The type of corruption which involves a small amount of money, minor favours, employment of friends and relatives in minor positions.

[4] The type of corruption which involves top levels of management of a country which is very serious as it involves erosion of confidence in the governments, rule of law, and most importantly the economic stability of the country.

Meanwhile, governance indicators which were discussed in section 4.5 are used as an interaction variable for economic development level. In this situation, good institution act as catalyst for economic growth. Therefore, the incorporation of institutional factors plays a pivotal role in influencing the increase in income, economic growth, and development (Knack & Keefer, 1995; Siddiqui & Ahmed, 2013). In addition, Bloom, Canning and Sevilla (2004) assert that high quality of governance has a positive association with total factor productivity or GDP growth of a country. Hence, in this study, the sample of airlines is divided into low and high governance quality of airlines of the origin country. Determination of low and high governance quality for each of the six governance dimensions follows the technique for grouping of airlines based on size of the company using median as the reference point. The sample of airlines which are lower than the median point of governance quality for specific governance dimension is grouped as airlines for low governance and the reverse holds true.

In addition to main variables of our interest, we include other variables such as passenger load factor, available seat kilometer, and revenue passenger kilometer to control for the quality, capacity, and size of the respective airlines in the GMM estimation. These variables are commonly found in various econometric estimations, which investigate sources of efficiency and productivity in airlines.

4.6 Specification of model

The study develops four models based on one step System GMM estimator to explain the following relationships in the airline sample:

i. extent of outsourcing activities with dependent variables namely technical efficiency and productivity change in the contexts of group of small scale sample of airline and large scale airlines;
ii. economic development level with dependent variables namely technical efficiency and productivity change in the context of groups of low quality of governance and high quality of governance from where the airline sample are originated.

These relationships between metafrontier technical efficiency, MTECHEFF and outsourcing, OSRC with respect to small scale and large scale airlines are specified in original form as follows:

$$MTECHEFF_{it} = \beta_0 + \ \beta_1 MTECHEFF_{it-1} + \beta_2 OSRC_{it} + \beta_3 (OSRC_{it} X\ RPK_{it}) + \beta_4\ X_{it} + \varepsilon_{it} \qquad (4.41)$$

Meanwhile the relationship between MMPI and OSRC with respect to small scale and large scale airlines are modeled as follows:

$$MMPI_{it} = \beta_0 + \beta_1 MMPI_{it-1} + \beta_2 OSRC_{it} + \beta_3 (OSRC_{it} X\ RPK_{it}) + \beta_4 X_{it} + \varepsilon_{it} \qquad (4.42)$$

On the hand, the relationship between metafrontier technical efficiency, MTECHEFF and economic development, HDI with respect to low quality governance and high quality governance of six dimensions in the governance indicators are specified as follows:

$$MTECHEFF_{it} = \beta_0 + \beta_1 MTECHEFF_{it-1} + \beta_2 HDI_{it} + \beta_3 \left(HDI_{it} X\ GOV_{it}\right) + \beta_4 X_{it} + \varepsilon_{it} \quad (4.43)$$

Finally, the relationship between productivity, MMPI and economic development, HDI with respect to low quality and high quality governance of six dimensions of governance indicators are specified as follows:

$$MMPI_{it} = \beta_0 + \beta_1 MMPI_{it-1} + \beta_2 HDI_{it} + \beta_3 (HDI_{it} X\ GOV_{it}) + \beta_4\, X_{it} + \varepsilon_{it} \quad (4.44)$$

All the symbols corresponding to the variables expressed in equations 4.41 to 4.44 are as explained in tables 4.1 to 4.4 in sections 4.3 and 4.4 above. The subscript t gives the time period covered from 2003 to 2011. The term $(OSRC_{it} X\ RPK_{it})$ shows the interaction for the extent of outsourcing with the size of airlines viz. small and large scale groups of airlines as measured by the passenger revenues for each airline. The expected sign of the coefficient for the interaction effect between outsourcing and scale of the airline is positive for the sample of small scale airline. The term X_{it} represents the set of other explanatory variables for modeling outsourcing influence on the efficiency and productivity growth of airlines in equations 4.1 and 4.2 which are given by passenger load factor, available seat kilometer, and revenue passenger kilometer respectively. These variables are commonly used as control variables in examining the determinants of efficiency and productivity growth of airlines. Passenger load factor which reflects the service quality of airline is expected to relate positively to both technical efficiency and productivity of airlines. Next, capacity or measure of supply for airlines which is denoted by available seat kilometer is also expected to associate positively with technical efficiency and productivity of airlines. Meanwhile, revenue passenger kilometer which is the proxy to control the demand for air travel associates positively with technical efficiency and productivity of airlines.

On the other hand, the term $(HDI_{it}X\ GOV_{it})$ gives the interaction for economic development level with the quality of country governance, namely low and high quality of governance. The interaction of economic development level with the quality of institutions is expected to be positive in relation to technical efficiency and productivity growth of airlines. This is in line with past literature which contends that 1 percent increase economic growth leads to more than 1 percent increase in the demand for air transport.

Quality of institution in this study is given by six dimensions of governance which were explained in preceding section 4.5 on data description. Each dimension of governance is interacted with economic development level in a separate model which comprises six models altogether. The rationale for separating each dimension of governance in different model is that all the six dimensions of governance are highly correlated, thus having the potentiality to cause the problem of multi-collinear if all the six dimensions are modelled in a single equation (Naghavi, 2014). Therefore, to overcome high correlation issue, each dimension of governance is model separately in six GMM models. Set of other explanatory variables used in equations 4.3 and 4.4 to model economic development impact on airline efficiency and productivity growth are denoted by the symbol, X_{it}. These variables act as control variables which are commonly found in the literature to investigate sources of inefficiency and low productivity of airlines among others are quality of institution, available seat kilometer, and revenue passenger kilometer.

The influences of outsourcing and economic development level upon the technical efficiency score are modeled separately to overcome the issue of too many variables which may reduce the efficiency of GMM as an efficient estimator. The same argument is for modeling separately the impact of outsourcing and economic development level upon productivity growth of airlines. Meanwhile, the symbol given by ε_{it} expresses the well-behaved error term.

4.6 Summary of chapter

This chapter discusses the methodological framework used in assessing the technical efficiency and productivity growth of airlines with a focus on the metafrontier DEA and the metafrontier Malmquist productivity index techniques. Both techniques provide the basis for comparing the technical efficiency and the productivity growth of two heterogeneous groups of airlines namely low cost and full cost carriers. The study proceeds to the next step by providing detailed explanations on the Generalized Method of Moments framework to model the determinants of technical efficiency and productivity growth of airlines. The results from the assessment of technical efficiency and productivity growth are now used as dependent variables in the second stage to regress upon the explanatory variables of our interest such as outsourcing and economic development level. Therefore, this chapter is useful to provide a detailed procedure for use in empirical analysis in the next two analytical chapters 5 and 6.

CHAPTER 5: EMPIRICAL FINDINGS AND DISCUSSIONS FOR TECHNICAL EFFICIENCY AND PRODUCTIVITY CHANGE OF AIRLINES

5.1 Introduction

The first analysis in this chapter presents empirical findings with regard to the variations in the technical efficiency estimates which is the static measure of performance for individual airline with reference to the frontiers for each group of full cost carriers and low cost carriers and their respective metafrontier[5] technical efficiencies at a given point of time for each year observed from 2002 to 2011. The objective of carrying out the above analysis is to examine the efficiency of each group of FCC and LCC with respect to the metafrontier technology. The analysis adopts the metafrontier concept of technical efficiency using the DEA approach as applied in O'Donnell et al. (2008).

Next, the analysis is extended to calculate the productivity change over time using the approach of the metafrontier Malmquist productivity index (MPI) as introduced by Oh and Lee (2010). The analyses use panel data set consisting of 43 full cost carriers and 13 low cost carriers over the period 2002 to 2011. The objective of using panel data to implement the DEA technique in this study is to assess and compare changes in productivity and its decompositions into sources of productivity change namely as efficiency change (EC), technical change (BPC) and technology gap ratio change (TGC) across time in FCC and LCC groups using the approaches of the metafrontier Malmquist productivity index. In addition, the metafrontier MPI analysis also enables the researcher to identify which airline group forms best practice frontier (approaching the world frontier) thus catching up with the global technology and which group is lagging behind.

[5] The term metafrontier and global frontier is used interchangeably throughout this text.

In measuring the technical efficiency, the metafrontier concept is adopted based on the DEA technique as proposed in O' Donnell et al. (2008) using the One-Stage DEA, constant returns to scale (CRS) assumption to compute the technical efficiency scores for each individual airline, with respect to group frontiers of full costs and low costs carriers, as well as the metafrontier estimates with regards to the two groups of airlines, for each year observed from 2002 to 2011. Next, the technological gap ratio (TGR) for each individual airline in each group of airline is computed on a yearly basis. The technology gap ratio is calculated by taking the ratio of geometric mean of metafrontier technical efficiency to geometric mean of group frontier technical efficiency scores in each airline group using the formula in equation 4.14. These scores provide measurement for calculating the technology gap between group frontier and the metafrontier technology (world technology). The closer the score of TGR to 1, the faster the group is said to be catching up with the metafrontier technology. Meanwhile the farther the score of TGR away from 1, the farther is the country lagging behind the world technology.

Next, in order to compute the metafrontier productivity change, the DEA-Malmquist Productivity Index (MPI) model, with an assumption of constant returns to scale as proposed by Oh and Lee (2010), is adopted which gives the score of MPI relative to the metafrontier and its decompositions into sources of productivity change namely as efficiency change, technological change, and technological gap change throughout the period from 2002 to 2011. The first component in the decomposition of MPI index, which is the efficiency change (EC) gives the information on whether the group is good at catching up or not. The highest score of EC indicates that the group is good at catching up, while a low score implies that the group is poor at catching up. Next, the best practice change provides the information on which group is innovative. Meanwhile, the technology gap change gives the rate of change in the technological leadership which has to be further confirmed by examining the score of the technology gap ratio. The group is the leader in the technology if it has the highest scores in both technology gap change and technology gap ratio.

This chapter starts with a diagnostic test using the Mann Whitney U test to examine the suitability of the DEA metafrontier approach which is applied in the context of the airline industry. The statistical test results from the Mann Whitney U test is reported in sub section 5.2. Next, the results derived from the technical efficiency estimates with respect to group frontier of FCC and the technical efficiency estimate related to the metafrontier estimates are discussed in sub-section 5.3.1. Sub-section 5.3.2 provides the results of the technical efficiency scores obtained from the group frontier of LCC and the technical efficiency score with respect to the metafrontier. Later, the technology gap ratio for each individual airline in the FCC group and LCC group are discussed in sub-section 5.3.3. The findings with regard to the productivity changes of FCC group frontier for individual airline and the productivity change relative to the metafrontier are elaborated in sub-section 5.4.1. Sub-section 5.4.2 presents and discusses the results of productivity change for group frontier of LCC and the metafrontier. Next, the results and discussions with respect to metafrontier productivity change, efficiency change, technological change, technological gap ratio and technology gap ratio change between the two groups of FCC and LCC are explained in sub section 5.5. Finally, section 5.6 provides the summary of the results obtained from each sub-section.

5.2 Results of non-parametric test for appropriateness of the metafrontier approach

Full cost and low cost carriers are different in many aspects. A major distinction between the two categories of airlines relies on their cost structures. For low cost carriers, the most important objective of the airlines is to minimize their cost to the lowest possible level. Meanwhile, full cost carriers cannot simply slash their cost to be closer to low cost carriers, because of the complex nature of their operations. The Full cost carriers adopt hub-and-spoke network strategy in order to benefit from long haul operations, by providing services at customers' convenience including connecting flights and baggage transfers to the connecting flights. Their pricing strategy is unique in the sense that they customize services for different flights to cater for customer segments who are willing to pay more for the additional services. Differences in objectives, nature of service operations, and financial capability made them operate using different production technologies. A very good example of different production technologies adopted by the two categories of airlines is the type of aircraft used in their operations. Full cost carriers usually have a variety of aircraft types to accommodate different volume of passengers for both short and long haul services. Meanwhile, for low cost carriers, due to the nature of point to point service, they usually utilize single type of aircraft which may help them greatly reduce their maintenance costs. Therefore, assuming homogeneity in the production technology for full cost carriers and low cost carriers is misleading. The implication of treating the two categories of airlines as homogeneous is inappropriate. In this respect, it may provide misleading estimates of technical efficiency and productivity scores.

This subsection serves as a platform to scientifically prove that the two groups of airlines are technologically non-homogenous, thus indicating that the application of the metafrontier DEA technique in analyzing and comparing the technical efficiencies and productivities between the two groups of airlines-namely as the full cost and the low cost carriers, is scientifically feasible.

The data in this study (inputs and outputs) are not normal because they are obtained from annual reports and do not follow common statistical procedure (without statistical checks or adjustments) as compared to those of economic data which are compiled by the statistical department of a country. Therefore, a non-parametric diagnostic test, which is the Mann-Whitney U test, is engaged to support our argument that full cost carriers and low cost carriers are indeed heterogeneous in terms of the production technology. The Mann-Whitney U test is applied when we need to verify if the two groups belong to the same population. Otherwise, if the number of groups exceeds two, we can apply the Kruskal Wallis test as commonly used in the metafrontier technical efficiency approach to test for heterogeneity nature of the data as applied by Sala-Garrido, Molinos-Senate, and Hernández-Sancho (2011); Tiedemann, Francksen and Latacz-Lohmann (2011); and Medal-Bartual, Jose Garcia and Sala-Garrido (2012). The null hypothesis for the Mann-Whitney U test states that the two groups of airlines came from the same population. Meanwhile the alternative hypothesis contrasts. The results from the analysis confirmed our prior expectation that the two groups are different as they demonstrate heterogeneity characteristics of the groups which strongly support our decision to use the metafrontier DEA approach to benchmark the efficiency levels of the two groups of airlines. This approach would provide a more reliable measure of technical efficiency estimates for comparing relative efficiencies between two groups of non-homogenous airlines.

Table 5.1: Rank results of Mann-Whitney U test

Variable	Type of Airline	N	Mean Rank	Sum of Ranks
OPEREV	Full Cost Carriers	430	318.9	137157
	Low Cost Carriers	130	153.2	19923
	Total	560	-	-
RPK	Full Cost Carriers	430	304.3	130847
	Low Cost Carriers	130	201.7	26233
	Total	560	-	-
OPCOST	Full Cost Carriers	430	316.9	136303
	Low Cost Carriers	130	159.8	20777
	Total	560	-	-
OPFLEET	Full Cost Carriers	430	294.1	126479
	Low Cost Carriers	130	235.3	30600
	Total	560	-	-

Table 5.2: Test statistics results of Mann-Whitney test

	OPEREV	RPK	OPCOST	OPFLEET
Mann-Whitney U	11408	17718	12262	22085.50
Wilcoxon W	19923	26233	20777	30600.50
Z	-10.23	-6.32	-9.70	-3.62
Asym.sig (2-tailed)	.000	.000	.000	.000

The results in Table 5.1 show that across all the variables tested, full cost carriers recorded the highest mean rank values compared to low cost carriers which indicate that the two groups of airlines are operating at different levels of operating revenues, revenue passenger kilometers, operating costs, and number of operating fleets. Meanwhile, the results from the Mann-Whitney Test statistics in Table 5.2, confirmed the argument that full cost carriers and low cost carriers are non-homogenous. Furthermore, past literature claimed that firms are heterogeneous in terms of resources and capability (Barney, 1991; Rumelt, 1991; Wernerfelt, 1984). According to these studies, mobility of capital and resources are imperfect, which results in competitive advantage of the efficient firms in terms of access to resources for production activities. Both U-values and p-values for all variables tested in Table 5.2, namely as OPEREV (u=11408, p-value=0.000), RPK (u=17718, p-value=0.000), OPCOST (u=12262, p-value=0.000), and OPFLEET (u=22085.50, p-value=0.000) signify that the two groups are statistically and significantly different. These results confirm the suitability of the application of the metafrontier model based on DEA technique used in this study. Furthermore, an application of the metafrontier approach to measure technical efficiency and productivity is suitable when different airline categories are facing different technological frontiers. Otherwise, an application of the metafrontier approach is inappropriate if the categories of airlines are sharing an identical technology frontier.

5.3 Results of group and metafrontier technical efficiencies estimates for full cost and low cost carriers

In this sub section, the group technical efficiency estimates for full cost carriers and low cost carriers which are denoted by the abbreviations TE^K and its corresponding metafrontier technical efficiency estimates (TE) for both groups of airline in each year are analysed using a mathematical linear programming in DEA as specified in equation 4.4. The calculation of technical efficiencies with regard to groups of full cost carriers, low cost carriers and the metafrontier are done by solving equation 4.4 separately for all three frontiers using 1-Stage DEA model. The adoption of 1–Stage DEA is followed by a seminal paper on the metafrontier model by O’Donnell et al. (2008). The 1-Stage DEA technique enables the slacks in the DEA model to be calculated using 1-Stage approach. Next, pooling the sample airlines from both groups yield the metafrontier technical efficiency scores for each group of airlines. The group technical efficiency scores for full cost carrier are calculated by solving the DEA mathematical programming as stated in equation 4.4 in the methodology section by 43times for the total number of 43 full cost carriers in the group. The same applies to low cost carriers which consist of 13 samples of airlines from the category. The metafrontier technical efficiency scores are obtained by pooling all airlines in both groups. This is done by solving the LP in equation 4.4 by 56 times for the total number of 56 airlines. The analysis employs the Data Envelopment Analysis software called the MaxDEA Pro 6.6 developed by Cheng and Qian (2014).

The results in tables 5.3 and 5.4 show the average technical efficiency scores for each group of full cost and low cost carriers (TE^K), their respective metafrontier technical efficiency estimates (TE) and technological gap ratio (TGR) for the period of 2002 to 2011. A fully efficient airline is shown by the technical efficiency score equal to 1. Whereas, technical efficiency score less than 1 implies that the airline does not achieve an optimal level of output with the input mix that it has in the production possibility set. In terms of the TGR, the larger the value of TGR, the closer the group towards the meta technology frontier. Meanwhile, the value of TGR equal to unity indicates that the group is operating at the world technology frontier, in a way it is technologically more advanced relative to the other groups.

5.3.1 Result of technical efficiency estimates for the groups of full cost carriers and its metafrontiers.

The results of the technical efficiencies in Table 5.3 are obtained by solving DEA linear programming in equation 4.4. As reported in Table 5.3, over the 10 years period observed, 5 years showed similarity in the scores of technical efficiency with respect to group frontier of full cost carrier and the metafrontier score relative to FCC except for years 2005, 2006 and 2008, 2010 and 2011 where the values of group technical efficiency and the metafrontier technical efficiency slightly, thus showing a much higher value when compared to the metafrontier technical efficiency score. In fact, the technology gap ratio (TGR) scores for the FCC group are exceptionally high and are approaching 1 for all the years observed (see figure 5.1). This finding suggests that FCC forms world technology frontier in the airlines business. The exceptionally high TGR values recorded by FCC throughout the period indicate that the world technology frontier is determined by airlines from the FCC group.

Figure 5.1 exhibits that in general, the geometric mean of technical efficiencies with respect to FCC group frontier is coinciding with the metafrontier technical efficiency. Trend wise, the scores in table 5.3 exhibit an increasing trend in the technical efficiency of FCC relative to the metafrontier estimates. The average technical efficiency scores of FCC showed an improvement of 20 percent throughout 10 years period observed, which is an increase from 60 percent to 82 percent in 2002 and 2011 respectively. On average the FCC group recorded a decent performance improvement as indicated by the increase in the metafrontier technical efficiency from 60 percent to 81 percent in 2002 and 2011 respectively. The highest score of metafrontier technical efficiency throughout the study is recorded in 2010 with the geometric mean technical efficiency of 85.1 percent. The examination of the efficiency score by airline concluded that FCC group from the Asia Pacific is led by Singapore Airlines, Japan Airlines (JAL), All Nippon Airways, Chinese Southern Airlines, Emirates and Garuda Airlines recorded the highest levels of technical efficiency when measured with respect to the metafrontier technology throughout the period of study from 2002 to 2011. This is consistent with the findings revealed in Inglada et.al (2006) and Rey et al. (2009) which argued that Asian airlines are relatively more economically efficient than its counterparts in the United States and Europe.

The improvement in the metafrontier technical efficiency score for FCC, is compensated by narrowing technology gap with respect to the global frontier. It implies that the FCC group is catching up with airline global technology as the gap in the technology continues to narrow down. In addition, the finding suggests that the technical efficiency of FCC with respect to group frontier and the metafrontier are converging throughout the study period from 2002 to 2011. The positive progress in the performance of full cost carrier is not surprising particularly when facing with stiff competition from the low cost carriers since the beginning of the millennium. Therefore, the FCC group has been aggressively seeking for upgrading of their technological capabilities among others by selling air tickets through direct distribution channels from the airline company's website. This initiative has cut substantial distributional costs as compared to the old practice by selling the air tickets through the Global Distribution System (GDS) and travel agents who reap much of the revenues which are supposed to enter the pockets of the airline companies.

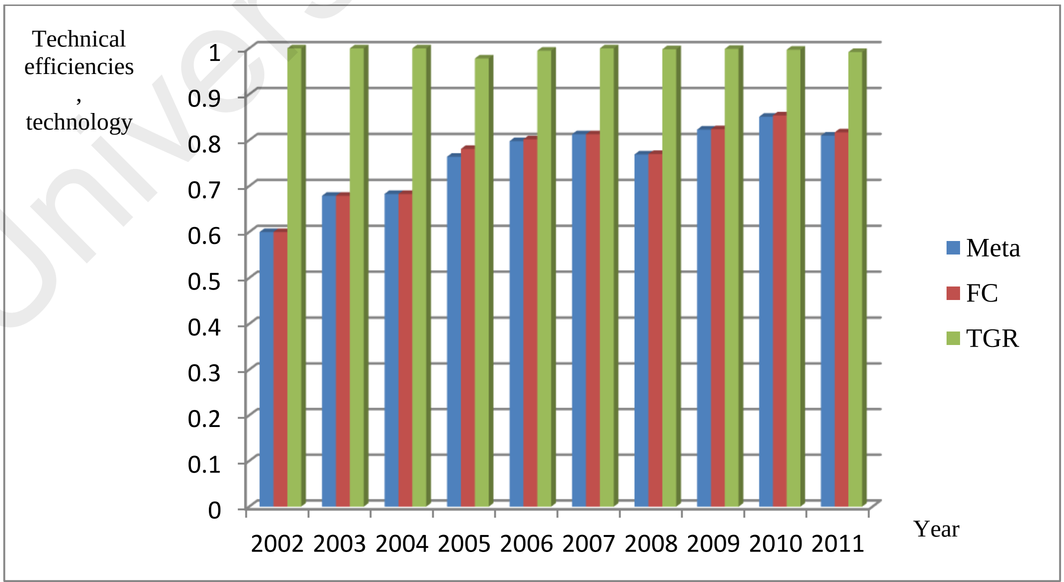


Figure 5.1: Trend of geomean technical efficiency of FCC relative to group and metafrontier, and technological gap ratio, 2002-2011

This result can best be associated with KPMG analysis which contended that legacy carriers (FCCs) have successfully streamlined their costs, hence narrowing the costs gap between LCCs and FCC from 2006 to 2011 (KPMG International, 2013). According to the analysis, legacy carriers manage an average unit cost of 3.6 US cent per average seat kilometer (ASK) in 2006. This figure has been successfully slashed further by 30 percent to 2.5 US cents per ASK in 2011. The claim by KPMG International is further supported by Bitzan and Peoples (2016) as they found that legacy carriers in the United States enjoyed large cost reductions throughout the observed period from 1993 to 2014. By and large, there is a trend of convergence between LCCs and FCCs with regards to costs of operation which partly explained why technology gap between group of FCC and the global technology is narrowing down throughout the period of study.

