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Time Series Analysis of Global Airline Passengers Transportation Industry

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Time Series Analysis of Global Airline Passengers Transportation Industry

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Abstract: Technological developments and the global economic crisis are two types of developments that have affected the commercial airline industry in the last decade. This paper investigates time series analysis of the airline industry. The research has been conducted and is being presented, in a number of steps. First, a new, large database covering the global airline industry was assembled. Second, as part of the descriptive analysis of the industry and modeling a number of statistical tests are investigated. Third, the passenger airline transportation services models are estimated, to investigate their transportation entry and exit activities, as well as issues of heterogeneity and autocorrelation. Finally, we predict future developments within the industry. The empirical results are based on a large panel of 130 airlines observed monthly from January 2001 to April 2009. The airline produce two services of passenger and goods separately or jointly. The results show that specialized passenger companies cannot obtain sufficient revenues to stay at the market for long time. Airlines reduce costs through adding additional products. The worst performed joint service airlines' result of carrying passengers is much better than the result of specialized best practice airlines. In order to gain profit and improved survival rate, airlines specialized in passenger transportation must diversify their practice to carry both goods and passengers together.

Keywords: Airlines, time series analysis, ARIMA model, forecasts, information technology.

JEL Classification Numbers: C22, C53, D21, L20, L93

1. Introduction

Over the last decade, the airline industry has experienced several challenging events including the September 11 terrorist attacks, widely fluctuating oil prices, and economic slowdown that have significantly impacted the characteristics of the airline markets such as passenger demand, available capacity, competition, and pricing. In response to these changes, airlines are continuously fine-tuning their network structures and timetables by adding and removing flights, to maintain profitability and to cut losses (Abdelghany and Guzhwa, 2010). The airline business deals with passenger, goods transportation and also value added issue to maximize profit. In this research we will consider passenger transportation problems as one of most important points supporting a properly running economy in developed and developing countries.

During the period of 1997-2007 the number of air transportation companies had risen by 60%. In 2005 the number of airlines' passengers carried in EU increased by 8.5% compared to the year of 2004 (European Commission, 2007). This paper investigates the period between 2001 and 2009. Thus, our research goes beyond the result of European Union Commission and covers the period before September 2001. We hope that it will be interesting to observe the trend in airline services. The airline services include transportation of passenger and goods. The number of Revenue Passenger Kilometers (RPK) is a measure of the volume of passengers carried by an airline. It is the total number of kilometers travelled by all passengers. Freight Tonne Kilometers (FTK) performs substantially the same function as RPK for freight.

In this research we use time series methodology to investigate the development in the airline industry. We try to prove our hypothesis concerning the autoregressiove integrated moving average (ARIMA) model prediction results' possibility to support investment decision processes for an air transportation company's development. Taken as a whole, the main objective of this paper is designed to address the following research question: How can we help managers of passenger air transportation companies with strategic decision solutions for operational management in a highly competitive air passenger transportation market? Moreover, to investigate whether the New Technology outlay is going to bring greater profit for air companies and makes them more competitive in the market. Time series econometrics methodology and monthly time series data limited to passenger transportation service is used for this purpose.

The analysis was conducted in a number of steps. First, a new and large database was assembled covering the population of global airline industry observed monthly from the period of January 2001 through to April 2009. The airlines produce 2 services namely passengers and goods separately or jointly. Second, as part of the descriptive analysis of the industry and modeling the several time series issues are investigated. Third, the passenger airline transportation services model are estimated, to investigate their entry and exit activities, as well as issues of heterogeneity and autocorrelation. Finally, based on selected model specification we predict future developments within the industry. The unique data used allows for in-depth analysis of the aggregate airline industry and individual airlines, trends in their investments, development and performance, as well as predictions of their future potential.

The result based on the up-to-date data show significant changes in the airline industry following the technological developments channeled through information and communication and the development of the worldwide economic crisis. The former impacted through service provision, while the later has led to decreased demand and, subsequently, increased competition, reducing profitability and causing issues that threaten the very survival of many commercial airlines. The empirical result show that specialized passenger companies cannot obtain sufficient revenues to stay at the market for long time. We find that the worst joint service airlines' result of carrying passengers is much better than the result of the best single service airlines. In order to gain profit and improved survival rate, airlines specialized in passenger transportation must diversify their practice to carry both goods and passengers together. Airlines are able to reduce costs through adding additional products.