The final row in Table 5.3 exhibits the trend in the percentage of fully efficient FCC airlines relative to the metafrontier estimates. In terms of the metafrontier technical efficiency score, the percentage of fully efficient FCC increases from 7 percent in the beginning of the observation period of 2002 to 14 percent in 2011. The metafrontier technical efficiency estimates for FCC recorded the largest increase which is 20.9 percent in 2007 just before the global economic downturn which took place in 2008 after which the performance persistently slowing down from 18.6 percent in 2009 to 14 percent in 2011. Nevertheless, during the first 6 years, the percentage of fully efficient FCC with respect to the group frontier technology increases drastically from 7% to 20.9% between 2002 and 2007 respectively. However, from 2009 to 2011, the percentage of fully efficient FCC when benchmarked against the group frontier showed a decreasing trend from 20.9% to 18.6%.

As seen from the results in last row of table 5.3, the finding indicates a decrease in the technical efficiency estimates of airlines regardless of the reference technologies used in the benchmarking. The fall in the technical efficiency for FCC during the period from 2009 to 2011 is not surprising and is aligned with IATA's revision of aviation's profit where the institution announced a fall in global aviation's profit in June 2011 to $4 billion as compared to end of 2010 projection for 2011 of $9.1 billion (World Airline Financial Results, 2011).

Table 5.3: Technical efficiency estimates for group frontier and metafrontier of full cost carriers, 2002-2011

Year	2002	2002	2002	2003	2003	2003	2004	2004	2004	2005	2005	2005	2006	2006	2006	2007	2007	2007	2008	2008	2008	2009	2009	2009	2010	2010	2010	2011	2011	2011
Airline	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**
ACA	0.568	0.568	1.000	0.603	0.603	1.000	1.000	1.000	1.000	0.741	0.749	0.989	0.791	0.791	1.000	0.849	0.849	1.000	0.781	0.781	1.000	0.872	0.872	1.000	0.883	0.883	1.000	0.846	0.847	0.998
ADR	0.454	0.454	1.000	0.579	0.579	1.000	0.512	0.512	1.000	0.758	0.791	0.959	0.811	0.811	1.000	0.912	0.912	1.000	0.641	0.641	1.000	0.733	0.733	1.000	0.742	0.742	1.000	0.889	0.891	0.998
AFL	0.470	0.470	1.000	0.674	0.674	1.000	0.633	0.633	1.000	0.716	0.743	0.963	0.748	0.753	0.993	0.845	0.845	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AFR	0.539	0.539	1.000	0.612	0.612	1.000	0.622	0.622	1.000	0.714	0.714	1.000	0.702	0.702	1.000	0.678	0.678	1.000	0.795	0.795	1.000	0.798	0.798	1.000	0.709	0.709	1.000	0.615	0.615	1.000
ALK	0.913	0.913	1.000	0.832	0.832	1.000	0.821	0.821	1.000	0.788	0.788	1.000	0.842	0.842	1.000	0.885	0.885	1.000	1.000	1.000	1.000	0.893	0.893	1.000	0.874	0.881	0.992	0.649	0.712	0.911
AMR	0.365	0.365	1.000	0.498	0.498	1.000	0.527	0.527	1.000	0.537	0.537	0.999	0.595	0.595	1.000	0.621	0.621	1.000	0.607	0.607	1.000	0.639	0.639	1.000	0.654	0.654	1.000	0.633	0.635	0.998
ANA	0.783	0.783	1.000	0.835	0.835	1.000	0.948	0.948	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.950	0.950	1.000	0.849	0.849	1.000	1.000	1.000	1.000	0.886	0.886	1.000
ASA	0.382	0.382	1.000	0.478	0.478	1.000	0.487	0.487	1.000	0.611	0.644	0.948	0.619	0.626	0.989	0.718	0.718	1.000	0.582	0.582	1.000	0.724	0.727	0.996	0.786	0.789	0.997	0.727	0.729	0.998
AUA	0.963	0.963	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.960	0.960	1.000	0.912	0.912	1.000	0.890	0.890	1.000	0.979	0.979	1.000	0.903	0.904	0.999
BAW	0.736	0.736	1.000	0.866	0.866	1.000	0.852	0.852	1.000	0.853	0.853	1.000	0.798	0.798	1.000	0.751	0.751	1.000	0.836	0.836	1.000	0.768	0.768	1.000	0.744	0.744	1.000	0.768	0.768	1.000
CAL	0.673	0.673	1.000	0.761	0.761	1.000	0.740	0.740	1.000	0.726	0.726	1.000	0.743	0.743	1.000	0.725	0.725	1.000	0.663	0.663	1.000	0.798	0.798	1.000	0.824	0.824	1.000	0.602	0.602	1.000
CES	0.718	0.718	1.000	0.738	0.738	1.000	0.746	0.746	1.000	0.725	0.773	0.937	0.749	0.762	0.982	0.764	0.764	1.000	0.587	0.593	0.989	0.734	0.739	0.993	0.857	0.857	1.000	0.846	0.848	0.998
CON	0.487	0.487	1.000	0.598	0.598	1.000	0.721	0.721	1.000	0.810	0.851	0.952	0.781	0.782	0.998	0.800	0.800	1.000	0.757	0.757	1.000	0.731	0.731	1.000	0.740	0.741	1.000	0.839	0.841	0.998
CPA	0.840	0.840	1.000	0.732	0.732	1.000	0.853	0.853	1.000	0.929	0.929	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.960	0.960	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.955	0.955	1.000
CSA	0.431	0.431	1.000	0.516	0.516	1.000	0.475	0.475	1.000	0.635	0.672	0.945	0.726	0.730	0.994	0.801	0.801	1.000	0.583	0.583	1.000	0.590	0.590	1.000	0.752	0.765	0.983	0.896	0.902	0.993
CSN	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.801	0.860	0.931	0.857	0.874	0.980	0.889	0.889	1.000	0.773	0.788	0.982	0.956	0.964	0.992	0.988	1.000	0.988	0.866	0.868	0.998
CYP	0.556	0.556	1.000	0.566	0.566	1.000	0.565	0.565	1.000	0.561	0.583	0.961	0.596	0.628	0.948	0.832	0.841	0.989	0.660	0.660	1.000	0.715	0.715	1.000	0.624	0.624	0.999	0.594	0.595	0.998
DAL	0.754	0.754	1.000	0.804	0.804	1.000	0.813	0.813	1.000	0.799	0.799	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.899	0.911	0.987	0.952	0.953	0.999	0.940	0.952	0.988
ETH	0.383	0.383	1.000	0.458	0.458	1.000	0.454	0.454	1.000	0.740	0.785	0.942	0.729	0.738	0.988	0.721	0.721	1.000	0.654	0.659	0.992	0.785	0.785	1.000	0.801	0.811	0.987	0.747	0.749	0.998

‘Table 5.3 continued’

Year	2002	2002	2002	2003	2003	2003	2004	2004	2004	2005	2005	2005	2006	2006	2006	2007	2007	2007	2008	2008	2008	2009	2009	2009	2010	2010	2010	2011	2011	2011
Airline	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**
EVA	0.751	0.751	1.000	0.822	0.822	1.000	0.819	0.819	1.000	0.821	0.821	1.000	0.785	0.785	1.000	0.650	0.650	1.000	0.794	0.794	1.000	0.648	0.648	1.000	0.800	0.800	1.000	0.688	0.688	1.000
FIN	0.534	0.534	1.000	0.600	0.600	1.000	0.724	0.724	1.000	0.740	0.751	0.985	0.732	0.733	0.998	0.778	0.778	1.000	0.727	0.727	1.000	0.741	0.741	1.000	0.786	0.786	1.000	0.825	0.826	0.999
GIA	0.818	0.818	1.000	0.621	0.621	1.000	0.664	0.664	1.000	0.827	0.888	0.931	0.942	0.960	0.981	1.000	1.000	1.000	0.795	0.796	0.999	1.000	1.000	1.000	0.899	0.924	0.973	0.846	0.847	0.999
HAL	0.447	0.447	1.000	0.657	0.657	1.000	0.664	0.664	1.000	0.640	0.640	1.000	0.685	0.685	1.000	0.722	0.722	1.000	0.699	0.699	1.000	0.850	0.850	1.000	0.802	0.802	1.000	0.793	0.795	0.997
IBE	0.547	0.547	1.000	0.643	0.643	1.000	0.611	0.611	1.000	0.583	0.583	0.999	0.678	0.678	1.000	0.754	0.754	1.000	0.714	0.714	1.000	0.712	0.712	1.000	0.773	0.773	1.000	0.834	0.835	0.999
JAI	0.324	0.324	1.000	0.533	0.533	1.000	0.564	0.564	1.000	0.902	0.943	0.957	0.842	0.852	0.988	0.757	0.757	1.000	0.627	0.636	0.986	0.687	0.687	1.000	0.846	0.853	0.991	0.793	0.828	0.957
JAL	1.000	1.000	1.000	0.939	0.939	1.000	0.865	0.865	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
KAL	0.968	0.968	1.000	0.883	0.883	1.000	0.879	0.879	1.000	0.841	0.841	1.000	0.859	0.859	1.000	0.861	0.861	1.000	0.791	0.791	1.000	0.942	0.942	1.000	0.986	0.986	1.000	0.765	0.765	0.999
KLM	0.922	0.922	1.000	0.813	0.813	1.000	0.671	0.671	1.000	0.767	0.767	1.000	0.967	0.967	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.996	0.996	1.000	1.000	1.000	1.000
MAS	0.660	0.660	1.000	0.754	0.754	1.000	0.660	0.660	1.000	0.551	0.571	0.965	0.672	0.672	1.000	0.763	0.763	1.000	0.674	0.674	1.000	0.785	0.785	1.000	0.774	0.774	1.000	0.692	0.694	0.997
OAS	0.523	0.523	1.000	0.492	0.492	1.000	0.441	0.441	1.000	0.613	0.636	0.964	0.662	0.668	0.992	0.710	0.710	1.000	0.497	0.497	1.000	0.526	0.526	1.000	0.590	0.591	0.999	0.557	0.559	0.997
PIA	0.550	0.550	1.000	0.651	0.651	1.000	0.610	0.610	1.000	0.624	0.650	0.959	0.648	0.653	0.992	0.698	0.698	1.000	0.634	0.634	1.000	0.835	0.843	0.991	0.789	0.790	0.999	0.682	0.684	0.997
PINN	0.222	0.222	1.000	0.295	0.295	1.000	0.272	0.272	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.959	1.000	0.959
QFA	0.744	0.744	1.000	0.819	0.819	1.000	0.907	0.907	1.000	0.898	0.898	1.000	0.947	0.947	1.000	0.960	0.960	1.000	1.000	1.000	1.000	0.969	0.969	1.000	0.991	0.991	1.000	1.000	1.000	1.000
SAF	0.631	0.631	1.000	0.675	0.675	1.000	0.767	0.767	1.000	0.833	0.838	0.993	0.806	0.806	1.000	0.836	0.836	1.000	0.825	0.825	1.000	0.691	0.691	1.000	0.902	0.902	1.000	0.841	0.842	0.998
SAS	0.651	0.651	1.000	1.000	1.000	1.000	0.696	0.696	1.000	0.715	0.715	1.000	0.664	0.664	1.000	0.720	0.720	1.000	0.695	0.695	1.000	0.650	0.650	1.000	0.700	0.700	1.000	0.681	0.681	1.000
SIA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.927	0.927	1.000	1.000	1.000	1.000
SKYW	0.195	0.195	1.000	0.228	0.228	1.000	0.211	0.211	1.000	0.567	0.588	0.964	0.600	0.605	0.992	0.642	0.642	1.000	0.528	0.536	0.986	0.751	0.755	0.995	0.863	0.898	0.961	0.800	0.855	0.936
THA	0.888	0.888	1.000	0.884	0.884	1.000	0.932	0.932	1.000	0.785	0.785	1.000	0.830	0.830	1.000	0.926	0.926	1.000	0.804	0.804	1.000	0.940	0.940	1.000	0.868	0.868	1.000	0.852	0.852	1.000
THY	0.663	0.663	1.000	0.700	0.700	1.000	0.674	0.674	1.000	0.747	0.786	0.952	0.755	0.766	0.986	0.382	0.382	1.000	0.718	0.718	1.000	0.924	0.924	1.000	0.844	0.844	1.000	0.805	0.806	0.998
TSO	0.380	0.380	1.000	0.713	0.713	1.000	0.699	0.699	1.000	0.687	0.740	0.927	0.804	0.822	0.979	0.804	0.812	0.990	0.757	0.765	0.990	0.994	1.000	0.994	0.998	1.000	0.998	0.996	1.000	0.996

'Table 5.3 continued'

Year	2002	2002	2002	2003	2003	2003	2004	2004	2004	2005	2005	2005	2006	2006	2006
Airline	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**
UAE	0.809	0.809	1.000	0.981	0.981	1.000	0.991	0.991	1.000	0.946	0.946	1.000	0.938	0.938	1.000
UAL	0.787	0.787	1.000	0.971	0.971	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
USA	0.562	0.562	1.000	0.628	0.628	1.000	0.669	0.669	1.000	0.828	0.881	0.940	0.846	0.846	1.000
Geo-metric Mean	0.600	0.600	1.000	0.679	0.679	1.000	0.683	0.683	1.000	0.764	0.781	0.978	0.798	0.802	0.995
Number fully efficient	**3**	**3**	**43**	**4**	**4**	**43**	**5**	**5**	**43**	**6**	**6**	**19**	**8**	**8**	**27**
Percent-age fully efficient	7.0	7.0	100.0	9.3	9.3	100.0	11.6	11.6	100.0	14.0	14.0	44.2	18.6	18.6	62.8

Year	2007	2007	2007	2008	2008	2008	2009	2009	2009	2010	2010	2010	2011	2011	2011
Airline	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**	**Meta**	**FC**	**TGR**
UAE	0.970	0.970	1.000	0.954	0.954	1.000	0.966	0.966	1.000	1.000	1.000	1.000	1.000	1.000	1.000
UAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.814	0.844	0.965
USA	0.825	0.825	1.000	0.716	0.716	1.000	0.865	0.870	0.994	0.899	0.899	0.999	0.853	0.854	0.998
Geo-metric Mean	0.813	0.813	1.000	0.769	0.770	0.998	0.823	0.824	0.999	0.851	0.854	0.997	0.810	0.817	0.992
Number fully efficient	**9**	**9**	**41**	**9**	**9**	**36**	**8**	**9**	**34**	**7**	**9**	**25**	**6**	**8**	**11**
Percent-age fully efficient	20.9	20.9	95.3	20.9	20.9	83.7	18.6	20.9	79.1	16.3	20.9	58.1	14.0	18.6	25.6

5.3.2 Result of technical efficiency estimates for low cost carriers (LCC) related to group frontier and metafrontier

Table 5.4 shows the results of the technical efficiency estimates for low cost carriers related to group frontier and metafrontier technologies. The technical efficiency scores presented in table 5.4 are derived from equation 4.4. On average, LCCs show an increasing trend in both geomean group frontier and the geomean metafrontier technical efficiency scores throughout the period of study from 2002 to 2011.

The geomean technical efficiency estimates of LCC when benchmarked against the group frontier increase from 74.8% to 88.3 % in 2002 and 2011 respectively. Meanwhile, the geomean of the LCC related to the metafrontier technical efficiency estimates increases from 36.2% to 78.4% in 2002 and 2011 respectively despite a slightly lower value of technical efficiency scores when compared to group technical efficiency scores. Figure 5.2 shows the bar chart of technology gap ratio, TGR for LCC. The LCC almost completely close the gap in group technology related to world frontier as indicated by a favourable improvement in the technology gap ratio from 48.4 percent to 96.3 percent in 2002 and 2005 respectively, which is an increase of approximately 50 percent in TGR during the period of 2002 to 2005. The gap, however, widens gradually later in subsequent year for three consecutive years until 2008 where the TGR is 81.1 as compared to the score in 2006 which was 93.4 percent. Nevertheless, the LCC group recorded a moderate improvement in the technology gap with respect to the global technology frontier to 92.2 percent and 92.8 percent in the subsequent two years before falling to 88.8 percent in 2011 (Figure 5.2). The improvement in the TGR can be observed from the small differences between the technical efficiency scores measured relative to both group frontier technology and global technology for each year observed. Furthermore, an investigation at individual airline observed that only a few airlines recorded high frequency of fully efficient score related to the metafrontier technology across each year from 2002 to 2011. These airlines are Air Asia, Virgin Australia, Ryanair, and Frontier. Among the four carriers, Air Asia recorded the highest frequency of fully efficient score in both the group and the metafrontier estimates from 2006 to 2011. This indicates that Air Asia successfully close the technology gap with respect to the global technology. This finding is not surprising as Air Asia is the first airline to introduce Airbus model A320 in its fleet with sharklet wing tips which is an innovation to promote fuel cost saving. In addition, the airline has been announced as a winner for best low cost carriers by Skytrax since 2009 which has made it an airline of choice for low cost travel in Asia Pacific.

Meanwhile, Virgin Australia and Ryanair fell second with the frequency of fully efficient scores in both the group technology and global technology equal to 2. The two airlines are known as highly performed LCCs in both Australia and Europe continents. It is worth mentioning that Virgin Australia is one of the well-established airlines in Australia after it highly performed national carrier, Qantas.

Table 5.4: Technical efficiency estimates for group frontier and metafrontier low cost carriers, 2002-2011

Year	2002	2002	2002	2003	2003	2003	2004	2004	2004	2005	2005	2005	2006	2006	2006	2007	2007	2007	2008	2008	2008	2009	2009	2009	2010	2010	2010	2011	2011	2011
Airline	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**
AA	0.360	0.898	0.401	0.297	0.380	0.781	0.460	1.000	0.460	0.907	0.907	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.878	1.000	0.878	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AGA	0.263	0.558	0.472	0.295	0.500	0.590	0.346	0.664	0.521	0.529	0.530	0.998	0.664	0.664	1.000	0.659	0.711	0.927	0.616	0.659	0.934	0.755	0.789	0.957	0.689	0.712	0.968	0.640	0.683	0.937
ATA	0.283	0.591	0.479	0.426	0.480	0.888	0.394	0.614	0.641	0.537	0.537	0.999	0.612	0.623	0.981	0.659	0.734	0.898	0.581	0.694	0.836	0.687	0.709	0.969	0.689	0.696	0.990	0.644	0.700	0.920
BEE	0.470	0.961	0.489	0.448	0.534	0.839	0.411	0.634	0.648	0.884	0.888	0.995	0.743	0.846	0.879	0.970	1.000	0.970	0.661	0.930	0.710	0.612	0.696	0.879	0.744	0.936	0.795	0.933	1.000	0.933
EIN	0.567	1.000	0.567	0.715	1.000	0.715	0.668	1.000	0.668	0.691	1.000	0.691	0.759	1.000	0.759	0.814	1.000	0.814	0.686	1.000	0.686	0.733	1.000	0.733	0.800	0.966	0.829	0.830	1.000	0.830
EJ	0.472	1.000	0.472	0.825	0.912	0.905	0.683	1.000	0.683	0.966	0.966	0.999	0.965	0.998	0.967	0.945	1.000	0.945	0.844	0.969	0.871	0.801	0.818	0.980	0.998	1.000	0.998	0.931	1.000	0.931
FRA	0.306	0.628	0.486	0.419	0.458	0.915	0.387	0.583	0.664	0.636	0.636	1.000	0.760	0.801	0.949	0.856	0.915	0.936	0.885	1.000	0.885	1.000	1.000	1.000	0.951	1.000	0.951	0.817	0.890	0.918
JBU	0.632	1.000	0.632	0.735	1.000	0.735	0.683	1.000	0.683	0.620	0.649	0.955	0.699	0.871	0.803	0.706	0.980	0.720	0.643	0.860	0.748	0.679	0.693	0.980	0.716	0.739	0.969	0.654	0.750	0.872
NA	0.189	0.527	0.358	0.536	0.581	0.923	0.466	0.619	0.753	0.856	0.857	0.999	0.874	0.925	0.945	0.904	0.992	0.911	0.616	0.878	0.702	0.836	0.945	0.884	0.809	0.899	0.900	0.783	0.918	0.853
RYA	0.407	0.877	0.464	0.558	0.629	0.887	0.552	0.974	0.567	0.974	0.977	0.997	0.978	0.978	1.000	0.931	1.000	0.931	1.000	1.000	1.000	0.710	0.726	0.977	1.000	1.000	1.000	0.968	1.000	0.968
SW	0.390	0.723	0.540	0.465	0.620	0.750	0.451	0.658	0.686	0.560	0.579	0.966	0.610	0.647	0.944	0.614	0.746	0.823	0.560	0.686	0.816	0.553	0.593	0.933	0.599	0.662	0.904	0.603	0.739	0.815
VAU	0.260	0.507	0.513	0.991	1.000	0.991	0.860	1.000	0.860	1.000	1.000	1.000	1.000	1.000	1.000	0.835	1.000	0.835	0.732	0.943	0.777	0.737	0.914	0.807	0.794	0.895	0.887	0.759	1.000	0.759
WJ	0.364	0.757	0.481	0.499	0.552	0.904	0.448	0.668	0.670	0.690	0.713	0.969	0.835	0.878	0.951	0.893	0.989	0.903	0.726	0.952	0.762	0.782	0.835	0.937	0.813	0.901	0.903	0.770	0.911	0.845

'Table 5.4 continued'

Year	2002	2002	2002	2003	2003	2003	2004	2004	2004	2005	2005	2005	2006	2006	2006
Airline	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**
Geo-metric Mean	0.362	0.748	0.484	0.521	0.631	0.825	0.505	0.781	0.647	0.738	0.767	0.963	0.796	0.852	0.934
Number fully efficient	**0**	**3**	**0**	**0**	**3**	**0**	**0**	**5**	**0**	**1**	**2**	**2**	**2**	**3**	**4**
Percent-age fully efficient	0	23.1	0	0	23.1	0	0	38.5	0	7.7	15.4	15.4	15.4	23.1	30.8

Year	2007	2007	2007	2008	2008	2008	2009	2009	2009	2010	2010	2010	2011	2011	2011
Airline	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**	**Meta**	**LCC**	**TGR**
Geo-metric Mean	0.820	0.921	0.890	0.714	0.881	0.811	0.750	0.814	0.922	0.806	0.868	0.928	0.784	0.883	0.888
Number fully efficient	**1**	**6**	**1**	**1**	**4**	**1**	**2**	**3**	**2**	**2**	**4**	**2**	**1**	**5**	**1**
Percent-age fully efficient	7.7	46.2	7.7	7.7	30.8	7.7	15.4	23.1	15.4	15.4	30.8	15.4	7.7	38.5	7.7

In general, throughout the period of 2002 to 2011, most LCC displays high efficiency scores when benchmarked against the LCC group frontier. However, the technical efficiency scores fell short when compared with the metafrontier technology. The discrepancy in the metafrontier-group technical efficiency scores leaves the LCCs in a large technology gap with the world frontier which indicates that LCC technology is lagging far behind the global airline technology. Although the results from this analysis suggest that FCC is technically more efficient than LCC (Tables 5.3 and 5.4), however there is a tendency for the low cost carriers to be more technically efficient in the years ahead, looking at a fast increase in the trend of the technical efficiency with respect to group and metafrontier technologies.

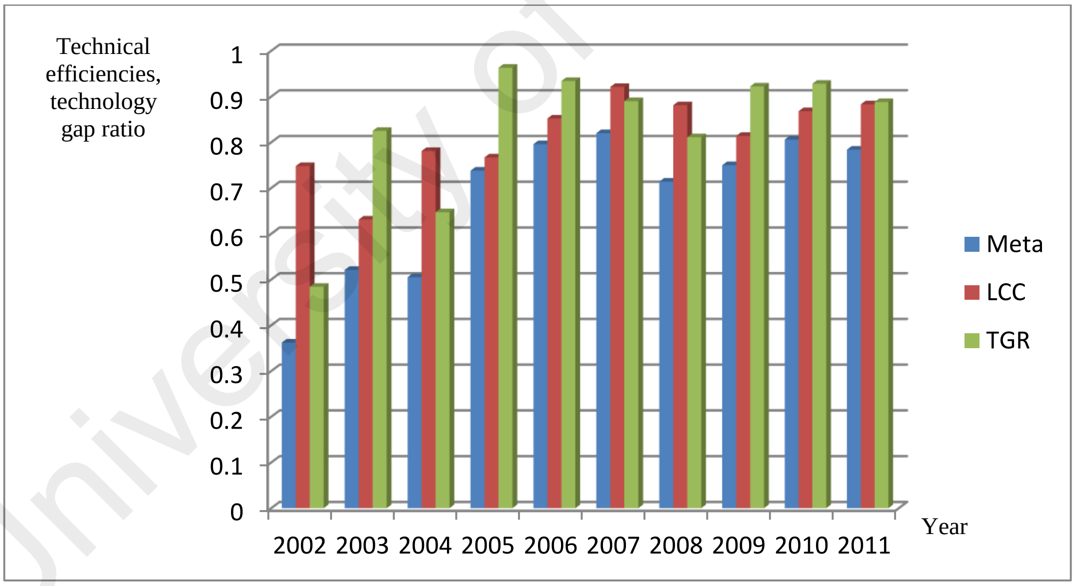


Figure 5.2: Trend of geomean technical efficiency between LCC-Metafrontier, LCC- group frontier, and technological gap ratio, 2002-2011

This finding challenges the traditional view that LCCs are relatively more technically efficient than FCCs as supported by the findings of Barbot et. al. (2008); Lee and Worthington (2010); Assaf and Josiassen (2011); and Lu et al. (2012). However, the latest study conducted by Smyth and Pearce (2006); Tsoukalas, Belobaba, and Swelbar (2008); KPMG International (2013), and a recent study by Bitzan and Peoples (2016) confirmed that there is a pattern of convergence in operational costs between full cost carriers and low cost carriers. According to Tsoukalas, Belobaba, and Swelbar (2008), labour cost and stage length have been improved for legacy carriers in the United States as the airlines streamlined its business by engaging in downsizing and cost cutting in their effort to regain profitability. In addition, a recent study by Arjomandi and Seufert (2014) confirmed that FCCs are the most efficient airlines in their study observed from 2007 to 2010. In addition, Bitzan and Peoples (2016) suggest that FCC gained the largest cost cutting as compared to LCC for airlines in the United States. Meanwhile, low cost carriers experience increasing operational costs attributing to maturity of the business model as evidenced by the increase in the fleet age and seniority of employees. As contended in KPMG International (2013), the cost gap between low cost carriers and legacy carriers have contracted significantly from 2006 to 2011. Although per unit cost for legacy carriers was reported as USD$ 3.6 cents/ASK higher than the cost of low cost carriers in 2006, but the cost difference has further contracted to USD$ 2.5 cents/ASK in 2011.

5.3.3 Results of technological gap ratios (TGR) for full cost and low cost carriers

The technology gap ratio (TGR) measures proximity of an airline or an airline group to the global technology frontier. TGR values presented in tables 5.5, 5.6 and 5.7 are computed using the formula expressed in equation 4.17. Tables 5.5 and 5.6 show the TGR values for output oriented groups of full cost carriers and low cost carriers for the period of 2002 to 2011.

Table 5.5: Technology gap ratios of full cost carriers, 2002 to 2011

Airline	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ACA	1.000	1.000	1.000	0.989	1.000	1.000	1.000	1.000	1.000	0.998
ADR	1.000	1.000	1.000	0.959	1.000	1.000	1.000	1.000	1.000	0.998
AFL	1.000	1.000	1.000	0.963	0.993	1.000	1.000	1.000	1.000	1.000
AFR	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ALK	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.992	0.911
AMR	1.000	1.000	1.000	0.999	1.000	1.000	1.000	1.000	1.000	0.998
ANA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ASA	1.000	1.000	1.000	0.948	0.989	1.000	1.000	0.996	0.997	0.998
AUA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999
BAW	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CES	1.000	1.000	1.000	0.937	0.982	1.000	0.989	0.993	1.000	0.998
CON	1.000	1.000	1.000	0.952	0.998	1.000	1.000	1.000	1.000	0.998
CPA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CSA	1.000	1.000	1.000	0.945	0.994	1.000	1.000	1.000	0.983	0.993
CSN	1.000	1.000	1.000	0.931	0.980	1.000	0.982	0.992	0.988	0.998
CYP	1.000	1.000	1.000	0.961	0.948	0.989	1.000	1.000	0.999	0.998
DAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.987	0.999	0.988
ETH	1.000	1.000	1.000	0.942	0.988	1.000	0.992	1.000	0.987	0.998
EVA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
FIN	1.000	1.000	1.000	0.985	0.998	1.000	1.000	1.000	1.000	0.999
GIA	1.000	1.000	1.000	0.931	0.981	1.000	0.999	1.000	0.973	0.999
HAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.997
IBE	1.000	1.000	1.000	0.999	1.000	1.000	1.000	1.000	1.000	0.999
JAI	1.000	1.000	1.000	0.957	0.988	1.000	0.986	1.000	0.991	0.957
JAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
KAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999
KLM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MAS	1.000	1.000	1.000	0.965	1.000	1.000	1.000	1.000	1.000	0.997
OAS	1.000	1.000	1.000	0.964	0.992	1.000	1.000	1.000	0.999	0.997
PIA	1.000	1.000	1.000	0.959	0.992	1.000	1.000	0.991	0.999	0.997
PINN	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.959
QFA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SAF	1.000	1.000	1.000	0.993	1.000	1.000	1.000	1.000	1.000	0.998
SAS	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SIA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SKYW	1.000	1.000	1.000	0.964	0.992	1.000	0.986	0.995	0.961	0.936
THA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
THY	1.000	1.000	1.000	0.952	0.986	1.000	1.000	1.000	1.000	0.998
TSO	1.000	1.000	1.000	0.927	0.979	0.990	0.990	0.994	0.998	0.996
UAE	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
UAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.965
USA	1.000	1.000	1.000	0.940	1.000	1.000	1.000	0.994	0.999	0.998
Geomean	**1.000**	**1.000**	**1.000**	**0.978**	**0.995**	**1.000**	**0.998**	**0.999**	**0.997**	**0.992**
Geomean all	**0.996**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

In table 5.5, most of the airlines in the full cost category recorded the values of TGR which are equal to unity throughout the period of 10 years from 2002 to 2011 which indicate that majority of FCCs are operating on the world technology frontier across all years observed. The finding indicates that the FCC group produces approximately 100 percent of the outputs (operating revenue and revenue passenger kilometer) that is feasible using the world technology with a given input vector which comprise of operational cost, and number of aircraft, therefore, suggesting that the FCC group is the technology leader in the airline industry. A slight improvement in the technical efficiency estimates in relation with the global technology has improved the technology gap between FCC group and the world airline technology throughout the 10 years of period. It shows the important role of technical efficiency in narrowing the technology gap of the group frontier related to the best performing frontier which is the FCC group.

Table 5.6: Technology gap ratios for low cost carriers, 2002 to 2011

Airline	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AA	0.401	0.781	0.460	1.000	1.000	1.000	0.878	1.000	1.000	1.000
AGA	0.472	0.590	0.521	0.998	1.000	0.927	0.934	0.957	0.968	0.937
ATA	0.479	0.888	0.641	0.999	0.981	0.898	0.836	0.969	0.990	0.920
BEE	0.489	0.839	0.648	0.995	0.879	0.970	0.710	0.879	0.795	0.933
EIN	0.567	0.715	0.668	0.691	0.759	0.814	0.686	0.733	0.829	0.830
EJ	0.472	0.905	0.683	0.999	0.967	0.945	0.871	0.980	0.998	0.931
FRA	0.486	0.915	0.664	1.000	0.949	0.936	0.885	1.000	0.951	0.918
JBU	0.632	0.735	0.683	0.955	0.803	0.720	0.748	0.980	0.969	0.872
NA	0.358	0.923	0.753	0.999	0.945	0.911	0.702	0.884	0.900	0.853
RYA	0.464	0.887	0.567	0.997	1.000	0.931	1.000	0.977	1.000	0.968
SW	0.540	0.750	0.686	0.966	0.944	0.823	0.816	0.933	0.904	0.815
VAU	0.513	0.991	0.860	1.000	1.000	0.835	0.777	0.807	0.887	0.759
WJ	0.481	0.904	0.670	0.969	0.951	0.903	0.762	0.937	0.903	0.845
Geomean	**0.484**	**0.825**	**0.647**	**0.963**	**0.934**	**0.890**	**0.811**	**0.922**	**0.928**	**0.888**
Geomean All	**0.814**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 5.6 exhibits the values of TGR for low cost carriers for the period of 2002 to 2011. In general, the average TGR scores for LCC throughout the period 2002 to 2011 are far lesser than unity as compared to FCC. However, the TGR values increase from 48.4% to 88.8% in 2002 and 2011 respectively which showed about 50% improvement during the period observed. Among the airline in the low cost carriers, Air Asia, Virgin Australia, Ryanair, Allegiant Air, and Frontier recorded the highest values of TGR particularly after 2005. No doubt these airlines are known as highly performed airlines in the low cost carrier segment.

The difference in TGR scores between Full cost carrier and Low cost carrier is depicted in Figure 5.3 below. Initially, in 2002 there is a large gap in the TGR between full cost and low cost carriers' categories. The gap in the technology between the FCC and the LCC, however is narrowing since 2002 to record the highest TGR in 2010.

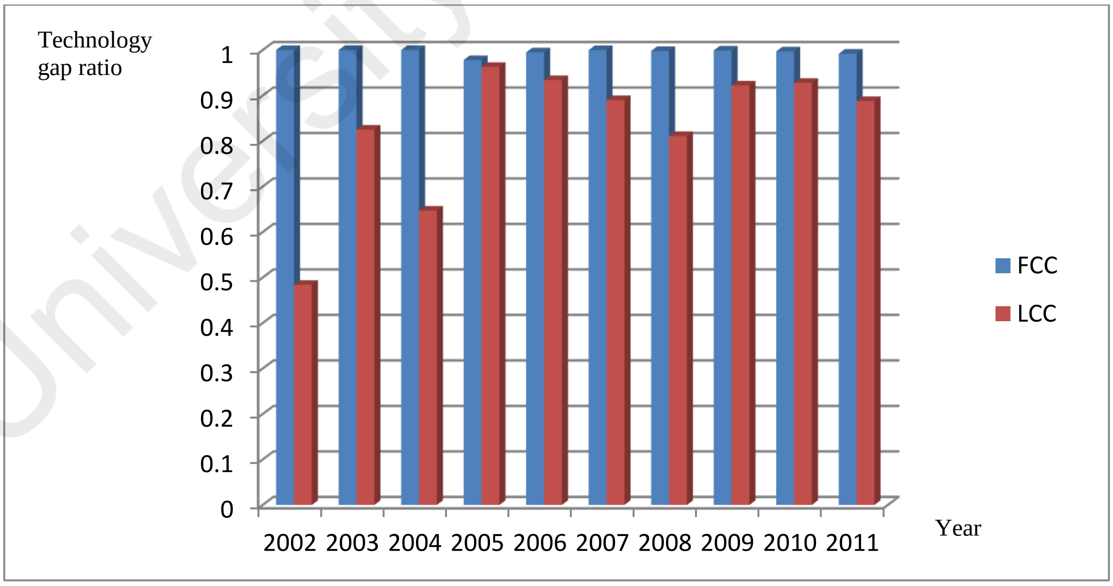


Figure 5.3: Geomean technology gap ratios for full cost carriers and low cost carriers, 2002 to 2011

Table 5.7 indicates the variations in the average technical efficiency estimates when benchmarked using both group technology and world technology frontier approaches. This finding suggests the importance of comparing the efficiency of different categories of airlines using the metafrontier model.

Next, the geomean TGRs for both FCC and LCC in Table 5.7 are obtained by averaging up the TGR scores in tables 5.5 and 5.6. Table 5.7 suggests that on average, the low cost carrier group is technically more efficient when benchmarked against airlines from similar group. This is evidenced by a high score of geometric mean technical efficiency of 81% for LCC when compared to full cost carrier group which recorded the geometric mean technical efficiency score of 75.8%. In addition, a low variation in the efficiency scores recorded by full cost carrier group indicate that the group has the highest degree of similarity in the efficiency scores as shown by a low dispersion (standard deviation value) in the technical efficiency scores of airlines in the group.

Table 5.7: Geomean group technical efficiencies (TEK), metafrontier technical efficiencies (TE), and technological gap ratios (TGR), 2002-2011

Group Carrier	**Observation**		**Geomean**	**Standard Devia-tion**	**Mini-mum**	**Maxi-mum**	**Percent-age of efficient firms**
Full Cost	43 firms /430 obs	TE^K	0.758	0.169	0.195	1.000	16
		TE	0.755	0.168	0.195	1.000	15
		TGR	**0.996**	-	-	-	-
Low Cost	13 firms/130 obs	TE^K	0.810	0.172	0.380	1.000	30
		TE	0.659	0.205	0.189	1.000	8
		TGR	**0.814**	-	-	-	-

In contrast, when the technical efficiency is benchmarked relative to the world technology, the results portrayed that the full cost carriers are the most efficient group with an average score of 75.5% when compared to low cost carrier which recorded an average score of 65.9%. In addition, the table shows a relatively larger degree of dispersions in the metafrontier technical efficiency score (low degree of similarity) as indicated by a comparatively higher value of standard deviations of 0.168 and 0.205 for full cost and low cost carriers respectively.

Based on Table 5.7, full cost carrier shows the highest TGR value of 99.6% which suggests that the maximum output (operating revenue and revenue passenger kilometer) possible using the full cost carrier technology given an input vector (number of operating aircraft, jet fuel, and employees) is about 99.6% of the potential output that could be produced using global technology given the same input vector. This notion suggests that full cost carrier forms best practice frontier. In addition, the high average value of TGR indicates that there is a large capacity for FCC to absorb new technology in the future. As for the low cost carrier technology, the TGR is 81.4%, suggesting that there is room for improvement for the carrier. In this respect, low cost carriers may increase its output level comparably to that of the global frontier (FCC) through an increase in its potential output by 18.6%. This can be materialized by raising the technical efficiency of LCC through various approaches among others introducing new fleets to replace old fleets, and recruiting staff based on contract tenure. These approaches may help in tackling the rising unit cost per ASM as the LCC turning mature. According to Tsoukalas, Belobaba, and Swelbar (2008), among factors that contribute to the rising unit cost per ASM are the increase in operating costs attributing to maturity in the LCC which can be seen in an increase in the salary of senior employees and rising aircraft maintenance cost resulting from high employment of old aircrafts.

It can be concluded that on average, FCC is the most efficient airline from the techno-economic perspective as reflected by a high value of TGR which is 99.6%. Being an airline segment in the market for a relatively long period as compared to LCC which only recorded a massive influx into the market after the deregulation of the air transport market in the United States in 1978. It is reasonable to accept that FCC has invested in various aspects including the technology in their effort to improve the efficiency of their operation. This finding is contradicted with earlier literature which supported that FCC is relatively less efficient than LCC (Barbot et al., 2008; Lee and Worthington, 2010; Assaf and Josiassen, 2011). One possible explanation for the contrast in the result of our study and that of the past studies is because these studies treat LCC and FCC as homogeneous, therefore they do not apply the metafrontier model to overcome the issue of heterogeneity among FCC and LCC. Furthermore, it has been proven that the technical efficiency of FCC has improved across time which implied that the airlines have taken necessary actions in order to improve their efficiencies (Barros et al., 2013; and Arjomandi and Seufert, 2014). In addition, Barros et al. (2013) pointed that U.S. airlines which consisted a majority of FCC, showed an increase in the efficiency level across the period from 1998 to 2010. Meanwhile, Arjomandi and Seufert (2014) found that FCCs are the most technically efficient airlines which are dominated by airlines from China and North Asia.

No doubt FCC is the most efficient carrier based on the analysis above. However, LCC has displayed an impressive improvement in closing the technology gap with the world technology as shown by a significant increase of about 50 percent in the growth of TGR between 2002 and 2011 respectively as compared with FCC which recorded barely zero growth during the same period. It can be inferred that in future, there is a tendency for LCC to improve further and moving closer to the world frontier through various innovations for example, aggressive selling of air tickets via online platform, electronic ticket itinerary via smartphones to replace printed ones, innovative self-service check in kiosk[6] which is economical as used by Japanese LCC, Peach, self-service baggage tagging, use of modern yet economical aircrafts such as Airbus A320 for domestic and short haul routes which is fuel saving as found in Air Asia fleets, and outsourcing of some activities which are more expensive to be carried in house, for instances leasing of aircraft to fulfill temporary high surge of demand during peak seasons as commonly practiced by a newly established LCC instead of purchasing a new one; aircraft maintenance by highly capable third parties, catering, cleaning and other services which have the potential to save large costs through outsourcing.

5.4 Results of productivity changes using metafrontier Malmquist Productivity Index (MMPI) technique

This sub section discusses the results of productivity change which is given by the Malmquist Productivity Index (MPI) score with regards to contemporaneous, intertemporal and global benchmark technologies for full cost carrier and low cost carriers' groups. The MPI scores, with respect to contemporaneous, intertemporal and global benchmark technologies, are calculated by solving DEA linear programming as depicted by equations 4.22, 4.25 and 4.28 respectively. Whilst measurements of the technical efficiencies discussed in sub section 5.2 provides the picture of static efficiency values (efficiency at a given point of time) and its technological gap ratios. In this sub section, performance for different groups of airlines are measured by examining changes

[6] The kiosk which is largely made up of card board is said able to save up to 80 percent of the cost of using traditional kiosk machine (http://www.airlinetrends.com/category/low-cost-airlines/).

in different periods which not only give the scores of the technical efficiency but also extend the metafrontier DEA analysis in section 5.2 to encompass panel data that enables calculation of productivity change across time during the period of 2002 and 2011 with respect to contemporaneous, intertemporal and global benchmark technologies. The MPI calculation for the three frontiers follows the approach of Oh and Lee (2010). Therefore, this sub section provides the results of MPI score and its decompositions into efficiency change (EC), best practice change (technological change) and technological gap change (TGC) using the concept of metafrontier Malmquist productivity index based on DEA.

The results of metafrontier MPI and its decomposition into sources of productivity change such as technical efficiency change (EC), technological change (BPC), and technological gap ratio change (TGC) are obtained by running a linear programming DEA as indicated in model 4.28 in chapter 4 using MaxDEA Pro software. The results provide variations in the productivity change scores of full cost and low cost airline with regard to the respective group technologies (FCC group frontier and LCC group frontier) and the metafrontier technology. However, for discussion purpose, tables on productivity change indexes (MPI) namely tables 5.8 and 5.9 are produced in the following sub-section 5.4.1 to compare the changes in productivity levels between contemporaneous, intertemporal and global (metafrontier) frontiers for each airline in the FCC and LCC models respectively. It is worth noting, that the productivity change score related to contemporaneous technology, is also referring to the MPI score which is calculated using the standard MPI model as proposed by Fare et al. (1994). Meanwhile, intertemporal productivity change reflects the MPI score, which is benchmarked using the group technology frontier, as discussed in O'Donnell et al (2008). Finally, global frontier indicates the productivity change which is benchmarked using the global technology approach as discussed in Pastor and Lovell (2005).

5.4.1 Results of productivity change for full cost carriers

Table 5.8 depicts variations in the scores of productivity change for FCC with respect to contemporaneous, intertemporal and global frontier technologies. All the estimated productivity change scores with respect to the three technologies are calculated by employing linear programming as stated in equations 4.22, 4.25 and 4.28 respectively. The aggregated Malmquist productivity index result from the FCC group shows that 2 out of 9 periods (2003/2004 to 2010/2011) exhibit a progress in the productivity change with regards to all the three benchmark technologies. The FCC group recorded moderate average productivity growths of 5.1, 2.5, and 2.7 percent respectively in relation with contemporaneous, intertemporal and global technologies during the period of 2003/2004.

The favourable productivity growth, however, is not sustainable by the subsequent period of 2004/2005, the change in productivity declines quite drastically to negative productivity growth of 7.5, 2.3 and 2.3 percent with respect to contemporaneous, intertemporal and global technology frontiers. This regressive trend in the change of productivity continues until the period of 2008/2009 where average MPI scores as benchmarked against contemporaneous, intertemporal and global technologies recorded a progress of 3.9 percent, 0.4 percent and 0.4 percent respectively. The FCC group, however, managed to record a moderate productivity growth recovery of 3.3, 4.8 and 4.8 percent respectively, with regard to contemporaneous, intertemporal and global benchmark technologies during the period of 2009/2010. This positive average MPI scores with respect the three technologies indicate that FCC gains a fast recovery from global economic recession during the period of 2007/2008. The impact of global economic recession on the productivity growth rate does not take effect immediately. In fact, the impact is rather slow, and can only be felt later, after a couple of years as shown by a large regressivity, in the average score of productivity changes, which are 5.2, 5.8, 5.8 percent respectively related to contemporaneous, intertemporal and global technologies during the period of 2010/2011. The slow impact of economic recession on airline's performance can be attributed to the nature of airline as one of the important modes of transportation today as it saves travel time. In a way, economic downturn does not affect the demand for air transport immediately as consumer takes time to react to global economic slowdown thus slowly changing their pattern of demand for air transport.