The remainder of this study is organized as follows. A research framework of airline's passenger industry will be presented based on evolution of RPK growth and recent literature. Proper data, theory, a particular model, and ARIMA method to predict passenger capacity development will be presented. Empirical results are divided into descriptive statistics and prediction graph results globally, and with regional division. Finally, we conclude by examining the implications, followed by various useful recommendations for passenger transportation.

2. The Passenger Airline Industry and Literature Review

While the airline industry has experienced a number of significant institutional innovations over the years, including the adoption of hub-and-spoke networks, Frequent Flier Programs, and the use of yield management techniques, true technological innovations have been less frequent. The most important such innovation over the last fifty years was the emergence of the jet passenger aircraft in the 1960s, and Information Technology application.

More recently, the 1990s have witnessed another innovation that, while less dramatic than the jet revolution, is nevertheless significant (Brueckner et al., 2009). This innovation is the introduction of the Low Cost Carriers (LCC). Morrell (2005) argues that establishment of LCC offshoots by network carriers has three possible objectives: to spin off profitable businesses, to see off low cost competition in key markets, and to establish a test-bed for adapting low cost business processes to their mainline operations.

This study implies that an increasingly growing number of passengers using air transportation around the world require new technology support, rather than additional low cost carrier's net or building a new passenger jet aircraft. This is because wide and proper forecasting generates fundamental changes in the prediction and application of technology in business. Information and Communication Technologies (ICTs) can provide powerful strategic and tactical tools for organizations, which, if properly applied and used, could bring great advantages in promoting and strengthening their competitiveness (Porter, 2001). A comprehensive understanding of ICT factor will help passenger transportation companies' policymakers invest in information technology which will in turn support development of the air transportation companies to a greater degree.

Concerning intra-European scheduled passenger airline industry recently underwent significant economic liberalization with the maturing of the single market of the European community in the 1990's. Prior to this, the entry and exit, capacity, frequency and even pricing decisions on each route was highly regulated. Since the entry to most routes was immensely restricted, new industry entrants were relatively few and far in between. (Ping, 2009)

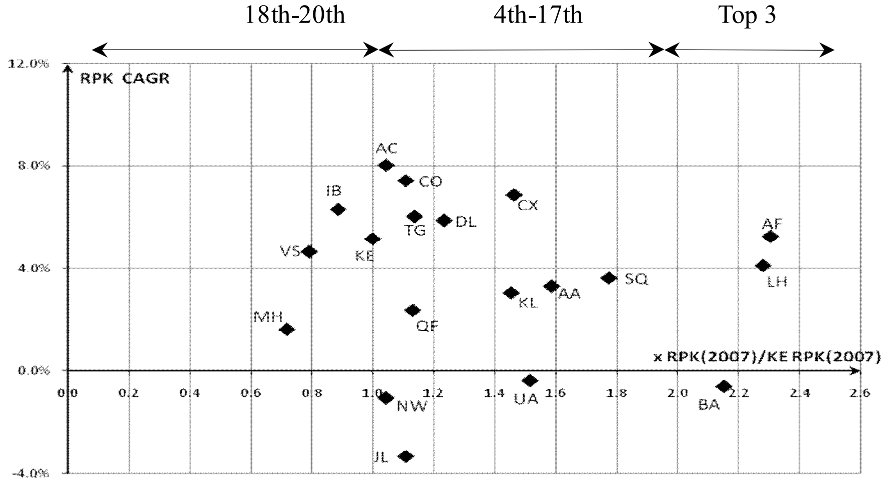

Figure 1. Top 20 airlines (of 160) revenue passenger kilometers compound annual growth rate (RPK-CAGR).[1] **(**Source: IATA Statistics (2009)**)**

We argue that this study's RPK prediction results allow the airline companies to stay in such competitive market in a significant way. These findings are of practical importance to all those interested in the passenger air transportation industry, especially the airlines' board members and anyone who customarily, habitually or professionally deals with air companies' profit maximization.

The Figure 1 indicates the top 20 air companies with their value of RPK. The vertical axis shows Revenue Passenger Kilometers Compound Annual Growth Rate (RPK-CAGR) measured in percentage scaled up to a maximum value of 12.00%. Thus, Emirates Airlines with the highest growth rate of 24.60% RPK-CAGR cannot be viewed at the picture due to the axis scale. The horizontal axis indicates a ratio of each individual airline company's Revenue Passenger Kilometers divided by the RPK of Korean Air[2]. Air France and Deutsche Lufthansa are great examples in respect to this RPK formula due to their high growth rates and large sizes relative to Korean Air.

In Figure 1, Air Canada achieved the highest RPK compound annual growth rate (corresponding to 8.03 %) but there is still a big gap between it and Emirates Airlines with a 24.60% growth rate. In contrast, Malaysia Airlines closes out the top 20 airlines with an

[1] This picture includes 160 IATA airlines.

[2] **See Appendix 4, Table 4.D. IATA (2009)**

RPK-CAGR of 1.62%. Additionally, the smallest growth rate belongs to Japan Airlines with -3.33%, whereas Air France achieved the result of the growth rate of 5.30%.

These rankings were measured among 160 airlines in the period 1999-2006 according to the International Air Transport Association. Korean Air's Growth Rate in 2006 achieved an RPK-CAGR of 5.16% overtaking Virgin Atlantic (VS), Lufthansa (LH), Singapore Airlines Ltd (SQ), and all of the remaining 8 airlines including Japan Airlines (JL) with the lowest growth rate.

3. The Data Description and Distribution Analysis

Three sources of data are used in this analysis: IATA 2009, SITA 2009[3] and World Development Indicator WID 2008. We collected the data for this study from the International Air Transport Association (IATA) Monthly International Statistics (MIS). All air company's individual IATA data are from the individual airlines via direct submission through the MIS data collection or through airline websites. We use the IATA panel data to conduct passenger transportation analyzes. The growth of the data, development and heterogeneity was a cause for concern. This specific airline market creates sophisticated survival conditions for new entrants wherein some passenger air companies had to exit the market a mere couple of months after inception.

Daraban (2008) argues that availability of route level panel data allows to examine the role of low cost carriers' entry and exit in a dynamic setting. Low cost carries refers to a "no frills" airline with limited service compared to regular, major airlines offering more standardized service options. We agree with the Daraban hypothesis but in our oint service data analysis we find out more factors determining the circumstances for the entry and exit in and out of the market for many airlines. Low cost carriers, Network, and Major airlines exit and entry to a market is affected by financial instability, terrorist attacks, competitors' activity, etc. Ping (2009) examines whether or not the probability of survival of a Denovo entrant in the liberalized intra-European air transport market is affected by three sets of determinants: strategic positioning, inaugural market entry and network economics. Among these three sets of determinants, network economics provide the most consistent (and statistically significant) influence on the survival of new entrants.

3.1 Description of Passenger Transportation data

In this section we investigate passenger transportation, thus we analyze 130 airlines qualified for research[4] from International Air Transportation Association 2009. The data represents 8 main regions and consists of 11,244 monthly observations. There are two tables which indicate passenger transportations for the period of January 2001 to April 2009 divided into yearly (Table 1) and monthly (Table 2) dimensions.

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[3] The Airline' IT Trends Survey

[4] Appendix 4, Table 4.A.

Table 1. Summary statistics of yearly Revenue Passenger Kilometers based on IATA (2009) with 130 airlines.

Year	Frequency	Mean	Std Dev	Maximim	Minimum
2001	1234	1270783	1815772	9903120	0
2002	1376	1171574	1754569	8610450	0
2003	1379	1164109	1705142	9012305	0
2004	1386	1343684	1909430	9898788	0
2005	1397	1463711	2042206	10307189	8021
2006	1409	1513317	2141919	10618000	0
2007	1360	1676312	2312844	11460000	0
2008	1329	1763847	2375603	11600000	0
2009	374	1764551	2258850	9811000	971

Table 2. Summary statistics of monthly Revenue Passenger Kilometers based on IATA (2009) with 130 airlines.