Table 5.8: Malmquist productivity index of full cost carriers by contemporaneous, intertemporal and metafrontier technologies, 2002/2003-2010/2011

Airline	Benchmark technology	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011
ACA	Contemporaneous	0.850	3.531	0.328	0.994	1.014	0.910	1.043	1.052	0.945
	Intertemporal	0.851	2.066	0.596	1.058	1.035	0.960	0.970	1.105	0.984
	Global	0.851	2.066	0.596	1.058	1.035	0.960	0.970	1.105	0.984
ADR	Contemporaneous	1.080	0.944	0.887	1.010	1.048	0.862	1.022	1.058	1.156
	Intertemporal	1.083	0.944	0.935	0.840	1.296	0.973	0.955	0.928	1.202
	Global	1.083	0.944	0.935	0.840	1.296	0.973	0.955	0.928	1.202
AFL	Contemporaneous	1.159	0.983	0.920	0.967	1.066	1.359	0.922	1.018	0.984
	Intertemporal	1.161	0.993	0.959	1.068	1.151	1.285	0.837	1.116	0.993
	Global	1.161	0.993	0.959	1.068	1.151	1.285	0.837	1.116	0.993
AFR	Contemporaneous	0.976	1.028	1.079	0.967	1.011	1.125	0.950	0.911	0.917
	Intertemporal	0.986	1.057	1.092	0.947	0.991	1.154	0.936	0.899	0.833
	Global	0.986	1.057	1.092	0.947	0.991	1.154	0.936	0.899	0.833
ALK	Contemporaneous	0.854	1.017	0.971	0.981	1.009	1.063	0.800	0.963	0.729
	Intertemporal	0.838	1.007	0.978	1.000	0.994	1.047	0.800	1.088	0.733
	Global	0.838	1.007	0.978	1.000	0.994	1.047	0.800	1.088	0.733
AMR	Contemporaneous	1.083	1.057	0.996	1.025	0.999	0.929	1.023	1.052	0.923
	Intertemporal	1.085	1.044	1.044	1.064	1.021	0.980	0.959	1.070	0.975
	Global	1.085	1.044	1.044	1.064	1.021	0.980	0.959	1.070	0.975
ANA	Contemporaneous	0.963	1.139	1.038	0.995	0.952	0.907	0.845	1.173	0.981
	Intertemporal	0.974	1.180	1.038	1.003	0.964	0.918	0.848	1.198	0.982
	Global	0.974	1.180	1.038	1.003	0.964	0.918	0.848	1.198	0.982
ASA	Contemporaneous	0.993	1.038	1.108	0.896	1.126	0.841	1.224	1.029	0.910
	Intertemporal	0.992	1.018	1.105	0.954	1.138	0.912	1.143	1.053	0.988
	Global	0.992	1.018	1.105	0.954	1.138	0.912	1.143	1.053	0.988
AUA	Contemporaneous	0.983	1.009	0.900	1.026	0.966	0.937	0.922	1.123	0.954
	Intertemporal	1.014	1.009	0.890	0.952	1.046	0.929	0.877	1.092	0.977
	Global	1.014	1.009	0.890	0.952	1.046	0.929	0.877	1.092	0.977

‘Table 5.8 continued’

Airline	Benchmark technology	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011
BAW	Contemporaneous	1.047	0.967	0.968	0.918	0.996	1.033	0.873	0.997	1.041
	Intertemporal	1.052	0.998	0.969	0.902	1.006	1.023	0.851	0.985	1.097
	Global	1.052	0.998	0.969	0.902	1.006	1.023	0.851	0.985	1.097
CAL	Contemporaneous	0.920	0.958	0.940	1.004	0.997	0.908	1.165	1.061	0.766
	Intertemporal	0.912	1.013	0.972	1.020	0.994	0.861	1.085	1.162	0.275
	Global	0.912	1.013	0.972	1.020	0.994	0.861	1.085	1.162	0.275
CES	Contemporaneous	0.816	1.160	0.630	0.911	0.996	0.799	1.247	1.149	0.961
	Intertemporal	0.815	1.179	0.655	1.042	1.031	0.864	1.112	1.335	1.028
	Global	0.815	1.179	0.655	1.042	1.031	0.864	1.112	1.335	1.028
CON	Contemporaneous	0.984	1.235	0.999	0.857	0.987	0.913	0.957	1.010	1.088
	Intertemporal	0.985	1.225	0.994	0.943	1.019	0.998	0.873	1.029	1.194
	Global	0.985	1.225	0.994	0.943	1.019	0.998	0.873	1.029	1.194
CPA	Contemporaneous	0.815	1.135	1.058	1.053	0.996	0.948	1.040	1.043	0.987
	Intertemporal	0.812	1.173	1.057	1.065	1.029	0.694	1.292	1.044	0.902
	Global	0.812	1.173	1.057	1.065	1.029	0.694	1.292	1.044	0.902
CSA	Contemporaneous	1.021	0.965	0.908	1.042	1.034	0.902	0.903	1.284	1.145
	Intertemporal	1.027	0.965	0.963	1.069	1.109	0.934	0.887	1.203	1.153
	Global	1.027	0.965	0.963	1.069	1.109	0.934	0.887	1.203	1.153
CSN	Contemporaneous	0.762	1.141	0.385	0.918	1.012	0.861	1.284	0.967	0.863
	Intertemporal	0.813	1.157	0.611	0.899	1.060	0.926	1.105	1.105	0.948
	Global	0.813	1.157	0.611	0.899	1.060	0.926	1.105	1.105	0.948
CYP	Contemporaneous	0.900	1.011	0.943	0.870	1.283	0.774	0.999	0.872	0.933
	Intertemporal	0.914	0.945	0.921	0.965	1.146	1.108	0.912	0.847	0.990
	Global	0.914	0.945	0.921	0.965	1.146	1.108	0.912	0.847	0.990
DAL	Contemporaneous	0.986	1.015	1.052	1.047	0.963	0.888	0.971	1.014	0.940
	Intertemporal	0.991	1.022	1.059	0.994	0.984	0.937	0.827	1.166	0.947
	Global	0.991	1.022	1.059	0.994	0.984	0.937	0.827	1.166	0.947
ETH	Contemporaneous	1.005	1.053	1.098	0.887	0.952	0.971	1.157	0.966	0.916
	Intertemporal	1.001	1.061	1.097	1.054	0.988	1.013	1.145	0.957	0.976
	Global	1.001	1.061	1.097	1.054	0.988	1.013	1.145	0.957	0.976
EVA	Contemporaneous	0.895	0.984	0.959	0.939	0.866	1.172	0.792	1.272	0.890
	Intertemporal	0.906	1.039	0.985	0.925	0.826	1.208	0.750	1.323	0.913
	Global	0.906	1.039	0.985	0.925	0.826	1.208	0.750	1.323	0.913
FIN	Contemporaneous	0.979	1.201	0.937	0.943	0.994	0.946	0.931	1.111	1.041
	Intertemporal	0.988	1.202	0.978	0.974	1.019	0.973	0.894	1.099	1.104
	Global	0.988	1.202	0.978	0.974	1.019	0.973	0.894	1.099	1.104
GIA	Contemporaneous	0.629	1.151	0.936	0.988	1.038	0.828	1.249	0.851	0.911
	Intertemporal	0.636	1.170	0.933	1.030	1.070	0.944	0.998	0.976	1.034
	Global	0.636	1.170	0.933	1.030	1.070	0.944	0.998	0.976	1.034

‘Table 5.8 continued’

Airline	Benchmark technology	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011
HAL	Contemporaneous	1.189	0.996	0.971	0.958	1.029	0.897	1.206	0.935	0.950
	Intertemporal	1.204	1.004	0.991	0.936	1.086	0.911	1.112	0.981	1.012
	Global	1.204	1.004	0.991	0.936	1.086	0.911	1.112	0.981	1.012
IBE	Contemporaneous	0.998	0.944	0.914	1.107	1.069	0.890	0.951	1.118	1.069
	Intertemporal	1.010	0.960	0.944	1.123	1.135	0.935	0.918	1.105	1.096
	Global	1.010	0.960	0.944	1.123	1.135	0.935	0.918	1.105	1.096
JAI	Contemporaneous	1.382	1.128	0.938	0.851	0.856	0.993	1.009	1.216	0.937
	Intertemporal	1.415	1.129	0.969	0.945	0.963	1.054	1.003	1.123	0.945
	Global	1.415	1.129	0.969	0.945	0.963	1.054	1.003	1.123	0.945
JAL	Contemporaneous	0.867	0.953	1.118	0.958	1.032	1.038	0.965	1.080	1.066
	Intertemporal	0.894	0.952	1.119	0.924	1.043	1.015	0.952	0.917	1.215
	Global	0.894	0.952	1.119	0.924	1.043	1.015	0.952	0.917	1.215
KAL	Contemporaneous	0.793	0.990	0.903	1.009	1.022	0.878	1.116	1.074	0.818
	Intertemporal	0.795	1.021	0.966	1.003	1.027	0.867	1.046	1.127	0.831
	Global	0.795	1.021	0.966	1.003	1.027	0.867	1.046	1.127	0.831
KLM	Contemporaneous	0.842	0.866	1.047	1.297	1.105	0.984	0.993	0.998	1.072
	Intertemporal	0.735	0.884	1.065	1.194	1.197	0.899	0.923	1.042	1.082
	Global	0.735	0.884	1.065	1.194	1.197	0.899	0.923	1.042	1.082
MAS	Contemporaneous	1.015	0.941	0.810	1.079	1.086	0.832	1.158	0.973	0.855
	Intertemporal	1.014	0.947	0.781	1.143	1.036	0.905	0.987	1.019	0.900
	Global	1.014	0.947	0.781	1.143	1.036	0.905	0.987	1.019	0.900
OAS	Contemporaneous	0.803	0.933	1.082	1.000	1.017	0.768	1.033	1.073	0.915
	Intertemporal	0.806	0.932	1.135	1.005	0.896	0.919	0.950	1.051	1.014
	Global	0.806	0.932	1.135	1.005	0.896	0.919	0.950	1.051	1.014
PIA	Contemporaneous	1.011	0.970	0.910	0.895	1.049	0.862	1.351	0.897	0.837
	Intertemporal	1.018	0.940	0.963	0.884	1.095	0.899	1.215	0.961	0.903
	Global	1.018	0.940	0.963	0.884	1.095	0.899	1.215	0.961	0.903
PINN	Contemporaneous	1.016	1.020	1.039	0.964	1.013	0.992	1.059	0.919	0.878
	Intertemporal	1.006	1.020	1.196	0.958	0.898	1.060	0.969	1.141	1.086
	Global	1.006	1.020	1.196	0.958	0.898	1.060	0.969	1.141	1.086
QFA	Contemporaneous	1.023	1.083	0.954	1.047	1.042	1.025	0.930	1.064	1.073
	Intertemporal	0.952	1.096	0.976	0.973	1.070	1.033	0.876	1.083	1.027
	Global	0.952	1.096	0.976	0.973	1.070	1.033	0.876	1.083	1.027
SAF	Contemporaneous	0.916	1.146	1.017	0.925	1.002	0.927	0.832	1.357	0.929
	Intertemporal	0.899	1.165	1.080	0.962	1.015	0.869	0.856	1.368	0.948
	Global	0.899	1.165	1.080	0.962	1.015	0.869	0.856	1.368	0.948
SAS	Contemporaneous	1.792	0.714	1.006	0.914	1.029	0.958	0.852	1.110	1.015
	Intertemporal	1.402	0.717	1.029	0.908	1.064	0.964	0.810	1.079	1.042
	Global	1.402	0.717	1.029	0.908	1.064	0.964	0.810	1.079	1.042

‘Table 5.8 continued’

Airline	Benchmark technology	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011
SIA	Contemporaneous	0.955	0.928	1.020	0.990	1.025	1.011	0.936	0.938	1.077
	Intertemporal	1.000	0.891	1.016	0.876	0.965	1.011	0.901	1.003	1.124
	Global	1.000	0.891	1.016	0.876	0.965	1.011	0.901	1.003	1.124
SKYW	Contemporaneous	0.949	1.058	1.092	0.976	1.025	0.938	1.432	1.074	0.866
	Intertemporal	0.950	1.059	1.307	1.208	1.038	1.000	0.944	1.043	1.079
	Global	0.950	1.059	1.307	1.208	1.038	1.000	0.944	1.043	1.079
THA	Contemporaneous	0.899	1.018	0.850	1.023	1.126	0.880	1.136	0.954	0.983
	Intertemporal	0.877	1.034	0.839	0.971	1.117	0.859	1.085	1.023	0.972
	Global	0.877	1.034	0.839	0.971	1.117	0.859	1.085	1.023	0.972
THY	Contemporaneous	0.898	1.002	0.850	0.914	0.511	2.010	1.185	0.920	0.921
	Intertemporal	0.885	1.015	0.854	0.967	0.434	2.686	1.097	0.951	0.978
	Global	0.885	1.015	0.854	0.967	0.434	2.686	1.097	0.951	0.978
TSO	Contemporaneous	1.605	1.076	0.909	0.931	0.936	0.863	1.432	0.938	1.009
	Intertemporal	1.583	1.112	0.868	0.961	0.983	0.911	1.377	0.942	1.064
	Global	1.583	1.112	0.868	0.961	0.983	0.911	1.377	0.942	1.064
UAE	Contemporaneous	0.999	1.005	0.932	0.931	1.018	0.942	0.965	1.089	0.993
	Intertemporal	0.991	0.974	0.986	0.974	1.040	0.966	0.979	1.061	0.991
	Global	0.991	0.974	0.986	0.974	1.040	0.966	0.979	1.061	0.991
UAL	Contemporaneous	1.143	1.077	1.065	0.865	0.934	0.886	1.102	0.955	0.792
	Intertemporal	1.136	1.105	1.045	0.887	0.943	0.895	1.098	0.965	0.639
	Global	1.136	1.105	1.045	0.887	0.943	0.895	1.098	0.965	0.639
USA	Contemporaneous	1.013	1.049	1.216	0.875	0.925	0.930	1.198	0.991	0.934
	Intertemporal	1.001	1.065	1.325	0.889	0.792	0.947	1.091	1.045	1.002
	Global	1.001	1.065	1.325	0.889	0.792	0.947	1.091	1.045	1.002
Geo-mean	***Contemporaneous***	**0.979**	**1.051**	**0.925**	**0.968**	**0.997**	**0.949**	**1.039**	**1.033**	**0.948**
	Intertemporal	***0.993***	***1.025***	***0.977***	***0.985***	***1.004***	***0.974***	***0.996***	***1.048***	***0.942***
	Global	***0.993***	***1.027***	***0.977***	***0.985***	***1.004***	***0.974***	***0.996***	***1.048***	***0.942***
No change	Contemporaneous	0	0	0	0	0	0	0	0	0
	Intertemporal	0	0	0	0	0	0	0	0	0
	Global	0	0	0	0	0	0	0	0	0
Progress (>1)	Contemporaneous	16	27	16	14	26	9	23	25	12
	Intertemporal	14	27	18	18	26	12	21	28	16
	Global	13	27	18	17	26	12	21	28	16
Regress (<1)	Contemporaneous	27	16	27	29	17	34	20	18	31
	Intertemporal	29	16	25	25	17	31	22	15	27
	Global	30	16	25	26	17	31	22	15	27

The insignificant growth of the overall productivity change in FCC is attributed to negative growth encountered by the business model during the periods of 2002/2003, 2004/2005, 2005/2006, 2007/2008, 2008/2009, 2010/2011. These periods are associated with a number of major disruptions namely as the World Trade Centre attacks in September 2001 and world economic downturn in 2008 due to the sub-prime mortgage crisis in the US which have severely affected many economies, and, the aviation industry in particular. These events have adverse impacts on the global economy. In addition, the impacts are explicitly reflected in the low productivity achievement of FCC over the period from 2002/2003 to 2010/2011.

The average Malmquist productivity index, of FCC, with respect to contemporaneous, intertemporal and global benchmark technologies in table 5.8 are plotted into line graphs as shown in figure 5.4. The FCC's geomean productivity change of intertemporal and global technologies coincides throughout most of the period from 2003 to 2011. The overlap pattern of average MPI score, between intertemporal, and global frontier, over the whole period studied, is identical to the pattern of average mean technical efficiency, which is discussed in sub-section 5.3.1 (figure 5.1) which showed that the gap between group technical efficiency of FCC and metafrontier technical efficiency of FCC is rather small. In contrast, the average MPI score related to contemporaneous technology, however, shows a diverging pattern from the intertemporal and global technologies. The variation, in the productivity growth score, implies the importance of benchmarking, the performance of airline using the metafrontier technique, as one, can compare the scores, generated from each different technique. In addition, all the three MPI scores, are consistent in terms of the trend over the period observed from 2002/2003 to 2010/2011, where, the productivity change falls during the post-terrorist attacks on the World Trade Centre in 2002/2003 and the global economic downturn in 2007/2008.

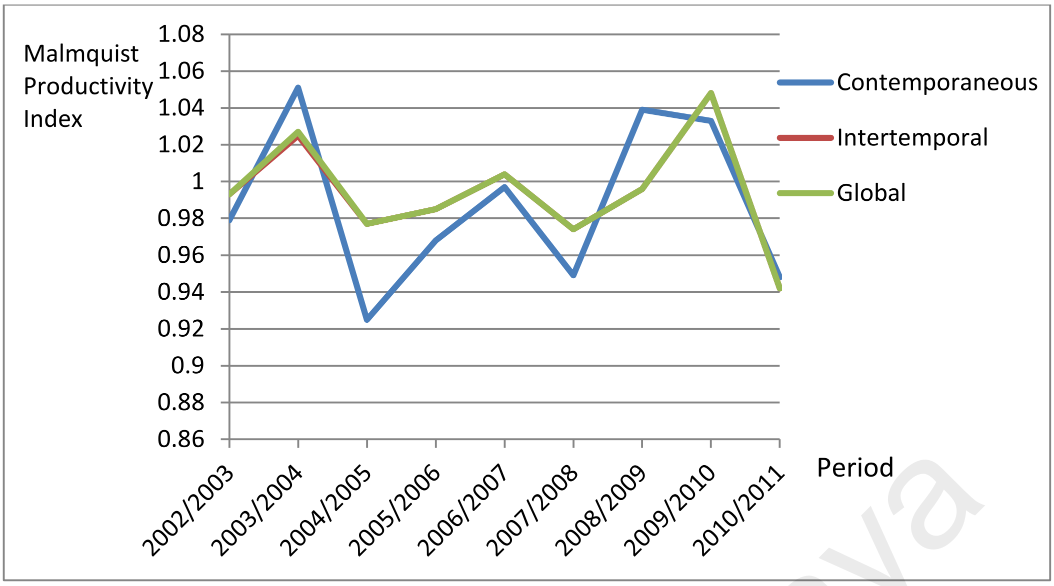


Figure 5.4: Trend of FCC Malmquist productivity index by contemporaneous, intertemporal and metafrontier technologies, 2002/2003-2010/2011

5.4.2 Results of productivity change for low cost carriers

In this sub section, the Malmquist productivity index scores of LCC with respect to contemporaneous, intertemporal and global technologies are obtained by running the DEA linear programming models as stated in model equations 4.22, 4.25 and 4.28 respectively on input and output variables for LCC. Variations in the productivity change, related to contemporaneous, intertemporal and global technologies for LCC are presented in table 5.9 and figure 5.5 as below.

Table 5.9: Productivity changes of low cost carriers by contemporaneous, intertemporal and metafrontier technologies, 2002/2003-2010/2011

Airline	Benchmark technology	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
AA	Contemporaneous	0.676	1.789	0.924	1.049	0.766	0.783	1.485	0.891	1.163
	Intertemporal	0.595	2.598	0.757	1.058	0.779	0.968	1.343	0.943	1.323
	Global	0.666	1.744	1.140	1.080	0.959	1.035	1.353	0.893	1.435
AGA	Contemporaneous	0.904	1.348	0.848	0.987	0.939	0.900	1.372	0.856	0.877
	Intertemporal	1.237	0.964	0.825	1.004	1.005	1.054	1.092	0.979	0.935
	Global	0.875	1.382	0.842	1.154	1.050	0.946	1.198	0.949	0.886
ATA	Contemporaneous	1.196	0.992	0.949	0.977	1.045	0.850	1.285	0.932	0.940
	Intertemporal	1.211	0.999	1.012	1.048	1.111	0.994	1.072	1.020	1.036
	Global	1.190	1.013	0.961	1.016	1.084	0.947	1.179	0.958	1.084
BEE	Contemporaneous	0.794	1.005	1.028	0.801	1.242	0.816	0.833	1.277	1.221
	Intertemporal	0.754	0.875	1.060	0.806	1.227	1.048	0.853	1.091	1.140
	Global	0.796	1.006	0.997	0.655	1.443	1.124	0.850	1.117	1.150
EIN	Contemporaneous	1.047	0.937	0.977	1.010	1.018	0.845	1.006	1.130	1.003
	Intertemporal	1.102	0.952	1.021	1.051	1.053	0.983	0.874	1.101	1.031
	Global	1.032	0.931	1.000	1.050	1.053	0.904	0.949	1.103	1.031
EJ	Contemporaneous	1.451	0.901	0.919	0.873	0.960	0.900	1.016	1.155	0.926
	Intertemporal	1.042	0.862	1.017	0.967	0.981	1.006	0.950	1.115	1.030
	Global	1.467	0.880	0.962	0.943	0.978	0.951	0.968	1.131	0.993
FRA	Contemporaneous	1.145	1.003	1.002	1.078	1.097	1.043	1.212	0.918	0.874
	Intertemporal	0.963	0.964	1.249	1.100	1.086	1.230	1.130	1.093	0.776
	Global	1.152	1.003	1.152	1.085	1.072	1.163	1.167	1.099	0.843
JBU	Contemporaneous	1.021	1.001	0.865	0.883	0.941	0.829	1.142	0.980	0.919
	Intertemporal	0.995	0.974	0.873	0.955	1.002	0.981	1.055	1.015	1.017
	Global	1.026	1.009	0.881	0.876	0.941	0.853	1.105	0.968	0.967

‘Table 5.9 continued’

Airline	Benchmark technology	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011
NA	Contemporaneous	2.276	0.927	1.104	0.919	0.989	0.789	1.301	0.913	0.959
	Intertemporal	1.235	0.941	1.149	1.074	1.169	0.932	0.989	1.014	1.085
	Global	2.408	0.928	1.136	1.023	1.106	0.862	1.111	0.963	1.034
RYA	Contemporaneous	1.112	1.101	0.962	0.822	0.907	1.023	0.814	1.318	0.915
	Intertemporal	1.050	1.025	1.011	0.922	1.078	1.121	0.801	1.210	0.907
	Global	1.124	1.057	1.029	0.982	1.050	1.092	0.847	1.209	0.955
SW	Contemporaneous	0.987	1.004	1.011	0.937	0.978	0.893	1.038	1.020	0.996
	Intertemporal	1.002	1.006	1.041	1.018	0.997	0.991	0.982	1.086	1.103
	Global	0.983	1.010	1.009	0.953	0.988	0.971	0.988	1.076	1.065
VAU	Contemporaneous	3.153	0.930	0.919	0.796	0.805	0.894	1.021	1.062	0.920
	Intertemporal	2.953	1.000	1.000	0.839	1.003	0.901	0.977	1.147	1.000
	Global	3.125	0.958	1.162	0.677	0.901	0.893	0.975	1.132	0.998
WJ	Contemporaneous	1.090	0.966	1.125	1.065	1.041	0.866	1.091	0.970	0.934
	Intertemporal	1.092	0.982	1.262	1.111	1.099	0.999	0.879	1.077	1.096
	Global	1.091	0.949	1.202	1.106	1.083	0.935	0.943	1.055	1.027
Geo-mean	**Contempo-raneous**	**1.183**	**1.050**	**0.969**	**0.933**	**0.972**	**0.876**	**1.108**	**1.023**	**0.968**
	Intertemporal	**1.091**	**1.037**	**1.011**	**0.992**	**1.040**	**1.013**	**0.991**	**1.066**	**1.029**
	Global	**1.184**	**1.048**	**1.031**	**0.956**	**1.048**	**0.971**	**1.039**	**1.046**	**1.028**
No change	Contemporaneous	0	0	0	0	0	0	0	0	0
	Intertemporal	0	1	1	0	0	0	0	0	1
	Global	0	0	1	0	0	0	0	0	0
Progress (>1)	Contemporaneous	9	7	5	4	5	2	11	6	3
	Intertemporal	9	3	9	8	10	5	5	11	9
	Global	9	8	7	7	8	4	6	8	7
Regress (<1)	Contemporaneous	4	6	8	9	8	11	2	7	10
	Intertemporal	4	9	3	5	3	8	8	2	3
	Global	4	5	5	6	5	9	7	5	6

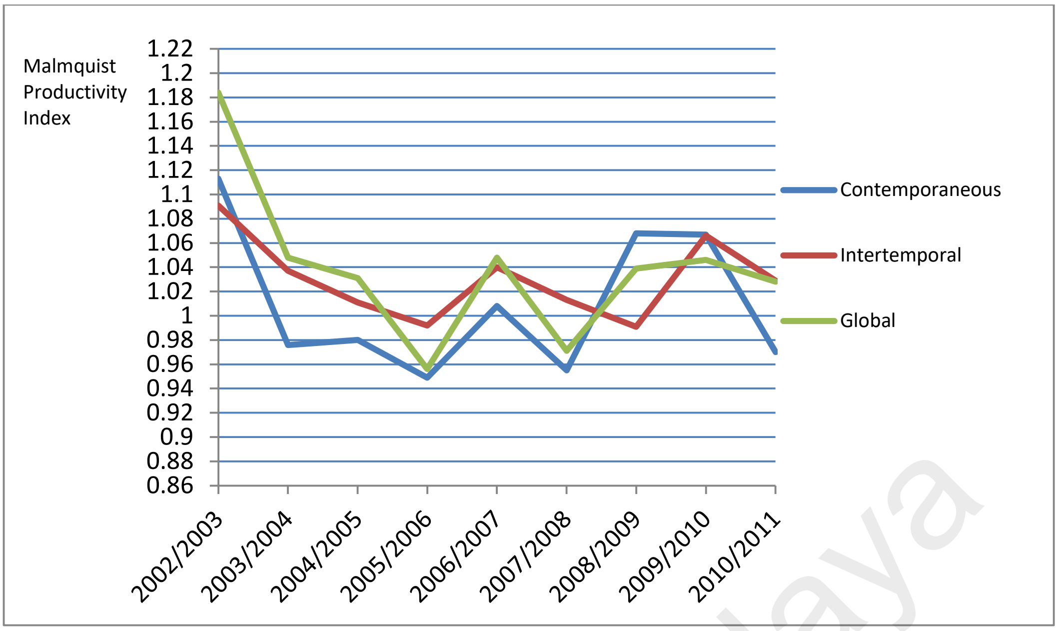


Figure 5.5: Trend of LCC Malmquist productivity index by contemporaneous, intertemporal and global technologies, 2002/2003-2010/2011

In general, LCC group exhibited three periods of progression in the average productivity change score relative to the three benchmark technologies for the periods 2002/2003, 2006/2007, 2008/2009 and 2009/2010. Throughout the whole period, the LCC observed spectacular productivity growths during the period of 2002/2003 which were 18.3, 9.1, and 18.4 percent with regards to contemporaneous, intertemporal and global technologies respectively. The change in the productivity of LCC, with regard to the global technology, which, is given by the scores of MPI, demonstrated a progressive trend throughout the whole period as observed from 2002/2003 to 2010/2011. Nonetheless, the rate of change, in the productivity is falling significantly, from 18.4 percent to 2.8 percent, during the period of 2002/2003 and 2010/2011 respectively as shown by geomean MPI scores in columns 3 to 11 of table 5.9 above.

Looking at the results in table 5.9, there are two interesting points, which merit a discussion. This is related to two events, in 2002/2003 and 2008/2009 respectively, which not only have badly affected the world economy in general, but also have severely affected the airline industry's performance. The period of 2002/2003 was known as gloomy period for the airline industry due to the tragedy of September 2001 where the World Trade Centre was attacked by terrorists. This tragedy has severely affected the performance of legacy airlines, particularly in the United States. Another period, where the aviation industry is severely affected, was 2008/2009. This period, remarks the post mortgage crisis which starts in the United States in 2006, later on continued by the Euro-zone crisis in 2009 which has badly affected the European economies. It is important to highlight a regressive in global MPI score of 2.9 percent during the post global economic crisis 2007/2008. This finding is not surprising, as majority of LCC in the sample performed badly, during the post-economic crisis period of 2007/2008 except Frontier, Ryanair and Air Asia which managed global MPI scores of 16.3 percent, 9.2 percent and 3.5 percent respectively. No doubt, these airlines, are known as highly performed LCC, in the United States, Europe, and Asia.

From the findings, it is concluded that LCCs have experienced positive productivity growth over all periods observed from 2002/2003 to 2010/2011 despite series of disruptions in 2002/2003 and 2008/2009. In contrast, the situation for full cost carriers is the reversed where these events have dragged the carriers into negative growth with regard to global MPI as indicated by negative productivity growth of 0.7 and 0.4 percent respectively during the periods 2002/2003 and 2008/2009 (table 5.8). Full cost carriers suffer a setback in the productivity change due to a massive cut in the number of passengers as they are seeking for low fare airline. Nevertheless, these two events are advantages for LCC as they can increase their capacity to meet the high demand for low cost travel.

5.5 Results of average metafrontier Malmquist Productivity Index (MMPI) and decomposition into efficiency change (EC), best practice change (BPC) and technology gap change (TGC).

Table 5.10, depicts the results of average metafrontier MPI, and the values of its decomposition, into efficiency change, best practice change and technological gap change for the full cost and low cost carriers, each year for the period from 2002/2003 to 2010/2011. The values of metafrontier MPI, and its decomposition, are aggregated from the results of MPI for an individual airline in FCC and LCC groups as demonstrated in tables 5.8 and 5.9. The values in table 5.10 is presented in graphs of yearly metafrontier Malmquist productivity change and its decomposition into efficiency change, best practice change and technological gap change as shown in figure 5.6 (panels i, ii, iii, and iv).

As shown in table 5.10, during the period 2002 to 2003, LCC recorded an increase in productivity level as shown by a change of 18.4 percent in the value of MPI which is attributed to a considerable increase in the efficiency level as exhibited by a change of 43.8 percent. However, in the subsequent period 2003 to 2004, both groups of FCC and LCC indicate an increase in the productivity level of 4.6 percent and 4.8 percent respectively. The positive productivity growth experienced by FCC is resulting from a high technological growth and the capability of the FCC managers to efficiently utilize the available inputs. Meanwhile, the positive productivity growth in LCC is best explained by a positive change in the efficiency of the production process. Next, during the period of 2004/2005, only LCC exhibits progress in the productivity growth, which, is associated with efficiency change. After recording a favourable performance in the productivity level, during the period of 2006/2007, once again, both groups of airlines presented progress in the productivity growth as indicated by the MPI scores of 1.007 and

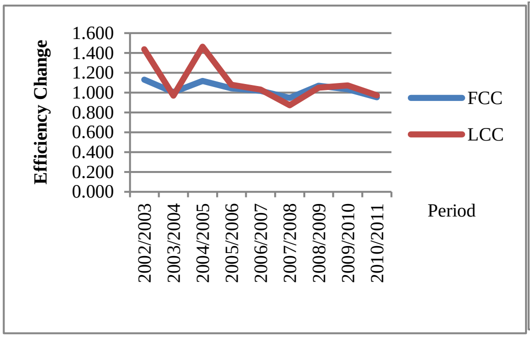
1.048 for FCC and LCC respectively. During this period, major sources of productivity growth in LCC, are attributed to technological and efficiency changes. Meanwhile, the growth of productivity in FCC is driven by, the efficiency change. However, the productivity performance during the period of 2007/2008, is as expected, where none of the FCC and LCC groups shows an increase in the productivity owing to the global economic crisis which sparked in the United States. Nevertheless, the LCC group makes a significant recovery as it recorded a productivity growth of 3.9 percent in the subsequent period of 2008/2009, which is supported by a significant efficiency change of 7 percent. A possible explanation, for the fast recovery of LCC during the period is owing to price transparency due to the massive distribution of tickets through the internet elsewhere over the world. (World Airline Report, July 2009).

In addition, the airline industry continues to post a fast recovery process despite the high pressure as a result of economic turbulence in 2008. During the period 2009/2010, FCC and LCC recorded another positive average growth in the productivity with the MPI scores of 1.060 and 1.046 respectively. This time around the productivity growth of FCC is attributing to a moderate increase in the efficiency change and technical change of 2.5 percent and 3.4 percent respectively. Nonetheless, for LCC group, the positive growth in the productivity is merely owing to the increase in efficiency of production. Despite a serious debt crisis which has greatly affected many economies in the European continent in 2010, the air transport industry managed it quite well. This positive notion is evidenced by a moderately positive growth of 2.8 in the productivity of the LCC group during the period of 2010/2011. The main source of the positive change in productivity during the period, is, owing to a favourable growth in the technical change of the airline industry. For this reason, innovation is central for LCC, to raise the productivity level, for example, the online booking system allows passengers to book their ticket through the individual airline website which has greatly reduced the cost of selling the air tickets thus avoiding a high selling cost as compared to dependence on the Global Distribution System to sell tickets.

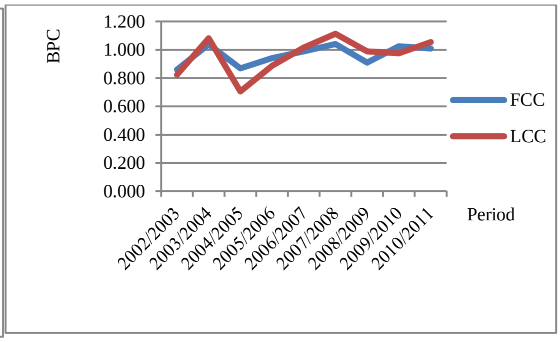
In summary, the change in the productivity of the LCC, exceeds that of the FCC throughout the periods examined, from 2002/2003 to 2010/2011. In most periods, LCC progressed in terms of the productivity growth as shown by the values of MPI which exceed one, excepted during the periods of 2005/2006 and 2007/2008. On average, the LCC group recorded a decrease in the productivity from 18.4 percent to 2.8 percent annually over the period from 2002/2003 to 2010/2011 respectively. It is noteworthy that the period of 2007/2008 is marked by global economic recession which has hard hit the aviation industry. The source of progress, in the productivity change of LCC, is due to innovation as indicated by a positive growth in the technical change of 5.6 percent. Not only that, LCC also exhibits outward shifts in the technology gap change for 5 periods throughout the 9 periods observed as compared to TGC scores for FCC which recorded only 2 periods of outward shifts from 9 periods observed. However, the indicator of TGC is a weak indicator to suggest that LCC is moving closer to the global frontier technology. Further diagnostic checks are required before confirming such a decision. The comparison between LCC and FCC with respect to their performance in terms of productivity change, efficiency change, best practice change, and technological gap change as benchmarked using the metafrontier technique are exhibited in figure 5.6 (panels i-iv) below.

Table 5.10: Average efficiency change, best practice change, technological gap change and metafrontier Malmquist productivity index for full cost and low cost carriers, 2002/2003-2010/2011

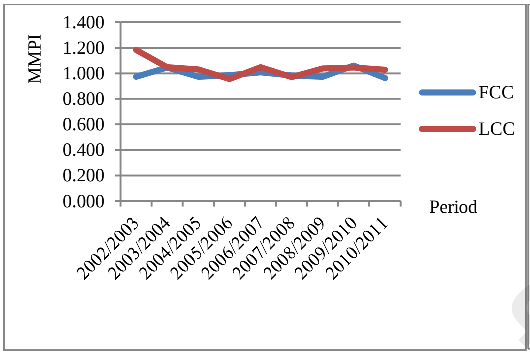
MPI & decom-positions	Group	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
EC	FCC	1.131	1.006	1.118	1.045	1.019	0.945	1.070	1.034	0.952
	LCC	1.438	0.969	1.462	1.078	1.030	0.871	1.051	1.073	0.973
BPC	FCC	0.860	1.040	0.869	0.942	0.988	1.041	0.910	1.025	1.010
	LCC	0.823	1.081	0.705	0.887	1.017	1.114	0.989	0.975	1.056
TGC	FCC	1.000	1.001	1.000	1.000	1.000	1.001	1.000	1.000	1.000
	LCC	1.085	1.010	1.019	0.964	1.008	0.958	1.049	0.981	0.998
MPIM	FCC	0.973	1.046	0.972	0.984	1.007	0.984	0.974	1.060	0.962
	LCC	1.184	1.048	1.031	0.956	1.048	0.971	1.039	1.046	1.028



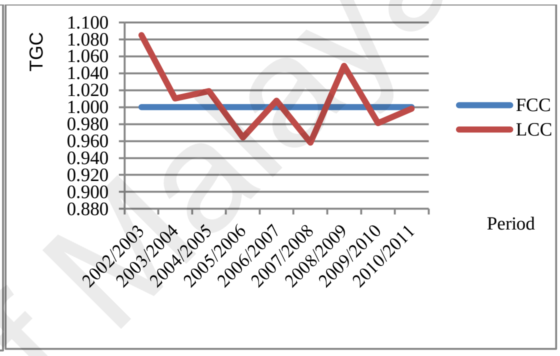
i. EC



ii. BPC



iii. MMPI



iv. TGC

Figure 5.6: Aggregated metafrontier Malmquist productivity index (MMPI) and its decomposition into efficiency (EC), best practice (BPC), and technological gap changes (TGC), 2002/2003-2010/2011

Table 5.11: Aggregated metafrontier Malmquist productivity index and its decompositions into efficiency change and best practice change, technological gap change, and technological gap ratio, 2002-2011

Carrier	**MPI**	**EC**	**BPC**	**TGC**	**TGR**
Full Cost Carrier	0.995	1.034	0.962	1.000	0.996
Low Cost Carrier	1.037	1.090	0.952	1.007	0.814
Total	1.005	1.047	0.96	1.002	0.95

Table 5.11 above shows the aggregated metafrontier productivity change and its decomposition into efficiency change, best practice change and technological gap ratio change. The values are obtained by aggregating the individual scores of productivity change, efficiency change, best practice change and technological gap ratio change of each group of airlines for all the periods observed. The heterogeneity natures of production technologies adopted by the full cost and the low cost carriers lead to differences in the results of productivity change and its decomposition.

As tabulated in table 5.11, in general, the productivity of both groups of airlines has increased marginally by a growth rate of 0.5 percent over the whole periods observed from 2002/2003 to 2010/2011. The main sources of productivity growth in the world airlines are due to efficiency change and the technological gap change with annual growth rates of 4.7 percent and 0.2 percent respectively and were offset by the technical regress of 4 percent per year. The low cost carrier is the most productive group with a productivity growth of 3.7 percent annually. In contrast, the least productive group is the full cost carrier with a negative productivity growth of 0.5 percent per annum. The low cost carriers recorded the highest change in efficiency with the growth rate of 9 percent per year which implies that the group is good in catching up. This outcome indicates that the performance of low cost carriers resulted from their ability to utilize endowed resources to the fullest.

Although the aggregated technology gap ratio (TGR) shows that the full cost carrier is closer to the world technology frontier as indicated by the high value of TGR of 0.996 which is approaching unity, however in terms of technology gap change, the group exhibits that full cost carrier is lacking the power to speed up the technological growth. It is noteworthy also, that although full cost carrier shows that it is moving closer to the world frontier, nevertheless the group recorded a decrease in the productivity growth of 0.5 percent per year. This finding is in line with the explanation regarding catch up to technology frontier by Howitt and Foulkes (2005) where the authors argued that closeness to the frontier implies a lower productivity growth. On the other hand, low cost carrier has the power to speed up the technological development as shown by the growth in the technology gap of 0.7 percent annually.

In terms of the result of technology gap change, it suggests that the low cost carrier is the world technology leader. Meanwhile, full cost carrier is technology follower. However, arguing that a group is world technology leader based on technology gap change per se is not convincing enough because TGC only gives the indicator of the rate of technology leadership change. Hence, there is a need for further diagnostic tests to support the result. For this purpose, a histogram and Kernel density analysis of technology gap ratio for each of FCC group and LCC group are adopted as proposed by Oh and Lee (2010). The results are presented in panels (a) and (b) of figure 5.6.

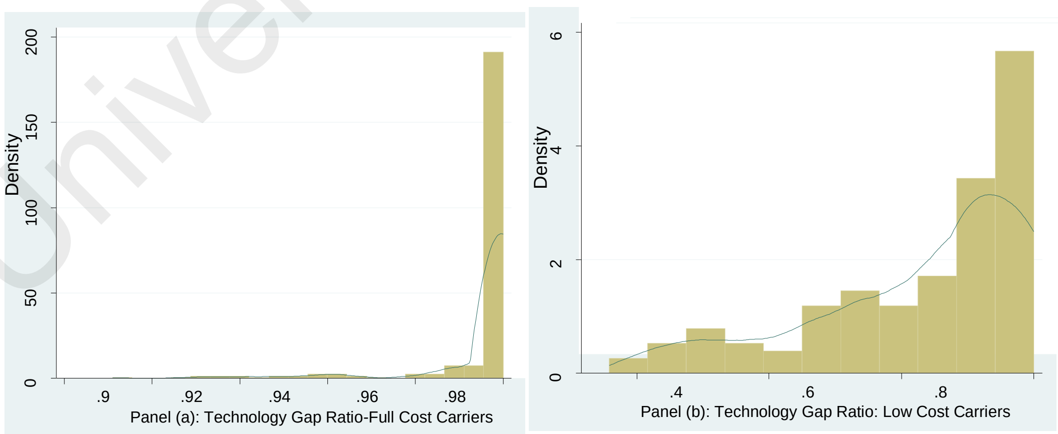


Figure 5.7: Histogram and Kernel density estimation of technological gap ratio for full cost and low cost carriers

The results from the further analysis in figure 5.7 (panels a and b) support that FCC is a world technology leader whilst LCC is the follower. This is evidenced by the distribution of TGR which nearing 1 for the individual airline in the FCC group despite a lower score for the technological gap change. On the other hand, the values of technological gap change (TGC) for LCC which exceed 1, despite the low TGR values, implies that the LCC is experiencing an outward shift of the group frontier but is positioned far from the global technology.

In terms of the technology gap change, on average, full cost carriers group is narrowing the gap with the aviation global technology. This is exhibited by the high scores of TGR, which is nearing 1, throughout the years observed from 2002 to2011. These results designated that the FCC technology is closed to the world frontier technology as indicated by the average TGR score of 0.996 (see table 5.5). A possible explanation about why the FCC group is converging with the metafrontier technology is in terms of the cost gap. A study conducted by KPMG International (2013) confirmed that the full cost carriers and the low cost carriers are converging in terms of unit cost per Available Seat Kilometer throughout the period from 2006 to 2011. This notion is further convinced by Tsoukalas et al. (2008) who argued that improvement in the cost efficiency among the legacy carriers is attributed to labour cost reductions. As the full cost carriers further trim its costs, the technical efficiency and the labour productivity will improve, thus raising the performance of the full cost carriers. In addition, the cost saving is partly attributed to innovations in FCC business model which increases the efficiency of the business model (Bitzan & Peoples, 2014). An interview with the CEO of Vueling, Alex Cruz argues that the airline industry today is converging in the sense that full cost carriers and low cost carriers are not embracing the pure business model (“Airlines in Transition”, 2013). This is because of the fact that there is a need for each business model to embrace some elements found in its counterparts, to suit present business challenges and requirements. For example, full cost carriers customized their products by lowering their costs. In contrast, there is a large gap in the technology adopted by LCC when compared to world airline technology. The average technological gap ratio which is 0.814 signifies that the LCC group produces less than the productive capacity of the metafrontier technology. In a way, there is a need for the low cost carriers to further increase its production level so as to be at par with the best practice frontier which is the FCC. In addition, the low cost carriers may want to upgrade their product and services, for instance by offering a comfortable long haul service, business class cabin etc. based on individual needs which are not being offered by the traditional low cost carriers.

Table 5.12 shows the comparison between the results of metafrontier MPI and its decomposition and that of conventional MPI of Fare et al. (1994). The finding demonstrates that the patterns and values of productivity growth and its decomposition between the two approaches have similarity.

Table 5.12: Comparison of results of productivity change, efficiency change, best practice gap change and technology gap change between metafrontier MPI (Oh & Lee, 2010) and MPI (Fare et al.,1994)

	Oh & Lee (2010) Metafrontier Malmquist Productivity Index				Fare et al. (1994) Malmquist Productivity Index		
Airlines	**MPI**	**EC**	**BPC**	**TGC**	**MPI**	**ECH**	**TECHCH**
ACA	1.017	1.045	0.973	1.000	0.993	1.045	0.950
ADR	1.008	1.077	0.936	1.000	1.004	1.077	0.931
AFL	1.055	1.087	0.970	1.000	1.034	1.087	0.951
AFR	0.984	1.015	0.969	1.000	0.994	1.015	0.979
ALK	0.935	0.963	0.971	1.000	0.925	0.963	0.961
AMR	1.026	1.063	0.965	1.000	1.008	1.063	0.948
ANA	1.006	1.014	0.992	1.000	0.994	1.014	0.981
ASA	1.031	1.074	0.960	1.000	1.012	1.074	0.942
AUA	0.974	0.993	0.981	1.000	0.978	0.993	0.985
BAW	0.984	1.005	0.980	1.000	0.981	1.005	0.976
CAL	0.865	0.988	0.876	1.000	0.963	0.988	0.975
CES	0.987	1.018	0.970	1.000	0.944	1.018	0.927
CON	1.024	1.062	0.964	1.000	0.998	1.062	0.940
CPA	0.992	1.014	0.978	1.000	1.005	1.014	0.990
CSA	1.030	1.085	0.949	1.000	1.016	1.085	0.937
CSN	0.942	0.984	0.958	1.000	0.871	0.984	0.885
CYP	0.968	1.007	0.961	1.000	0.945	1.007	0.938
DAL	0.988	1.025	0.964	1.000	0.985	1.025	0.961
ETH	1.031	1.077	0.957	1.000	0.997	1.077	0.926
EVA	0.972	0.990	0.981	1.000	0.964	0.990	0.974
FIN	1.022	1.049	0.974	1.000	1.006	1.049	0.958

'Table 5.12 continued'

	Oh & Lee (2010) Metafrontier Malmquist Productivity Index				Fare et al. (1994) Malmquist Productivity Index		
GIA	0.965	1.004	0.962	1.000	0.937	1.004	0.934
HAL	1.023	1.066	0.960	1.000	1.009	1.066	0.947
IBE	1.021	1.048	0.975	1.000	1.003	1.048	0.957
JAI	1.052	1.104	0.953	1.000	1.022	1.104	0.925
JAL	0.999	1.000	0.999	1.000	1.006	1.000	1.006
KAL	0.959	0.974	0.984	1.000	0.950	0.974	0.975
KLM	0.991	1.009	0.982	1.000	1.015	1.009	1.006
MAS	0.965	1.005	0.960	1.000	0.965	1.005	0.960
OAS	0.963	1.007	0.957	1.000	0.952	1.007	0.945
PIA	0.982	1.024	0.958	1.000	0.966	1.024	0.943
PINN	1.033	1.176	0.879	1.000	0.987	1.176	0.839
QFA	1.007	1.033	0.975	1.000	1.026	1.033	0.992
SAF	1.007	1.032	0.975	1.000	0.996	1.032	0.964
SAS	0.986	1.005	0.981	1.000	1.012	1.005	1.007
SIA	0.974	1.000	0.974	1.000	0.986	1.000	0.986
SKYW	1.064	1.170	0.910	1.000	1.036	1.170	0.885
THA	0.971	0.995	0.975	1.000	0.981	0.995	0.985
THY	0.986	1.022	0.965	1.000	0.964	1.022	0.944
TSO	1.068	1.113	0.960	1.000	1.054	1.113	0.946
UAE	0.995	1.024	0.972	1.000	0.985	1.024	0.962
UAL	0.956	1.004	0.952	1.000	0.973	1.004	0.969
USA	1.008	1.047	0.962	1.000	1.008	1.047	0.963
AA	1.105	1.120	0.987	1.052	1.009	1.120	0.900
AGA	1.018	1.104	0.922	1.013	0.987	1.104	0.894
ATA	1.044	1.095	0.953	0.991	1.011	1.095	0.923
BEE	0.991	1.079	0.919	1.021	0.984	1.079	0.912
EIN	1.004	1.043	0.963	0.988	0.994	1.043	0.953

'Table 5.12 continued'

	Oh & Lee (2010) Metafrontier Malmquist Productivity Index				Fare et al. (1994) Malmquist Productivity Index		
EJ	1.019	1.078	0.945	1.025	0.998	1.078	0.926
FRA	1.077	1.116	0.965	1.020	1.036	1.116	0.929
JBU	0.955	1.004	0.952	0.971	0.949	1.004	0.946
NA	1.118	1.171	0.955	1.055	1.074	1.171	0.917
RYA	1.034	1.101	0.939	1.026	0.986	1.101	0.896
SW	1.004	1.049	0.957	0.980	0.984	1.049	0.937
VAU	1.085	1.126	0.964	0.980	1.049	1.126	0.932
WJ	1.040	1.087	0.957	0.980	1.013	1.087	0.932
Total	**1.005**	**1.047**	**0.96**	**1.002**	**0.990**	**1.031**	**0.961**

To further support the similarity in productivity growth and its decomposition between the two different approaches, we employ the Spearman's Rho correlation test, which is a non-parametric test. The Spearman's Rho correlation results in tables 5.13 to 5.15 below show the correlations between metafrontier MPI and MPI of Fare et al. (1994), as well as the correlations between its decomposition namely as efficiency change, and best practice change for the metafrontier technique and that of the standard approach of Fare et al. (1994). The value of the Spearman's rank correlation namely ρ for productivity growth between the two methodologies is 0.844. Meanwhile, the value of ρ for efficiency change between the two methodologies is 1.000. On the other hand, the value of ρ for technical change between the two methodologies is 0.696. Since the coefficients of the Spearman's rank correlation with respect to productivity change, efficiency change, and technical change are greater than 0.5, hence it can be concluded that the metafrontier approach gives similar findings as the approach of Fare et al. (1994). Another superiority of the metafrontier approach of MPI is that the approach also provides the measure of technical leadership with ex ante information which is reflected in the value of technology gap change.