Month	Frequency	Mean	Std Dev	Maximum	Minimum
January	1018	1393512	1980321	9634000	0
February	1011	1244585	1762535	8671000	0
March	1000	1441662	2057760	10303000	0
April	986	1410408	2015913	10039950	0
May	911	1363333	1987479	10799812	0
June	909	1465214	2110017	11041150	0
July	909	1608633	2266997	11600000	0
August	908	1626363	2249599	11467000	0
September	905	1452445	2048245	10850269	0
October	899	1427639	2032023	10544774	0
November	894	1322933	1888942	9257000	0
December	894	1418269	2005101	9749000	0

Compared with other data sets, collecting data for airlines associated with the passenger data has been relatively complex. The frequency with which airlines enter and exit the volatile market creates distortions in the data collecting process. For example, in our data four passenger transportation companies quit the market after less than 16 months of their operation. They are: Syrian Arab Airlines (15 months), Tower Air Inc. (1 month), Pakistan International Airlines Corporation (16 months), and Air Seychelles Ltd (after 6 months).

In contrast Balkan Bulgarian Airlines was active 55 years before it exited the airline business due to financial instability. These factors made us convinced that there are difficulties in testing in such a diverse, changeable and sophisticated passenger air transportation market. Additionally, we focused on specialized passenger transportation air companies which have existed in the market for long time. We investigate how they have developed over time in regards to size, on a monthly and yearly basis.

Table 3 shows the top 20 passenger airlines with only passenger transportation activity.

Table 3. Top 20 specialized passenger transportation airlines. Source IATA 2009.

Number	IATA Code	Airline name	Region	Observations	Entrydata	Exit date	RPK	FTK	Rank[5]	Country
1	8M	Myanmar Airways	Asia	85	01/'02	01/'09	+	−	1	Myanmar
2	A4	Southern Winds	S. Amer.	12	08/'02	07/'03	+	−	15	Argentina
3	BU	SAS Scandinavian Airlines	Europe	33	01/'01	09/'03	+	−	7	Norge AS[6]
4	CE	Nationwide Airlines (Pty) Ltd	Africa	45	01/'05	03/'08	+	−	4	South Africa
5	FF	Tower Air, Inc.	N.Amer.	25	01/'00	01/'02	+	−	10	USA
6	G3	Gol Airlines	Brazil	16	07/'07	04/'09	+	−	14	S. America
7	IN	Macedonian Airl.	Europe	40	01/'06	04/'09	+	−	5	Macedonia
8	IX	Air India Charters	Asia	16	01/'08	04/'09	+	−	14	India
9	KF	Blue1 (Blue1 Ltd.)	Europe	24	02/'01	12/'03	+	−	11	Finland
10	PG	Bangkok Airways	Asia	46	07/'05	04/'09	+	−	3	Thailand
11	PU	Uruguaya PLUNA	S. Amer.	33	01/'04	12/'08	+	−	7	Urugway
12	PZ	TAM Transportes Aereos del Mercosur	South America	82	01/'01	04/'09	+	−	2	Paraguway
13	S4	SATA International	Europe	40	01/'06	04/'09	+	−	6	Portugal
14	TA	TACA	C.Amer/ Cari.	28	01/'07	04/'09	+	−	9	El Salvador
15	TV	Virgin Express	Europe	25	01/'02	01/'04	+	−	10	Belgium
16	TZ	American Trans Air	N.Amer.	32	01/'01	03/'08	+	−	8	USA
17	VH	Aeropostal Alas De Venezuela	S.Amer.	45	01/'04	03/'08	+	−	4	Venezuela
18	VK	Virgin Nigeria Air.	Africa	7	08/'08	04/'09	+	−	16	Nigeria
19	VX	Colombia ACES	S. Amer.	20	01/'02	08/'03	+	−	12	Colombia
20	WF	Wideroe Flyveselskap A/S	Europe	19	01/'02	07/'03	+	−	13	Norway

The list includes: Myanmar Airways Int., Southern Winds, Scandinavian Airlines

[5] Rank analysis concerning number of observations.