Table 5.13: Spearman's Rho correlation between metafrontier MPI and MPI of Fare et al. (1994)

	MPI Type		MPIM	MPIF
Spearman's Rho	MPIM	Correlation coefficient	1.000	0.844***
		Probability	-	0.000
		N	56	56
	MPIF	Correlation coefficient	0.844***	1.000
		Probability	0.000	-
		N	56	56

Table 5.14: Spearman's Rho correlation between metafrontier efficiency change and efficiency change of Fare et al. (1994)

	EC type		EC	ECF
Spearman's Rho	EC	Correlation coefficient	1.000	1.000***
		Probability	.	0.000
		N	56	56
	ECF	Correlation coefficient	1.000***	1.000**
		Probability	0.000	.
		N	56	56

Table 5.15: Spearman's Rho correlation between BPC and TECHCH of Fare et al. (1994)

	TECH Type		BPC	TECHCH
Spearman's Rho	BPC	Correlation coefficient	1.000	0.697^{***}
		Probability	-	0.000
		N	56	56
	TECHCH	Correlation coefficient	0.696^{***}	1.000^{**}
		Probability	0.000	-
		N	56	56

Note: The signs (**) and (***) indicate significant at 5 percent and 1 percent respectively

5.6 Summary of findings

The result of technical efficiency and productivity change of airlines for both groups of LCC and FCC business models varies. In the case of the technical efficiency results, the score varies for each airline when benchmarked against each group, and meta technology frontiers. The result from the analyses suggests that full cost carrier, is the most efficient form of airline business model as indicated by the highest score of technology gap ratio which is 99.6 percent as compared to the score for LCC which is 81.4 percent. This finding is further supported by the result from the Kernel density test of technology gap ratio which showed that the distribution of TGR approaches 1for FCC. In a way, the finding argues that FCC is the leader in technology for the aviation industry. Meanwhile, productivity wise, LCC is the most productive business model as indicated by the highest and positive value of technical change as compared to FCC. Therefore, it is worth investigating the determinants of variations in the technical efficiency and productivity of airlines in the sample of study which will be carried out in the next chapter.

CHAPTER 6: RESULTS AND DISCUSSIONS FOR THE GMM ESTIMATIONS

6.1 Introduction

The objective of this chapter is to report and discuss the results obtained from the GMM estimations. The variables of performance indicators, namely technical efficiency and productivity growth are estimated using the metafrontier technique based on the DEA approach as analysed in chapter 5. Sub-section 6.2 presents the finding associated with the relationships between technical efficiency and extent of airline outsourcing. Next, sub-section 6.3 explains the relationship between productivity growth and the extent of airline outsourcing. Subsequently, subsection 6.4 discusses the results related to the connection between technical efficiency and economic development level. After that, the relationship between productivity growth and economic development is explicated in subsection 6.5. Subsection 6.6 concludes.

The results are obtained by running four linear regression models as specified in equations 4.41 to 4.44, using one step System Generalized Method of Moments (GMM) technique as discussed in the methodology chapter. It is worth mentioning that in this case, where the number of airlines in the sample is 53, as compared to length of time period observed which is 10, the System GMM estimator is efficient (Roodman, 2009). Furthermore, Blundell and Bond (1998), suggested that the System GMM works well with small time period observation. The empirical results generated from the four model specifications are presented in tables 6.1 to 6.6.

6.2 Relationship between technical efficiency of airlines and extent of outsourcing.

In this sub section, sample of airlines are grouped into two, which are small and large scale, based on the volume of revenue generation as measured by Revenue Passenger Kilometer (RPK). The rationale to group the sample of airlines in such a way is because large scale airlines generate higher revenues than the small scale ones as large scale airlines require larger size of capitals thus serving larger number of passengers and routes.

The results pertaining to the relationship between the extent of outsourcing and the technical efficiency for samples of small scale and large scale airlines are presented in two models as summarized in table 6.1 below.

Table 6.1: Results of relationship between technical efficiency of airlines and the extent of outsourcing in small and large scale airlines

Metafrontier technical efficiency	Coefficient small scale airlines	Coefficient large scale airlines
Lag metafrontier technical efficiency, mtecheff ($\hat{\beta}_0$)	0.611*** (0.000)	0.511*** (0.000)
Outsourcing extent, OSRC ($\hat{\beta}_1$)	12.655* (0.074)	-0.772 (0.883)
Passenger Load Factor, PLF ($\hat{\beta}_2$)	-2.330 (0.119)	0.773 (0.668)
Available seat kilometer, ASK ($\hat{\beta}_3$)	-1.484 (0.166)	0.658 (0.553)
Revenue Passenger Kilometer, RPK ($\hat{\beta}_4$)	1.633 (0.159)	-0.689 (0.567)
Interaction effect: OSRC x RPK ($\hat{\beta}_5$)	-0.793* (0.067)	-0.062 (0.832)
Number of observation	216	216
Number of airlines	27	27
Number of instrument	12	12
Sargan test	0.163	0.402
Arrelano-Bond test, AR (2)	0.143	0.767

Note: Numbers in parenthesis are p-values

*indicates statistical significance at 10% level, *** indicates statistical significance at the 1% level.

The lag dependent variable, LMTECHEFF for both models are significant at 1 percent level respectively, thus implying that adoption of the dynamic one step System GMM models are appropriate in examining the relationship between technical efficiency and the extent of outsourcing in airlines. In a way, the result implies that past values of technical efficiency have the influence on values of present technical efficiency of airlines. This relationship is as expected because investment in aviation business incurs a huge capital costs, nevertheless the return is relatively slow (IATA, 2016). Besides that, the GMM dynamic panel data estimation has received wide acceptance from researchers who studied firm's performance, for example, Machin and Van Raneen (1993); Geroski and Machin (1997); Elsayed and Paton (2005); Nifo and Vecchione (2015) and; e Souza and Gomes (2015). Moreover, the instruments used in the two models seemed appropriate and efficient as indicated by the large value of Sargan test statistics of 0.163 and 0.402 for small and large scale airlines respectively.

Additionally, the Arellano-Bond second order serial correlation tests, are statistically not significant as shown by high values of AR(2) for both small scale and large scale models which are 0.143 and 0.767 respectively. The finding from both small and large scale models showed non-rejection of the Sargan tests, which signifies that the instruments used in the two models are valid. In addition, the results in both models also indicate non-rejection of the null hypothesis of no second order serial correlation hence, suggesting the absence of second order serial correlation in the first difference residuals. In a way, the result of the second order correlation implies that the error terms are independently and identically distributed within the sample of airline companies.

With regard to the relationship between the extent of outsourcing and the technical efficiency of airlines, the findings reveal that, outsourcing per se has a significant yet negative impact on the technical efficiency of airlines in the sample of small scale airlines[7]. The coefficient for outsourcing extent is 12.655 and the p-value is 0.074. It is noteworthy that the interpretation of the sign of the coefficients presented in the results as exhibited in table 6.1 is read in an opposite manner. This is because the extent of outsourcing in this study is proxied by the ratio of labour cost to total operating costs. Nevertheless, the interaction term between outsourcing (OSRC) and the size of airline company, (RPK) which is denoted by OSRCxRPK indicates a coefficient of -0.793. This suggests that outsourcing of airline activities is significant and has a positive correlation, albeit weak influence on the technical efficiency of airlines, as demonstrated by a slightly high p-value of 0.067. In other words, the results in this study pointed to the importance of outsourcing in driving up the technical efficiency of airlines in the context of small scale airlines. Despite limited specific literature related to the impact of outsourcing upon performance of airlines, the finding in this study is as expected and conformed with past empirical studies which suggests positive influence of outsourcing on performance of small scale firm as highlighted in Ono and Stango (2005) study. According to the author, smaller firms may benefit from scale economies of the external suppliers hence enjoying lower costs by outsourcing activities to external suppliers. In addition, the finding from exploratory study of Tayeb (2012) stresses that outsourcing of airlines' activities has positive impact on costs when the demand level for the activities is not worthwhile for investment on in-house provisions to be carried out. Some additional evidences, in the

[7] It is worth reminding that the extent of outsourcing by airlines in this study is measured by labour cost. The higher the labour cost, the more the activities are done in house. Thus, a positive coefficient sign in the estimation indicates a negative relationship and vice versa.

context of airports which support the important role of outsourcing, in influencing the efficiency of firms, are highlighted in researches done by Oum et al. (2006); Mol (2007) and; Tovar and Martin-Cejas (2009). In this respect, outsourcing enables firms to slash down costs, at the same time, raising the performance of the firms.

Meanwhile, passenger load factor, available seat kilometer, and revenue passenger kilometer which are commonly used as control variables, indicate no significant associations with the technical efficiency score of airlines in the sample. This is probably due to the metafrontier estimation technique used in estimating the technical efficiency score, where the technique generates large differences in the score as compared to the score obtained from an application of the standard DEA technique. The insignificance of the results for the control variables are not surprising. This is because of the fact that load factor, and revenue passenger kilometer are both indicators of structural demand intensity for airlines, therefore are beyond the control of airline managers (Bhadra, 2009). In addition, the author argued that, there is a possibility for an airline to perform technically well, in the absence of high demand intensity as long as the airline has an influence over its technical performance.

Interestingly, the finding in this analysis is contrasted to the finding from the regression analysis conducted by Tayeb (2012), where the author found that outsourcing has no effects on overall performance of airlines. It is argued by the author that part of the reasons for the absent of relationship between intensity of outsourcing and airlines' performance is owing to the limitation of outsourcing data set, as most past studies employed extensive data sets, in order to regress the intensity of outsourcing upon firms' performances. Also, the former study does not group the sample of airlines into small and large scale. This reason, perhaps, is one of the reasons for non-significance in the relationship between outsourcing and airline performance. Another possible explanation for the contradiction between the results of our study and that of Tayeb (2012) is probably due to differences in the definitions of performance (the dependent variable) where performance in our context of study is derived from the technical efficiency whilst in the latter, performance is proxied by operating statistics which are directly observed from the airline operations such as profit, average aircraft utilization and percentage of on time departure.

With regards to the results from large scale sample of airlines, the One Step System GMM seems to be adequate to estimate the determinants of technical efficiency as portrayed by the highly significant p-value for the lag of technical efficiency. Nonetheless, outsourcing individually and the interaction with size of airline have no influences on the technical efficiency of airlines in the study. As the size of airline increases, outsourcing may not a beneficial option which suggests that carrying the activities in-house is more efficient (Abraham & Taylor, 1996). Meanwhile, control variables as represented by passenger load factor, available seat kilometer and revenue passenger kilometer are not significant. The insignificance of results for the control variables are not surprising as explained in (Bhadra, 2009) study that the demand factors are not within the control of firms' managers.

6.3 Association between productivity growth of airlines and the extent of outsourcing

The results in table 6.2 show that the one step dynamic System GMM estimator adopted in the study seemed appropriate and efficient as indicated by highly significant lag dependent variables for both models of small and large scale samples of airlines. Despite showing the significant correlation between the values of past and present dependent variables, the instruments applied in the study are also statistically valid as indicated by the result of the Sargan test statistics. The null hypothesis of valid overidentifying restrictions, for the Sargan test is not rejected. Meanwhile, the statistical test to verify the absence of second order serial correlation also indicates non-rejection of the null hypothesis of no second order serial correlation between some of the regressors and the error terms. This property is important to be met, in order for a GMM to become an efficient estimator. Column 2, of table 6.2 indicates the results for small sample size of airlines.

Table 6.2: Results of relationship between productivity growth of airlines and the extent of outsourcing in small and large scale airlines

Metafrontier Productivity Growth (MMPI)	Coefficient small scale airline	Coefficient large scale airline
Lag metafrontier productivity growth, MMPI ($\hat{\beta}_0$)	-0.158*** (0.008)	-0.855*** (0.000)
Outsourcing extent, OSRC ($\hat{\beta}_1$)	0.691* (0.077)	3.576 (0.546)
Passenger Load Factor, PLF ($\hat{\beta}_2$)	3.088*** (0.002)	-0.092 (0.543)
Available seat kilometer, ASK ($\hat{\beta}_3$)	3.005*** (0.001)	-0.701 (0.246)
Revenue Passenger Kilometer, RPK ($\widehat{\beta 4}_4$)	-3.002*** (0.001)	0.833 (0.193)
Interaction effect: OSRC x RPK ($\hat{\beta}_5$)	-0.272* (0.084)	-0.269 (0.430)
Number of observation	208	216
Number of airlines	26	27
Number of instrument	12	12
Sargan test	0.262	0.468
Arrelano-Bond test, AR (2)	0.385	0.092

Note: numbers in the parenthesis are p-values.
* indicates statistical significance at the 10% level; *** indicates statistical significance at the 1% level.

All of the signs of the coefficients for control variables namely passenger load factor and available seat kilometer are as expected except for revenue passenger kilometer where the coefficient sign is negative. It is noteworthy that revenue passenger kilometer is a measure of the demand for air transport which is beyond the control of an airline. Small-scale airline may not be able to fulfill a high demand for air travel from passenger due to capacity constraint at least in the short term. All of the control variables have a significant association with the productivity of airlines.

The finding for outsourcing per se portrays that outsourcing by itself is significant nevertheless has negative impact on the productivity growth of airlines in the sample of small scale airlines. This implies that the more the airline outsources their activities, the lower the outcome of the productivity change. Nevertheless, the interaction term of outsourcing with size of airlines for the model in the sample of small scale airlines indicates a positive influence of outsourcing on the change in the productivity of airlines.

In essence, the finding indicates that outsourcing works in a positive direction towards productivity growth in the sample of small scale airlines as influenced by an interaction with size of airlines. This finding is similar to the finding obtained in the technical efficiency model for sample of small scale airline as discussed in sub-section 6.2. Furthermore, this finding is supported by Ono and Stango (2005) who argued that outsourcing only results in a reduction of costs in a situation where the size of the company is small. Therefore, the productivity as measured by output per input increases. In a way, this finding suggests that factor such as size of airline company (economies of scale) does matter for managers when it comes to deciding whether to outsource or not. Hence, the decision to outsource activities without considering the size of firm is misleading and may lead to further deterioration in the productivity performance of airlines. The result is not surprising, and, is supported by the transaction cost economic theory which contends that level of transaction of specific investment in the economic exchange as indicated by the costs of having related infrastructures in-house determines the decision whether to outsource a particular activity or not. For example, it is appropriate for a small airline company to appoint a third party to provide maintenance and catering services rather than having the hangar and kitchen in-house which involves a substantial cost implication to the company.

On the other hand, not all firms benefit most from outsourcing. In fact, some airlines are more competent to carry out certain activities in-house than to outsource. Not only that, those competent airlines even offer their services to third parties at a much lower cost. For instance, provision of maintenance, repair and overhauls (MRO) of aircraft services to third parties by Lufthansa Technik, a subsidiary of Lufthansa and SIA Engineering Company Limited, a subsidiary of Singapore Airlines. It is worth emphasizing that Lufthansa Technik generates the largest third parties MRO revenue amounted to \$4.8 billion in 2014 (Aviationweek, May 22, 2015). Meanwhile, SIA Engineering Company Limited is among the main players in South Asia Pacific. As argued in the Resource Based View, capability of the firm to perform the activity in-house relative to its competitors explains why an activity is managed internally.

As for the results in the model for large sample size, the lag dependent variable for productivity as denoted by the coefficient of lag MMPI, $\hat{\beta}_0$ is highly significant at 1 percent level, thus, confirming the suitability of dynamic model in estimating the relationship between outsourcing and productivity of airlines. The coefficient signs for outsourcing individually and the interaction with the size of airline are negative and positive respectively and in congruence with the coefficient signs in the result for small sample size in column 1 of table 6.2. Nonetheless, the results are not significant which imply that the decision to outsource for large airlines has no influence on the productivity level. This finding is similar to the evidence claimed by Jiang et al. (2006) that outsourcing has no impact on the productivity of firm. In their study, the authors deployed sample data of large public firms which have strategic outsourcing implementations. Another possible explanation offered by the author for the insignificance in the result associated to the relationship between outsourcing and productivity of airlines, is due to core competency theory where airlines make investment from the cost saving, gained owing to outsourcing to improve their core competency, therefore resulting in an insignificant improvement of productivity in the short term.

Furthermore, the signs of coefficients for the control variables namely passenger load factor and available seat kilometer are both negative and are not in accordance with our prior expectations except for revenue passenger kilometer where the coefficient is positive. All of the control variables in the model are not significant. The results found that load factor and available seat kilometer do not give significant impact on the productivity of airlines. A possible explanation for this reason is, because the productivity of airlines as measured in this study context, refers to the total factor productivity. As the airline's production depends on the price of many input factors involved, the impact of load factor and available seat kilometer on productivity may be negligible. The influence of these variables on productivity of airlines may be eroded by other factors which may have a direct effect on the productivity of inputs such as the capability of managers in negotiating flexible labour contract, fuel hedge, and other supplies and services needed for production activities. Airlines have to view cost reduction as a long-term strategy from now on, in order to be profitable in the era of high edge of competition as today (Doganis, 2001).

6.4 Relationship between technical efficiency of airlines and economic development level.

Tables 6.3 and 6.4 present the findings from System GMM estimations with regards to the association between technical efficiency and economic development level in each low and high governance samples. Each level of governance (low or high) comprises of six models which consist of different dimensions of governance, namely control of corruption (model 1), government effectiveness (model 2), political stability and absence of violence (model 3), regulatory quality (model 4), rule of law (model 5) and finally voice and accountability (model 6). The findings presented in tables 6.3 and 6.4 suggest that the dynamic System GMM model applied in the analysis are appropriated as the lag dependent variables notably, MTECHEFF for models 1-6 are strongly significant at 1 percent across all of the models as demonstrated in second row of both tables. It implies that the past values of the technical efficiency do affect the present value of technical efficiency in both low and high governance models. Furthermore, the Sargan and the multicollinearity tests (AR2) for instruments and second order correlation problems suggest that the sample data are free from both issues.

Table 6.3 demonstrates the influence of economic development level on the technical efficiency in the airline sample from low governance countries. Although the signs of coefficients for economic development is paralleled with our expectation, however they are not significant except for model 4. The result in the table indicates that economic development level individually has no capability to influence the technical efficiency across all models, except in model 4 where it shows a weakly significant and positive relationship with the technical efficiency of airlines. Model 4 is associated with the quality of regulation in a country. Intuitively from the finding, one can interpret that economic development works in a positive direction towards the technical efficiency of airlines under the presence of regulatory quality. As for governance quality of each of the six dimensions of governance, as stated in models 1-6, the finding suggests that governance individually cannot influence the technical efficiency of airlines. Out of the six dimensions of governance indicator examined, government effectiveness and political stability showed positive coefficients whilst the other four dimensions, namely control of corruption, regulatory quality, rule of law, and voice and accountability portray negative coefficients. Not only that, the interaction effect of economic development level with governance quality as indicated in models 1 to 6 also shows no significant relationship between economic development level and technical efficiency of airlines in low governance countries. Low institution as represented by all six dimensions of governance indicators leads to increased business transaction costs (North, 1990; Clauge, 1997), and high profits (Ngoboa & Fouda, 2012). These findings are reasonable because the sample of airlines in this model comes from low governance countries, hence has no impact on the technical efficiency of airlines.

Whilst this study modeled the determinants of technical efficiency like in previous models in tables 6.1 and 6.2, similar control variables are employed in the model viz passenger load factor, available seat kilometer and revenue passenger kilometer. The coefficients of passenger load factor and available seat kilometer are positive across all six dimension of governance and in close agreement with our prior expectations although not significant except for model 3 where with the presence of political stability, higher capacity of seat offered by airlines influences the technical efficiency in a positive direction. On the other hand, revenue passenger kilometer which is the indicator for the demand of seat shows negative coefficient and is not significant across all models except for model 3 in the presence of political stability/absence of violence/terrorism where the variable is weakly significant at 10 percent significance level. This result is not surprising since an increase in the demand for air travel may not be accompanied by the increase in performance, if supply is not sufficient. In the case of airlines for sample of low governance countries, poor political stability leads to an increase in market inefficiency and macroeconomic volatility. This situation in turn lead to low demand for air travel, consequently lead to low efficiency of airlines.

On the contrary, table 6.4 reveals that economic development level by itself has no significant effects on the technical efficiency of airlines in the sample of high governance countries as indicated by high p-values in models 1 to 6. However, the signs of the coefficients, which are positive for all models and are in line with our prior expectation except for model 1, where the sign is negative. The positive sign of economic development suggests the important role of economic development in improving the technical efficiency of airlines. Notwithstanding, the interaction term between economic development and the quality of governance (institutional quality) as shown by the variable HDIGQ in all models 1-6 suggests negative and significant associations between economic development and technical efficiency. Next, governance by itself positively and significantly influences the technical efficiency in all of the 6 models, indicating that high governance quality is important for ensuring high technical efficiency of airlines. These results can be associated with the finding in the study by Wan (2005) who supports the positive influence of good governance on firms' performance, and Ngoboa and Fouda (2012) who relates positive relationship between good institution and profitability. In essence, low level of institution affects performance of firm negatively as it drives up business transaction costs (North, 1990; Clague, 1997; Mora-Sanguinetti and Fuentes, 2012).

However, the presence of high governance quality which is the proxy for high institutional quality, has a negative yet significant implication on the technical efficiency of airlines in the sample of high governance countries as depicted in models 1 to 6 of table 6.4. This finding implies that economic development level is associated negatively with the technical efficiency of airlines in the sample airlines from high governance level. However, drawing a conclusion based on this outcome needs to be done in a careful manner as it may lead to inappropriate policy implication.

Good governance which is characterized by lower regulation, higher predictability and greater transparency contributes to better economic performance of a country (Hamilton1919; De Soto 2000; Loayza et al 2004; Dollar et al 2005). Studies suggest that institutional development is closely related to economic development level of a country (Nafziger, 2006, p. 108). However, a high level of economic development implies high wages in the respective country compared to wages in the country which has low level of economic development. This argument is evidenced by a much higher wage rates in developed countries such as the United States, UK and other developed European and industrialized Asian countries (ILO, 2015). No doubt this phenomenon has encouraged a substantial amount of outsourcing of production and service activities from highly developed countries to less developed ones, as evidenced by massive outsourcing of production and services to China and India and other developing countries across Asia. The opposite result as indicated by the negative sign of the coefficients of the technical efficiency is as expected because higher wages in economically developed and high governance countries influenced the labour costs in positive direction. It is worth mentioning that labour cost is one of the largest components of cost which involved a substantial portion of expenses in an airline operation after fuel costs. For instance, labour cost accounts for 28 percent and 27 percent of total costs in full cost and low cost carriers respectively (Bitzan & Peoples, 2016). High wages in high governance countries actually drives the technical efficiency down in this respect. Recap that a technically efficient production process refers to utilization of the lowest inputs in this context the lowest costs involved in a production process for a given output (Mandl et al., 2008). Therefore, economic development reacts negatively towards the technical efficiency of airlines in the sample from high governance countries.

As for the control variables, namely passenger load factor, available seat and revenue passenger kilometers, and the sign of coefficients are contrasted with the results generated from low governance sample. The directions for passenger load factor and available seat kilometer are negative and insignificant. Meanwhile, the coefficient sign for revenue passenger kilometer is positive and in line with our expectation although not significant.

Table 6.3: Results of relationship between technical efficiency of airlines and economic development level in low governance countries

Technical efficiency	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Lag technical efficiency, mtecheff ($\hat{\beta}_1$)	0.538*** (0.000)	0.519*** (0.000)	0.533*** (0.000)	0.634*** (0.000)	0.575*** (0.000)	0.659*** (0.000)
Economic Development Level, HDI ($\hat{\beta}_1$)	0.256 (0.397)	0.232 (0.315)	0.040 (0.853)	0.872* (0.063)	0.218 (0.495)	0.495 (0.229)
Governance Quality, GQ ($\hat{\beta}_2$)	-0.145 (0.692)	0.165 (0.593)	0.103 (0.596)	-0.055 (0.882)	-0.067 (0.873)	-0.289 (0.433)
Passenger Load Factor, PLF ($\hat{\beta}_3$)	0.954 (0.144)	0.759 (0.220)	1.084 (0.106)	0.816 (0.204)	0.749 (0.229)	0.404 (0.389)
Available seat kilometer, ASK ($\hat{\beta}_4$)	0.518 (0.103)	0.446 (0.134)	0.656* (0.063)	0.517 (0.121)	0.435 (0.146)	0.299 (0.253)
Revenue passenger kilometer, RPK ($\hat{\beta}_5$)	-0.565 (0.108)	-0.479 (0.146)	-0.702* (0.070)	-0.585 (0.114)	-0.471 (0.158)	-0.333 (0.245)
Interaction effect: HDI x GQ, HDIGQ ($\hat{\beta}_6$)	0.124 (0.787)	-0.277 (0.492)	-0.209 (0.456)	-0.140 (0.773)	0.019 (0.964)	0.299 (0.522)
Number of observation	168	168	168	168	168	168
Number of airlines	21	21	21	21	21	21
Number of instrument	34	34	34	34	34	34
Sargan test	0.632	0.645	0.624	0.783	0.606	0.714
Arrelano-Bond test, AR(2)	0.806	0.768	0.856	0.682	0.831	0.891

Note: numbers in the parenthesis are p-values.
* indicates statistical significance at the 10% level; *** indicates statistical significance at the 1% level.

Table 6.4: Results of relationship between technical efficiency of airlines and economic development level in high governance countries

Technical efficiency	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Lag technical efficiency, mtecheff ($\hat{\beta}_0$)	0.416*** (0.000)	0.359*** (0.000)	0.374*** (0.000)	0.377*** (0.000)	0.394*** (0.000)	0.439*** (0.000)
Economic Development Level, HDI ($\hat{\beta}_1$)	-0.165 (0.605)	0.363 (0.399)	0.041 (0.888)	0.141 (0.651)	0.294 (0.461)	0.209 (0.627)
Governance Quality, GQ ($\hat{\beta}_2$)	1.139* (0.069)	2.155*** (0.010)	3.082*** (0.003)	1.944*** (0.002)	1.183*** (0.006)	2.593** (0.033)
Passenger Load Factor, PLF ($\hat{\beta}_3$)	-0.003 (0.983)	-0.095 (0.481)	-0.010 (0.927)	-0.062 (0.556)	-0.117 (0.403)	-0.088 (0.571)
Available seat kilometer, ASK ($\hat{\beta}_4$)	-0.027 (0.929)	-0.256 (0.458)	0.010 (0.970)	-0.188 (0.484)	-0.361 (0.334)	-0.239 (0.561)
Revenue passenger kilometer, RPK ($\hat{\beta}_5$)	0.053 (0.861)	0.275 (0.420)	0.007 (0.981)	0.213 (0.424)	0.382 (0.302)	0.257 (0.527)
Interaction effect: HDI x GQ, HDIGQ ($\hat{\beta}_6$)	-1.254* (0.078)	-2.508*** (0.010)	-3.424*** (0.004)	-2.259*** (0.002)	-2.124*** (0.006)	-2.939** (0.032)
Number of observation	256	256	256	256	256	256
Number of airlines	32	32	32	32	32	32
Number of instrument	34	34	34	34	34	34
Sargan test	0.098	0.107	0.054	0.159	0.138	0.135
Arrelano-Bond test, AR(2)	0.616	0.683	0.567	0.543	0.505	0.646

Note: numbers in the parenthesis are p-values.
* indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; *** indicates statistical significance at the 1% level.

Note: Grouping of airlines into groups of low and high governance samples is executed by taking the median point for each dimension of governance for all of the six governance indicators. The sample of airlines which are lower than the median point of governance quality for a specific governance dimension is grouped as airlines of low governance and those airlines which have the score higher than the median point is considered as high governance.

6.5 Relationship between productivity change of airlines and economic development level.

Tables 6.5 and 6.6 summarize the results with regard to the connection between productivity growth of airlines and economic development levels from sample of low governance and high governance countries where the airlines are originated from. The GMM estimation results show that the models are appropriated and efficient, looking at the significances of the lag dependent variables of productivity growth in both models with low governance and high governance sample in the following tables. This implies that past performance of airlines in terms of the productivity growth has an impact on current performance of productivity growth of airlines in the sample. Moreover, the test statistics results show that the instruments applied in each model are valid as depicted by non-rejection of the null hypothesis of valid overidentifying restrictions in the Sargan test. This finding also indicates that the instruments are uncorrelated with the error terms in each model. In addition, the results of second order serial correlation tests as signified by AR (2) statistics value, show no serial correlation between error term and first differenced equation in each model with low governance and high governance.

Table 6.5 demonstrates the results of the analysis obtained from sample of airlines for low governance countries. The p-values relative to the lag dependent variable of productivity growth as denoted by MMPI for all models 1-6 are moderately significant at 5 percent significance level suggesting that the System GMM model employed in the study is appropriate and valid. The sign of coefficient for economic development level per se demonstrates positive but insignificant relationships with productivity change across six models except in model 2 where the relationship is negative. Similarly, governance indicators individually in the forms of six dimensions namely control of corruption, government effectiveness, political stability/absence of violence/terrorism, regulatory quality, rule of law, and voice and accountability have no significant influence upon the productivity change in the sample of airline from low governance countries. The coefficients for all models 1 to 6 are mostly negative except for model 2 which suggests that government quality is positively associated with the productivity of airlines in low governance countries.

There are two control variables employed in examining the relationship between economic development and productivity of airlines. These variables are available seat and revenue passenger kilometers. The result indicates that capacity of airlines as proxied by available seat kilometer which shows insignificant but positive coefficient sign is in agreement with our prior expectation. The results imply that increasing the supply of seats cannot improve the productivity of airlines in low governance countries. Nevertheless, the results are not significant for all models 1 to 6. Subsequently, revenue passenger kilometer per se which indicates the size of airline companies has no impact on productivity change of airlines. Additionally, the interaction term between economic development with quality of country governance as indicated by HDIxGOV also shows no impact on change of productivity in airlines. In general, the results of analysis from sample of low governance suggest that economic development alone and its interaction with six dimensions of governance has no significant influences on the productivity of airlines. This finding can be associated with low productivity level of labour in low governance economies. For instance, emerging economies experienced lower level of labour productivity compared to OECD countries (OECD, 2014).

The results in table 6.6 which refer to the sample of airlines obtained from high governance countries nevertheless reveals opposite findings to that presented in sample from low governance countries as demonstrated in table 6.5. Most of the variables in models 1 to 6 are significant for sample of high governance countries. As for the control variables, which are available seat and revenue passenger kilometers, and the sign of coefficients for high governance sample, are contrasted across all models from 1 to 6 to that recorded in low governance sample of airlines. The significant level for available seat kilometer are weak but positive coefficients for all of the 6 models which conformed with our prior expectation except for models 3 and 6 in the presence of political stability, and, voice and accountability where the variables do not show significant connections with the productivity. On the other hand, revenue passenger kilometer is weakly significant but indicates negative associations with the productivity of airlines in most models, namely models 1,2,4 and 5. However, 4 models from the 6 models for revenue passenger kilometer which are models 1,2,4, and 5 in the presence of control of corruption, government effectiveness, regulatory quality and rule of law, demonstrated significant and negative influences on productivity but with weak p-values. The other two models which are models 3 and 6 in the presence of political stability, and voice and accountability respectively showed absence of relationships with productivity.

Governance quality in the forms of six dimensions per se show significantly negative associations with productivity of airlines across all of the six models examined except in model 2 which refers to government effectiveness where the relationship is positive. This finding implies that government effectiveness is crucial as it positively influence the productivity change in airlines. A highly effective government provides fast and efficient solutions to problems faced by airlines, for example, during economic disruptions and events like natural disasters which may restrict the operations of airlines in the case of poor governance. Fast and efficient actions taken by the government can minimize losses and bankruptcies faced by airlines during these events.

The rest of governance quality types namely control of corruption, political stability/absence of violence/terrorism, regulatory quality, rule of law and voice and accountability demonstrated significant and negative associations with the productivity of airlines because those governance qualities are referred to as *Type One* institutions which regard institutions as rules of game (Axelrod, 1984; North, 1990). This type of institution is likely to have a market creating effect which encourages the emergence of new markets. Therefore, leading to intense competition in the present market and may possibly lead to the decrease in the productivity of airlines. On the other hand, economic development itself has significant negative influences on the productivity change of airlines across all of the six models, except for model 6, which indicates positive association with economic development and productivity in the presence of voice and accountability. Empirically, the findings show that level of economic development of a country per se is significant and has negative effects on the productivity growth of airlines in the sample. Possible explanation for the negative relationship is due to high wage rate in developed economies which lowers the productivity of airlines in high governance countries as explained in sub section 6.4. This finding is opposed to the findings in Vasigh et al. (2008); Backx et al. (2002); Gillispie (2007); Jenatabadi (2013); Ismail and Jenatabadi (2014) which suggested a direct positive influence of economic factor on performance of airlines.

However, with the influence of good institutions which are proxied by high quality of governance as indicated by each governance dimensions in models 1-6, the interaction effect which is denoted by HDIGOV suggest that economic development level is imperative in order to raise the productivity of airlines. The sign of coefficients across the six models are correct and as expected. Good governance affects the productivity of airlines in a positive manner. High quality of governance promotes highly productive workers which will be translated into high wages in high governance countries. The finding in this study can possibly be explained by the fact that labour in higher developed nations receives much higher average wage level compared to labour in emerging economies. This is evidenced by a high average wage in developed economies as compared to emerging economies. According to ILO (2015), average wage as measured in Purchasing Power Parity in developed economies was approximately USD 3000 compared to emerging economies where the average wage level was USD 1000 in 2013. In addition, it is argued that labour productivity growth proliferates much faster than the increase in real wage growth between 1999 and 2013. Therefore, a higher average wage affects the productivity change in a positive direction.

Not only that, the findings from this study support the notion that economic development level as proxied by HDI does matter in influencing the performance of airline as stressed in Jenatabadi (2013). There are two key differences between our study and that of Jenatabadi (2013). First, the context of performance used in the latter is profitability. Second, HDI influences performance in a direct manner, whilst, the finding in our study indicates that economic development level only affects the productivity growth with the interaction effect of good governance.

Furthermore, the impact of global economic crisis in 2008 on productivity change of airlines are indicated by the significance of time dummies as reflected in table 6.6. Based on the results in table 6.6, it can be concluded that all of the six components of governance are important in order to influence the productivity growth of airlines in high governance sample as indicated by the positive coefficients of interaction effect, which is denoted by HDIGOV.

Table 6.5: Results of relationship between productivity growth of airlines and economic development level in low governance countries

Productivity Growth (MMPI)	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Lag productivity growth, MMPI ($\hat{\beta}_0$)	-0.196** (0.019)	-0.193** (0.022)	-0.202** (0.020)	-0.197** (0.018)	-0.195** (0.020)	-0.191** (0.032)
Economic Development Level, HDI ($\hat{\beta}_1$)	0.186 (0.771)	-0.068 (0.913)	0.234 (0.817)	0.411 (0.565)	0.048 (0.953)	0.175 (0.864)
Governance Quality, GOV ($\hat{\beta}_2$)	-0.371 (0.752)	0.187 (0.825)	-0.096 (0.875)	-0.633 (0.560)	-0.105 (0.936)	-0.260 (0.886)
Available seat kilometer, ASK ($\hat{\beta}_3$)	0.162 (0.785)	0.052 (0.929)	0.242 (0.713)	0.275 (0.646)	0.089 (0.885)	0.105 (0.857)
Revenue Passenger Kilometer, RPK ($\hat{\beta}_4$)	-0.089 (0.880)	0.018 (0.975)	-0.168 (0.797)	-0.199 (0.738)	-0.017 (0.978)	-0.032 (0.956)
Interaction effect: HDI x GOV, HDIGOV ($\hat{\beta}_5$)	0.435 (0.761)	-0.241 (0.806)	0.109 (0.844)	0.691 (0.588)	0.123 (0.935)	0.360 (0.878)
Number of observation	168	168	168	168	168	168
Number of airlines	21	21	21	21	21	21
Number of instruments	26	26	26	26	26	26
Sargan test	0.910	0.907	0.902	0.915	0.904	0.903
Arrelano-Bond test, AR(2)	0.454	0.537	0.447	0.466	0.448	0.548

Note: Numbers in the parenthesis are p-values.
** indicates statistical significance at the 5% level

Table 6.6: Results of relationship between productivity growth of airlines and economic development level in high governance countries

Productivity Growth (MMPI)	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Lag productivity growth, MMPI ($\hat{\beta}_0$)	-0.167** (0.015)	-0.75*** (0.008)	-0.129** (0.015)	-0.166*** (0.006)	-0.156** (0.015)	-0.138** (0.015)
Economic Development Level, HDI ($\hat{\beta}_1$)	-9.527** (0.028)	-10.567 (0.003)	-6.987** (0.011)	-13.170*** (0.001)	-9.310** (0.025)	5.129** (0.015)
Governance Quality, GOV ($\hat{\beta}_2$)	-5.884*** (0.005)	6.498*** (0.001)	-8.258*** (0.000)	-8.415*** (0.001)	-5.276 (0.138)	-4.911*** (0.002)
Available seat kilometer, ASK ($\hat{\beta}_3$)	0.899* (0.060)	0.782* (0.070)	0.517 (0.139)	0.601* (0.090)	0.667* (0.075)	0.599 (0.132)
Revenue Passenger Kilometer, RPK ($\hat{\beta}_4$)	-0.898* (0.058)	-0.787* (0.067)	-0.501 (0.145)	-0.632* (0.073)	-0.683* (0.071)	-0.584 (0.140)
Interaction effect: HDI x GOV, HDIGOV ($\hat{\beta}_5$)	6.521*** (0.005)	7.221*** (0.001)	9.212*** (0.000)	9.495*** (0.001)	6.064* (0.094)	5.641*** (0.002)
Time Dummy	dum6	dum6	dum6	dum6	dum6	dum6
Time Dummy	dum7	dum7	-	-	-	-
Number of observation	256	256	256	256	256	256
Number of airlines	32	32	32	32	32	32
Number of instrument	26	26	26	26	26	26
Sargan test	0.998	0.996	0.895	0.932	0.952	0.926
Arrelano-Bond test, AR (2)	0.711	0.606	0.603	0.431	0.556	0.579

Note: Numbers in the parenthesis are p-values.
* indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; ***indicates statistical significance at the 1% level

6.6 Summary of findings

This chapter investigates influences of outsourcing and economic development level upon the technical efficiency and the productivity change of airlines for sample of small scale and large scale airlines. The results reveal two important outcomes. First of all, outsourcing plays a central role in influencing the technical efficiency and the productivity change in the sample of small scale airlines. A higher extent of outsourcing as portrayed by the interaction effect with size of airlines has positive influence on the technical efficiency and productivity change in sample of small scale airlines. These outcomes are parallel to what the transaction cost economics and the resource based view suggests. For instance, insourcing of aviation support activities such as maintenance and catering for small scale airlines involved high cost implications. Besides that, maintaining large capital infrastructures in-house such as aircraft hangar and kitchen also imply high transaction costs. In addition, the resource based view theory suggests that activities which involve firm's resource capability are best done in-house vice versa.

Finally, with respect to association of economic development level with the technical efficiency and the productivity growth, the findings conclude that economic development level has no influences on the technical efficiency and the productivity change of airlines in sample of low governance countries. Nonetheless, running the analysis for high governance sample implies that economic development when interacted with quality of governance in terms of six dimensions of governance, namely control of corruption, government effectiveness, political stability, regulatory quality, rule of law and voice and accountability yields negative relationship with the technical efficiency of airlines. This finding is justified by high average wages in developed countries as compared to developing ones. According to ILO (2014, December 5), average wages in developed countries are three times higher than that of developing countries. These statistics explain the negative association of economic development level with the technical efficiency of airlines in sample of high governance countries for all six dimensions of governance, as labour cost is one of the significant costs involved in the operation of airline. In contrast, the interactions between economic development with six dimensions of governance for sample of high governance countries conclude positive influence of economic development on the productivity of airlines. The findings imply pivotal role of high institutional level upon the productivity of airlines. Furthermore, statistics revealed that in 2015 labour productivity growth in developed economies increased faster than emerging economies.

CHAPTER 7: CONCLUSIONS AND POLICY IMPLICATIONS

7.1 Introduction

This research comprises of four main objectives. First, to evaluate the levels of technical efficiency of individual airlines with respect to group frontier technology for each full cost and low cost carriers and the metafrontier technology respectively, using the metafrontier model based on the Data Envelopment Analysis (DEA) approach as introduced by O'Donnell et al. (2008), and to suggest which group is narrowing in terms of technological gap with the metafrontier technology. Second, to measure the productivity changes over time across groups of full cost and low cost carriers, and to identify sources of productivity growth viz. technical change, efficiency change, and technological gap ratio change by applying the metafrontier model based on DEA Malmquist Productivity Index approach as introduced by Oh and Lee (2010). From these results, the type of airline business model which is the leader in world technology and the one which is catching up is determined.

Third objective is to investigate the impacts of outsourcing extent on the technical efficiency and the productivity of airlines. Fourth, is to examine the influence of economic development level on the technical efficiency and the productivity of airlines.

7.2 Summary of findings

On average, over the period of 10 years observed, the scores of the technical efficiency for group frontier and the metafrontier with respect to FCC business model, demonstrates a narrowing gap in the technical efficiency score between group frontier and the metafrontier technologies. This is indicated by the exceptionally high scores of technology gap ratio (TGR) which approaches 1 throughout all years observed from 2002 to 2011. Based on the finding, it is concluded that FCC formed world technology frontier which suggests that the carrier is catching up with the global technology. In addition, the result shows an increasing trend in the technical efficiency of FCC relative to the metafrontier estimates. On average, the FCC group recorded a decent performance improvement as indicated by an increase in the metafrontier technical efficiency score from 60 percent to 81 percent between 2002 and 2011 respectively. Besides that, the results also reveal that throughout the period of study from 2002 to 2011, airlines from the Asia Pacific region recorded decent technical efficiency scores when benchmarked against the metafrontier technology. Those leading airlines are, Singapore Airlines, Japan Airlines (JAL), All Nippon Airways, Chinese Southern Airlines, Emirates and Garuda Airlines. This finding is supported by Inglada et.al (2006) and Rey et al. (2009) who asserted the high economic efficiency of airlines from Asia when compared to their counterparts in the United States and Europe.

The influx of LCC into the aviation market in the beginning of the millennium introduced intensifying competition to the airline industry which had forced FCCs to aggressively seek new innovations in their operation in order to cut costs including selling of air tickets through direct distribution channels from the airline's official website. No doubt these initiatives have slashed substantial costs, thus, raising the technical efficiency level of individual airlines in the FCC business model. Furthermore, according to KPMG report, legacy carriers (FCCs) have successfully streamlined their costs, hence narrowing the cost gap between LCCs and FCC from 2006 to 2011 (KPMG International, 2013).

From the findings, although LCCs show an increasing trend in both the geomean group frontier technical efficiency and the geomean metafrontier technical efficiency scores throughout the period of study from 2002 to 2011, however, the technical efficiency scores when measured relative to each group frontier and metafrontier technologies respectively show a widening gap. The significant discrepancy in the metafrontier-group technical efficiency scores, leaves the LCCs in a large technology gap towards the world frontier which indicates that the LCC is lagging behind the global airline technology. On the overall, LCC recorded a favourable improvement in the TGR from 48.4 percent to 88.8 percent in 2002 and 2011 respectively, despite a disruption during post 2007/2008 world economic crisis. The rapid increases in the trend of the technical efficiency with respect to each of group frontier and metafrontier technology respectively, yields an optimistic anticipation that low cost carriers are likely to be more technically efficient in the future, which will rule out the empirical finding obtained in this study that the FCC is relatively more efficient than the LCC.

Next, the study carries out the productivity analysis by adopting the metafrontier Malmquist productivity index (MPI) model which is introduced by Oh and Lee (2010). In addition, the variation in the change of productivity score which is benchmarked against the contemporaneous, intertemporal and global technologies was examined and discussed.