[6] Scandinavian Airlines System (SAS) was severed in 2004, into four smaller firms: SAS Scandinavian Airlines Sverige AB, SAS Scandinavian Airlines Danmark AS, SAS Braathens AS and SAS Scandinavian International AS. SAS Braathens was re-branded SAS Scandinavian Airlines Norge AS in 2007.

Norge AS, Macedonian Airlines-MAT, Air India Charters Limited, Blue1 (Blue1 Ltd.), Bangkok Airways Co. Ltd, TAM Transportes Aereos del Mercosur, SATA International, TACA, Virgin Express, American Trans Air, Aeropostal Alas De Venezuela, Virgin Nigeria Airways Limited, Aerolíneas Centrales de Colombia S.A – ACES , Wideroe Flyveselskap A/S, Nationale Airlines (Pty) Limited, Tower Air, Inc., Gol Airlines and Primeras Lineas Uruguayas de Nevgacion Aera (PLUNA) in International Air Transport Association' Carriers Tracker 2009 data base. The compilation of these airlines acts as an indicative cross-section of the best of the airline market as a whole, enabling us to scrutinize the relevant success of many through their examination.

Some countries have numerous passenger transportation and goods transportation companies functioning within their own limited market, for example Nigeria has 11 airlines.[7]

The data analysis shows that the specialized activity of airlines registered in the market are mainly characteristic of a small number of observations. To conclude, generally speaking, specialized passenger airlines stay in the market for a short period of time. We examined the entrance into the market and exit from of above air companies, with the results present in the Table 3.

Most of the airlines practice joint (passenger and goods) activity, sometimes with some small percent of FTK within a whole year but they still usually differentiate their loads. Although the International Air Transport Association has been using every effort to ensure accuracy, the passenger airlines data has some missing. We use here Carrier Monthly Volume which is the actual figures reported to IATA by the carriers. If there is no traffic, the data item appears as zero. If the data has not been reported at the time of publication, the data item is blank or missing. (IATA, 2009)

Eventually, based on selected specification and estimation of models in this investigation we predict future development of the passenger transportation by individual airline companies. The rapid changes in the industry demand new analysis of the industry and technology's effects acting upon it based on updated data. The empirical result of passenger transportation is based on a large IATA panel data observed on monthly bases for the period 2001–2009. The data allows for an in-depth analysis of the aggregate passenger industry and individual airlines, trends in their investment, development and performance as well as predictions of their future potentials.

This distribution analysis will let us know other airlines from IATA Business Intelligence Service which could not be qualified for ARIMA modeling. Consequently we collected 130 Airlines' full set of actual data reported by the carriers from the time of January 2001 to April 2009 with a sample of 11,244 monthly observations. For comparative purpose and sensitivity analysis we used 4 specialized airlines with the largest

[7] Aero Contractors (Nigeria), Afrijet Airlines, Arik Air, Bellview Airlines (Nigeria), Capital Airlines (Nigeria), Chanchangi Airlines, Dornier Aviation Nigeria, EAS Airlines, Freedom Air Services, IRS Airlines, Overland Airways, Virgin Nigeria Airways.

number of observations presented in Table 3. We have not used Paraguay TAM Transportes Aereos del Mercosur airline (with 82 observations) from Table 3 due to the non-consecutiveness of observations in the data.

After the investigations about passenger transportation data sources, quantities and qualities, we have recognized that data from IATA used for the research has some limitations attributed to missing units and was thereby assessed as incomplete. However, after having investigated the issue and compared it with the existing knowledge in the literature we found that the limitations were not as serious as was expected. Thus, the data was found useful for analysis of the passenger transportation service.

4. Methodology

In this section we define the seasonal ARIMA model as described below. First, we will study the effects of historical data on future developments of Passenger Transportation (PT). Then we will consider how PT developed over time, and how they developed according to the size of the company over time, both monthly and yearly. Moreover, we will examine the airlines' entry and exit, as well as the acting effects of seasonality, the financial crisis, and even the 2001 terrorist attacks. We use regression analysis to make quantitative predictions of one variable by utilizing the past information. Then we divide our Data Set regionally to check regional proportional development. The IATA 2009 data set consists of two different activities of the airlines: specialized defined as the carrying of only either passengers or goods, and joint, carrying both passengers and goods together in their activities.