The findings from the metafrontier MPI analysis above reported that the FCC group is the least in terms of the frequency of positive productivity growth in which 3 out of 9 periods exhibited a progress in the productivity change with regard to all of the three benchmark technologies namely contemporaneous, intertemporal and global technology throughout the whole period observed from 2002/2003 to 2010/2011.

Meanwhile, LCC group exhibited the highest number in terms of frequency of positive change in MPI relative to the three benchmark technologies, where the airlines recorded four periods of progressivity in the productivity change, which were during the periods of 2002/2003, 2006/2007, 2008/2009 and 2009/2010 respectively. Nevertheless, the frequency of positive change in MPI with respect to global benchmark technology, which is our focus for this study, is exceptionally high which is 7 out of 9 periods observed.

The findings concluded that the LCCs have gained the most in terms of frequency of positive productivity growths throughout all of the periods observed from 2002/2003 to 2010/2011, despite series of economic disruptions in 2002/2003 and 2008/2009. In contrast, full cost carriers are at disadvantage due to reversed events which have dragged the carriers into negative growths relative to global MPI, as indicated by regressive productivity growth of 0.7 and 0.4 percent respectively during the periods from 2002/2003 to 2008/2009. Full cost carriers suffered the most from these events due to a massive cut in the number of passengers as they divert to low cost options during bad economic situation. Furthermore, the nature of cost structure adopted by FCC which is less flexible, may further worsening the productivity level, thus, leading to high frequency of negative productivity growths. For example, the problem of low demand, due to economic downturn, is not easy to address since most FCC have a large number of aircraft in its fleet. This factor results in some aircrafts left idle at the hangar in the event of low demand. This situation adds to additional costs for FCC due to overcapacity, resulting from underutilization of aircrafts. Unlike the LCC which usually maintains a smaller number of fleets in terms of aircraft families and manufacturers relative to that of FCC, maintaining small fleet size in these contexts is an advantage to LCC as they can ensure maximized utilization of aircrafts.

It is argued that airlines which have small number of aircraft families and manufacturers gain high technical, allocative and cost efficiencies (Merkert & Hensher, 2011). This is because the carrier is able to fully utilize pilots, technicians and engineers, thereby, saving operation costs by hiring only pilots, technicians and engineers which have the skills and expertise in handling the particular aircraft families or manufacturers. Hence, there is no requirement to employ pilots, technicians and engineers which have different expertise in handling various models of aircrafts. Moreover, the no frill business model along with its high innovation in the operations right from distribution to check in and boarding the aircraft has enabled the LCC to slash substantial costs, thus, slowing down the fall in the productivity level during an adverse situation.

Later on, the findings related to sources of productivity growth in airlines are discussed. Examining the trends in the productivity change is meaningless without investigating the sources that lead to variations in the productivity change. This can be done by decomposing the productivity change into efficiency change, best practice change and technological gap ratio change using the metafrontier Malmquist Productivity Index approach based on DEA. The values are obtained by aggregating individual score of the productivity change, efficiency change, best practice change and technological gap ratio changes for each group of airlines over all of the periods observed.

The average productivity growth for combined groups recorded a slow growth rate of 0.5 percent over the whole periods observed from 2002/2003 to 2010/2011. In general, the small change in the productivity of airlines is driven by the efficiency change and the technological gap change with annual growth rates of 4.7 percent and 0.2 percent respectively. Among the two groups of airlines, low cost carrier is the most productive group with a productivity growth of 3.7 percent annually. This finding conforms to the results by Barbot et al. (2008) and Assaf and Jossiasen (2012) who argue that the LCC is the most productive airlines. In contrast, the least productive group is the full cost carrier with a negative productivity growth of 0.5 percent annually. The main sources of productivity growth in LCC are efficiency change and technology gap change. The change in efficiency of LCC is 9 percent per year, which implies that the group is good at catching up, by its capability to efficiently utilize its inputs to produce maximum output. As a latecomer, who only enters the air transport industry during post-deregulation of the U.S air transport market in 1978, LCC is catching up faster than the pioneer which is FCC. The finding is supported by Gerschenkron, (1962) and Hobday (1995) who contended that latecomer catches up faster than long established firms as they enter the market that has already matured and at the end of its product life cycle.

This high average change in the efficiency, indicates that the aviation industry is not innovative enough, in improving the productivity of airlines as evidenced by a negative growth in best practice change of 4 percent. Additionally, the high positive growth in efficiency change suggests that the aviation industry's productivity growth is driven by the ability of the airlines to efficiently squeeze available inputs to the maximum in order to increase the production.

Based on the technology gap ratio results, the finding demonstrated that FCC is moving closer to the world technology frontier as shown by the high value of technology gap ratio which is approaching 1. This finding is further supported by the results from the Kernel density test, which indicates that the distribution of the technology gap ratio for individual airlines, in the FCC business model is approaching unity. In addition, the result implies that FCC group is narrowing the cost gap with the metafrontier technology as stressed by KPMG International (2013) which confirms that FCC and the LCC business models are converging in terms of unit cost per Available Seat Kilometer throughout the period from 2006 to 2011. The convergence, in terms of costs between the two business models, is further supported by an interview with Alex Cruz, the CEO of Vueling who stressed that airlines today do not strictly follow the business model they belong to, and rather tend to customize their services according to demands and needs of the present market (www.centreforaviation.com).

Nevertheless, the change in the technology gap ratio suggests that the FCC is lacking the power to speed up the technological growth. The fact, that FCC is the closest to the world technology frontier does not imply a high productivity growth as argued by Howit and Foulkes (2004), who claimed that closeness to the frontier implies a lower productivity growth. In addition, LCC has the power to speed up the technological development as shown by a moderate growth in the technology gap of 0.7 percent annually.

The technical efficiency and productivity are success indicators by which producers are evaluated (Miller, 1984). Therefore, investigating the determinants of variation in the technical efficiency and the productivity growth is pivotal to aid airline managers and policy makers in their decision making. In this study, the technical efficiency and the productivity growth are measured using the technique of metafrontier, based on the DEA approach. Meanwhile, outsourcing and economic development which are two variables of interest to the researcher are crucial factors in improving the technical efficiency and the productivity growth of firms. This study employes the One Step, System GMM technique which is a dynamic panel data approach to examine the connection between airlines' performance variables namely productivity growth and technical efficiency with outsourcing and economic development.

To examine the influence of outsourcing on the technical efficiency and the productivity, a sample of 53 airlines is segregated into two sub samples, one for small scale airlines and the other sub sample consists of large scale airlines. Each sub sample consists of 26 and 27 airlines respectively. The reason for splitting the sample into two sub samples is to investigate whether the size of airline has any significant influences on performance of airline in the contexts of the technical efficiency and the productivity growth as claimed by Abraham and Taylor (1996); and Ono and Stango (2005). The result, based on the System GMM estimator argues the positive influence of outsourcing on the technical efficiency and the productivity growth in the context of sample related to small scale airlines. This finding is paralleled with the result in Ono and Stango (2005) study that small scale firms benefit from outsourcing as they are at advantage of scale economies of external suppliers, which in turn, lowered down their cost of operations. Meanwhile, the result obtained from large sample airlines shows no significant association between outsourcing and performance variables namely the technical efficiency and productivity growth which is conformed to the finding of Abraham and Taylor (1996) that large scale firm does not benefit from outsourcing.

On the other hand, the impacts of economic development level on the technical efficiency and productivity growth are also modeled using the technique of the One Step, System GMM. For this purpose, the sample of airline is segreggated into two sub-samples. One sub-sample comprises of airlines from 32 high governance countries and the other consists of airlines from 21 low governance countries. The intention is to examine the role of six governance dimensions namely control of corruption, government effectiveness, political stability, regulatory quality, rule of law, and voice and accountability in influencing the technical efficiency and productivity growth of airlines. The rationale of breaking the sample down into two sub-samples of low governance and high governance airlines is because country characteristics in the sample of study vary across each airline which suggests differences in institutional constraint faced by the airline. Therefore, this study attempts to examine the impact of quality of institutions on the performance of airlines. For example, the negative influence of low institutional quality on performance of firm is stressed by North, (1990); Clague (1997); Mora-Sanguinetti and Fuentes (2012). While other literatures supports that good governance positively affects firms in terms of performance (Wan, 2005) and profitability (Ngoboa & Fouda, 2012).

The findings from our study highlighted two important results. First, based on the productivity growth model, it is suggested that economic development level affects the productivity growth of airlines positively as provided by the interaction with high institutional quality. The result is as expected and is conformed to previous empirical findings which proposed a positive association between GDP and airline performance, for instance, Backx et al. (2002); Gillespie (2007); and positive realtionship between HDI and airline performance (Jenatabadi, 2013); Ismail and Jenatabadi (2014). Furthermore, empirical evidences in the context of the banking industry also support the positive connection between economic factor and bank performance which are stressed in studies done by Mc Namara and Duncan (1995); Demirguc-Kuhn and Huizinga (2000); Bikker and Hu (2002); Panayiotis et al. (2008).

High institutional qualities in this study which are proxied by six dimensions of governance indicators acted as the catalysts to stimulate the impact of economic development level on the productivity growth. As argued by ILO (2015), the growth of labour productivity increases faster than the growth of real wage in developed economies which are also characterized as high governance countries. Therefore, this study distinguishes our study from the studies found in the literature review, as our study examines the interaction effect of HDI with quality of institution as proxied by six dimensions of governance indicators, which, to our knowledge, have not been investigated so far in the context of the airline performance.

Second, economic development demonstrates a negative effect on the technical efficiency of airlines with the presence of interaction effects of high governance qualities which are proxied by six dimensions of governance indicators. From this finding, one can infer that economic development level associates negatively with the technical efficiency of airlines in the sample airlines from high governance countries. Nevertheless, this result needs a careful interpretation. As asserted by Hamilton (1919); De Soto (2000); Loayza et al (2004); Dollar et al (2005), high quality institution which is characterized by lower regulation, higher predictability and greater transparency, contributes to better economic performance of a country. It is important to note that, the airlines sample in the model comes from developed economies. Hence, it is reasonable to associate developed economies with high wages when compared to wages in the country which has lower level of economic development.

Furthermore, based on ILO Global Wage Report 2014/2015, it is revealed that developed economies demonstrate a much higher wage rates for examples the United States, the UK and other developed European and industrialized Asian countries (ILO, 2015). Therefore, the finding is reasonable, as high wages imply high cost to airlines, thus, bringing down their technical efficiency performance. This contrasted finding adds a new contribution to literature on the technical efficiency of airlines as most studies in the past concluded a positive relationship between economic factor and the technical efficiency of airlines.

7.3 Implications

The results obtained from the analyses in chapters 5 and 6 hold some implications for airline managers, and air transport authorities. The findings from chapter 5 suggest that full cost carriers formed best practice frontier as indicated by the high value of technology gap ratio of 0.996 which is closer to 1. It implies that full cost carrier has the capacity to produce up to 99.6 percent of the total production generated from the global technology using present inputs viz. fuel, labour and aircraft. This indicates that FCC is the most efficient business model compared to LCC.

On the other hand, low cost carriers recorded the highest productivity growth, which is mainly driven by the capability of the airline to efficiently utilized available resources, which is portrayed by the high efficiency change score as compared to full cost carriers. Meanwhile, in terms of best practice change or technological change, none of the groups showed positive growth, which suggested that neither full cost nor low cost models are an innovator. However, it can be concluded that the full cost model is a close candidate of technology innovator, as the score of technology change is closed to 1, compared to low cost model which recorded the score of technological change much farther from 1. Similarly, the technological leadership effect is also not clear as to which airline model demonstrates those characteristics because technology gap change only infers to changes in the technology gap between full cost and, low cost models, and the metafrontier technology. Nevertheless, statistical checks based on the Kernel density estimation suggest that full cost carrier is world technology leader in the airline industry as more individual airlines in the sample portray values which are closer or equal to unity.

Meanwhile, the findings from GMM estimators in chapter 6 suggest two main conclusions. Outsourcing has a significant and positive influence on performance indicators in the contexts of technical efficiency and productivity growth for sample of small scale airlines as exhibited by the result of interaction effect with revenue passenger kilometer which is the proxy for size of the airline. Second, with regards to the impacts of economic development level on performance indicators which are the technical efficiency and the productivity growth within the context of high institutional level revealed two contrasted outcomes. The technical efficiency model shows a significant but negative influence of economic development level which is catalyzed by high governance indicator to stimulate the relationships between economic development and technical efficiency. Nonetheless, the relationship between economic development and the productivity growth suggests a significant, and positive influence of economic development level upon the productivity growth under the influence of high governance levels, which act, as the catalyst to strengthen the outcome in the productivity growth.

7.3.1 Policy Implications

Two parties which are policy makers in the aviation industry, and airline managers are expected to benefit from the findings outlined in chapters 5 and 6 related to the estimation results of technical efficiency, productivity, and GMM. The results from the analyses in chapter 5 aid airline managers with appropriate strategies in order to improve the efficiency and productivity level of their airlines amidst intense competition from LCC. Meanwhile, based on the empirical findings with regards to GMM estimations in chapter 6, two policy implications can be suggested in order to enhance the productivity and technical efficiency of airlines. First, the impact of outsourcing on airlines performance in the contexts of technical efficiency and productivity growth has the implications for two parties, namely the airline managers and air transport authorities in a respective country. Second, the influence of economic development on the technical efficiency and productivity growth draws policy implications for the government of the respective country, where the airline is originated from. Each policy implication is explained separately in the following sub-sections.

7.3.1.1 Implications to air transport authorities

The results of the analysis, with respect to the influences of outsourcing and economic development level on the performance of airlines in the contexts of technical efficiency and productivity growth in chapter 6, draw two policy implications for air transport authorities. First, the pivotal role of outsourcing in raising the performance of small scale airlines suggests consistent supports from the government through government policy in appointing third party service provider or ground handler is imperative. For instance, a proactive government policy that supports competition may provide airlines with an array of option of third party ground handlers to choose from at the airports outside its home-based. In addition, providing more options of third party ground handlers to the airlines will ensure that they get the best service at a competitive price. Meanwhile, a country which is rigid in the selection of third party service provider will result in limited access of airlines to available third party service providers. As a result, the outcome from outsourcing activities may not lead to maximum benefits, hence, cost reduction is anticipated from the airline's end. Therefore, it is crucial for the government to be proactive and support open market in order to promote high competition among third party service providers.

Next, the significant influence of economic development level on the technical efficiency and productivity of airlines in the sample of high governance countries suggests a crucial role of government in ensuring high governance quality in a country. There is a need for an effective intervention in the form of institutional quality to ensure high economic development level is translated into high airlines performance in a particular country. This is in line with Adam Smith (1776) research who stressed the importance of institution on economic sector development. The high level of economic development per se, does not guarantee an efficient and productive conduct of business, unless followed by a strong institutional development. Good institution ensures protection of property rights, and enforcement of contracts. Thereby, lowering the transaction costs involves in an exchange and facilitates economic growth (North, 1981).

7.3.1.2 Implications to airline managers

The results of technical efficiency and productivity scores obtained from the analysis in chapter 5 provide airline managers with information to identify and plan suitable strategies for future improvements. The findings from the evaluation of technical efficiency indicate that the FCC is the most efficient business model in the airline industry. As a technology leader in the airline industry, FCC has an advantage over LCC, in the sense that it has the financial resources to invest in an expensive innovation. For instance, purchasing of modern and highly fuel efficient aircraft may greatly reduce cost per unit of seat flown. Besides that, the airline may also invest in developing a comprehensive airline website which may save substantial cost of distribution. LCC on the other hand is less efficient.

The airline managers of LCC have to be aware of the strategies adopted by its competitors and react instantaneously to the fast changing business environment in the industry by constantly reviewing its business strategy to meet present demand of low cost passengers in line with rapid development in information technology and the internet. For example, this could be achieved by constantly conducting research to identify new innovation to simplify the process of travelling by air. In order to improve customer loyalty, it is also imperative for LCC to ensure that convenience and quality are both met by the airline by improving its technical efficiency. The managers of airlines should be aware of the present and future developments in the market which shape competition in the airline business.

Meanwhile, LCC recorded the highest productivity growth when compared to the FCC. The FCC may improve its labour productivity by focusing and competing on long haul service through hub-and-spoke strategy, in order to reap the benefit of economies of scale. FCC, in this case, has an advantage for example, of maintaining a large size of fleet to meet different requirement of length of services. By flying a larger aircraft, the productivity of labour can be increased because of the fact that the number of staff do not increase proportionately with the increase in the size of aircraft. Therefore, the carrier would benefit from economies of larger aircraft size and economies of density where it has a competitive advantage. In addition, due to the nature of its operation which adopts hub and spoke operation, the carrier may ensure that convenience and quality of services are maintained through seamless travel experience. For instance, the carrier may constantly improve the quality of its services by making air travel convenient to passenger through services such as connecting flight, baggage transfer, in-flight services like Wi-Fi, entertainment, refreshments, and other in-flight services in accordance with today's lifestyle trend. Those initiatives would become a magnet to attract a high volume of passengers to make FCC as their choice for long haul travels by both business and leisure travellers. This way the carrier can differentiate itself from its competitors.

On the other hand, the FCC managers may learn from the experience of its competitors by fully utilizing the e-commerce platform to increase the volume of direct sales of air tickets to customers via individual airline private website, in order to minimize the distribution costs to the least possible. This strategy may also help, in increasing the productivity of FCC. It enables the FCC to compete, in terms of low fare which is in line with a fall in the distribution costs. As for the FCC, there is also a need for the managers to constantly review its cost structure, in order to compete successfully with LCC. As fare, does matter for many passengers especially for leisure travellers, this initiative will ensure sustainable and high yields are achieved by the FCC.

The result in chapter 6 indicates that outsourcing has a significant impact on the technical efficiency and productivity growth of airlines. Specifically, the result suggests that outsourcing plays a significant role in improving the performance of airlines only for the case of small- scale airlines. This is because small-scale airlines may not own the expertise and large capital outlay to carry out all of the activities in-house as compared to large-scale airlines which have the capability to do so. Therefore, the decision to outsource specific activities requires the airline managers to critically evaluate resource capability of the firm before deciding to bring the activities in-house. This practice may minimize the risks of failure resulting from wrong decision made by managers to outsource particular activities.

7.4 Limitations of study

This study faces limitations in various aspects including industry specificity and data. The following subsections explain these limitations.

7.4.1 Industry specificity

For DEA analysis, the study only considers passenger airlines from two business models, namely full cost and low cost carriers due to availability of data. Cargo revenue is not specifically included in the study because most airlines do not report separate revenues generated from passenger and cargo businesses. Thus, total revenue is used to reflect the output characteristics of passenger and cargo businesses. This limitation may affect the technical efficiency and productivity growth scores obtained from DEA estimation when one knows that cargo is one of the important sources of revenues for some commercial airlines.

7.4.2 Data

Since the DEA estimation involves estimating the technical efficiency and productivity, it is best, if the data on inputs and outputs are quantified in physical measures. In particular, operating cost which is used as input variable in the technical efficiency and productivity growth estimation is obtained by summing up the costs associated with labour and fuel incurred by an airline annually. Unfortunately, data on the number of full time employees and quantity of jet fuel consumed are not consistently reported by individual airlines on yearly basis. For instance, in many occasions, airlines only report salary expenses for full time staff and fuel consumption. Unavailability of physical measures for inputs and outputs forces the researcher to use financial measure as the proxy for labour input, instead of the number of full time employees; and fuel expenses instead of quantity of fuel consumed.

Similar exercise is practiced for operating revenues where the financial measure is used instead of physical revenues such as number of passengers and quantity of cargoes carried. These shortfalls affect the evaluations of the technical efficiency and productivity growth scores obtained from the DEA technique, because physical measures of inputs and outputs are best measures for evaluating operational performance in the context of technical efficiency (Merkert & Hensher, 2011).

Data for outsourcing which is used in the GMM estimations is proxied by the extent of outsourcing as measured by the ratio of total expenditures on labour to total operating costs incurred by the individual airline. Furthermore, outsourcing data is treated as confidential by most airlines since it is regarded as the firm's business strategy. The use of proxy for a variable instead of actual data, may influence the accuracy of the results obtained from the regression analysis.

7.5 Recommendations for Future Research

The study examines the impact of outsourcing and economic development on the technical efficiency and productivity of airlines using dynamic micro panel data analysis by adopting the One Step, Generalized Method of Moments estimators. Nonetheless in the future, it would be interesting to extend the study by examining both the short run and long run impacts of outsourcing and economic development level on the technical efficiency and productivity growth. This is possible by extending the number of time period of observation, T, so that it is large enough compared to the number of firms, N, in order to apply the dynamic macro panel data analysis; for instance, Mean group and Pooled Mean Group estimation approaches.

Moreover, other alternative to collect data on outsourcing besides using financial information from individual airline's payroll is through primary data collection such as survey and questionnaires. Subsequently, the data can then be analysed using the Structural Equation Modelling (SEM). The advantage of this approach compared to the GMM estimators is that it allows a more flexible and detail way to look at the indirect influence of outsourcing on firm performance, namely the technical efficiency and productivity growth by incorporating the moderating and mediating variables. Furthermore, the reliability of the data can be rest assured by targeting executives who directly deal with outsourcing activities. No doubt, this approach of data collection is challenging, time consuming, costly and is only possible through e-mail or online survey, particularly for airlines which have no representative offices in Malaysia. However, once that data is collected, the researcher would have a high quality of data set. In addition, if the method of the study requires an interview approach to be used to complement the finding from survey questionnaires, the interview have to be structured in such a way that the sample of interviewees should be representative from airline executive teams of both small and large-scale airlines as defined in the study.

In future, the study would be interesting, if government policy on outsourcing can be brought up into the analysis by examining the impact of an interaction between government policy and outsourcing on the performance of airlines. This is because legislation policy has an impact on options available to airlines related to third party service providers for ground handlings at a particular airport (Tayeb, 2012). A policy which supports competition in ground handling services will provide choices for airlines according to their budgets, while ensuring the quality of the services delivered by the service providers are up to the expectations of the air carriers.

In the GMM estimations approach, the sample of full cost and low cost carriers are pooled together due to limited number of sample for low cost carriers. In future, as more new low cost carriers entering the market, it would be interesting to split the sample into both low cost and full cost carriers in order to investigate the impact of outsourcing and economic development from the perspective of a specific type of business model.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

Abdullah, M.A, Susila Munisamy, Nurulhuda, M.S. (2013, June). *Benchmarking the efficiency of airlines in Asia using Data Envelopment Analysis Metafrontier Approach: A preliminary finding*. Paper presented at the 17th Air Transport Research Society World Conference, Bergamo, Italy.

Abdullah, M.A, Susila Munisamy, Nurulhuda, M.S. (2014, April). *Measuring efficiency of different airline business models using DEA Metafrontier framework*. Paper presented at the 12th International Conference on Data Envelopment Analysis, University of Malaya, Kuala Lumpur, Malaysia.

Papers submitted to journals:

Contemporary issues in airline performance: A critical review. Abdullah, M.A, Susila Munisamy, and Nurulhuda, M.S. *Transport Reviews*. (ISI-Cited).

Technical efficiency of and technology gap between low cost and full cost carriers' business models. Abdullah, M.A, Nurulhuda, M.S. and Susila Munisamy. Under review, *Transportation Research Part A: Policy and Practice* (ISI-Cited).