Furthermore, we consider the 4 largest regional groups of airlines specialized Passenger Transportation Air Companies[8] from Table 3. All of them exist in the market for more than three years, and we check how they develop over time, and by size, both monthly and yearly. Then, we compare their RPK results with the 4 largest joint service airlines with the best key indicators among 160 carriers reported in Monthly International Statistics 2009 (see Table 1). These are: Deutsche Lufthansa, Air France, American Airlines and Japan Airlines. Here we ignored the Federal Express Corporations because of its specialization in goods transportation. Finally, we put the worst 4 joint service air companies[9] ranked by means (Appendix 4, Table 4.C.) in one graph together to test their development. The largest airlines are ranked by their level of revenue and by chance represent three regions: Europe, North America, and Asia. Eventually, for both groups (Average of RPK passenger development and Regional Growth rate development), we check historical results and apply regression analysis to make quantitative RPK predictions for the future RPK using past information. Finally, it concludes by examining implications, followed by various critical recommendations.

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[8] Myanmar Airways Int., Sata Internatcional, Bangkok Airways Co. Ltd, Macedonian, Airlines-MAT.

[9] Air Tanzania Company, Luxair, FlyLAL - Lithuanian Airlines, Hawaiian Airlines.

In general form and representing the service production by Y and taking into account the multi-output nature of the service, the output is written as:

$$Y = GT + PT \qquad (1)$$

where GT and PT represent goods and passenger segments of the overall service Y, respectively. Based on the objective of this study, the service is limited to passenger transportation. Hence, we apply the following universal econometric model presented in Wooldridge (2006). The passenger transportation model is written as:

$$PT_t = f(PT_{t-j}, Z_t, t) \qquad (2)$$

where PT_t indicates passenger transportation in time period t, j indicates time lag, Z is a vector of control variables characterizing producer, consumers, market organization and regulations, and t is a time trend capturing shift in the service or technological change. In our time series analysis of the airline industry, the seasonality of 12 months is very clear, so the typical selection of ARIMA model with (j=12) lags is justified. Passengers Transportation value of RPK typically increases in February and decreases in September. After having appended error terms to the equation it is estimated using ordinary least squares estimation method.

It should be noted that when the model is used to predict the future, it must consider the value of 12 month ago together with other control variables. Thus the time is measured in monthly and lag length is optimally chosen as 12 months. The model in 2 is applied here to data set consisting of airlines with passenger as their main service provision.

4.1. ARIMA Modeling

In this section we present only a broad outline and the practical dimensions of implementation of ARIMA modeling. The probability of the ARIMA process used considers, in detail, the historical revenue passengers kilometers. An ARIMA model forecasts a value in a response time series as a linear combination of its own past values, past errors (also called shocks or innovations), and the current and past values of other time series. Johnson (1997)

Estimation of the passenger transportation model involves and number of steps as follows. We apply Box and Jenkins (1970) approach to use ARIMA modeling. To do so, we must first check the PT series stationarity. From the autocorrelation properties of the transformed series we choose a few ARIMA specifications for estimation, and testing in order to arrive at preferred specification with white noise residuals. Afterwards we had to find the seasonality trends, and adjust to these effects for a stationary condition. Moreover, we had to transform the original data, and finally we calculated forecasts over a relevant time horizon from the preferred specification.

In the process of our data management we measure the volume of passengers carried out by an airline and we notice a phenomenon of seasonality characteristically affecting the air transportation market. In the ARIMA model, the seasonal length of a cycle is increased by the number of autoregressive and moving averages most frequent parameters at lags, and differencing operators. We decided to use the ARIMA model because it allows us to process regular seasonal fluctuation time series which actually match those of the airline market. If there is a constant coefficient A in the data possibly multiply by the response with appropriate lags the coefficient A is given out and added to ARIMA p, d, q, parameters, where the parameters p, d and q are the orders of autoregression, degree of integration and moving average.

Following Johnson (1997), the general notation for the order of a seasonal ARIMA model with both seasonal and non-seasonal factors is ARIMA(p,d,q)×(P,D,Q)A, and the term (p,d,q) gives the order of the non-seasonal part of the ARIMA model; the term (P,D,Q)s gives the order of the seasonal part. In our data A was observed 12 times per year so we decided to apply monthly seasonal series for our research. The seasonal ARIMA model is defined as follows:

Let X_t be the original RPK response at time t. Because X_t is non-stationary monthly time series, here we use the seasonal ARIMA model. If d and D are non-negative integers, then $\{X_t\}$ is seasonal. $ARIMA^{(p,d,q)x(P,D,Q)_s}$ process with period s if the differenced series is:

$$Y_t = (1-B)^d (1-B^s)^D X_t \text{ is a ARMA process defined by} \qquad (3)$$

$$\phi(B)\Phi(B^s)Y_t = \theta(B)\Theta(B^s)Z_t, \quad Z_t \sim N(0,\sigma^2), \text{ where} \qquad (4)$$

$$\phi(B) = 1-\phi^1 B - ... - \phi^p B^p, \quad \Phi(B) = 1-\Phi^1 B - ... - \Phi^Q B^Q \qquad (5)$$

$$\theta(B) = 1+\theta^1 B + ... + \theta^p B^p, \quad \Theta(B) = 1-\Theta^1 B - ... - \Theta^Q B^Q \qquad (6)$$

$$B^j X_t = X_{t-j} \mathrm{B}^j \text{ for all j}, \quad Z_t \sim N(0,\sigma^2), \qquad (7)$$

where Z_t is the random variable which follows normal (Gaussian) distribution with mean 0 and variance σ^2, e.g. Z^t is the white noise. The notations are defined as: B is backward shift operator; d is non-negative integer, differencing order, ϕ is polynomials whose coefficients are for AR terms, Φ is polynomials whose coefficients are for seasonal AR terms, θ is polynomials whose coefficients are for MA terms, Θ is polynomials whose coefficients are for seasonal MA terms, σ is standard deviation of the random noise, t is time, and D is non-negative integer.

Three steps are characterizing the ARIMA data development. These are identification, estimation and forecasting described as follow.

Identification: Using the Table 4 we decide on p and q values, as our parameters of interest. These are determined by the patterns of Autocorrelation Function (ACF) and Partial Autocorrelation function (PACF). The characteristics of these function is shown in Table 4

Table 4. ACF and PACF functions' characteristics. Source: Johnston (1997)

Process	ACF	PACF

AR (p)	Infinite: damps out	Finite: cuts off after lag p
MA (q)	Finite: cuts off after lag q	Infinite: damps out
ARMA	Infinite: damps out	Infinite: damps out

Estimation: In this step, given the order of the above model, we estimate the models' unknown parameters. For diagnostic testing we have to check the model if it is proper to our research case. Then we can apply it for predicting the future values using our estimated ARIMA model results.

Forecasting: The main purpose of fitting ARMA schemes is to project the series forward beyond the sample period or out of sample.

It should be noted that, in all that follows we will assume that observations are only available for periods 1 to n, and that all forecasts are made conditional on information available at time n (APR, 2009). The Mean Square Error (MSE) is a widely used criterion for the choice of a forecasting performance rule. We wish to find a forecasting rule that will minimize MSE. It can be shown that the minimum MSE forecast of Y_{n+s} is the conditional expectation of Y_{n+s}, given information available at time period n.

5. Testing Procedures and Analysis of the Results

Since following Gardner (2006) exponential smoothing methods are widely used for short-term prediction in business and industry, in this study we present this approach for the passenger air transportation analysis. The particular methodology allows us to work with our panel data in a very effective, but sometimes, due to seasonality, also difficult, way. Most time series models assume that the observations are sampled with the same frequency, but it is common to find time series with missing data. In order to carry out a precise analysis of our IATA-2009 time series data and obtain reliable forecasts, it was necessary to deal effectively with the missing data. (Bermudez at al., 2009)

We consider that time series forecasting is a research area that has drawn considerable attention for applications in a variety of areas. ARIMA models are one of the most important time series models that have been used in financial and other market forecasting over the past three decades. Recent research in time series forecasting indicates that two basic limitations detract from their popularity for time series forecasting are that: (i) ARIMA models assume that future values of a time series have a linear relationship with current and past values as well as with white noise, so approximations by ARIMA models may not be adequate for complex nonlinear problems, and (ii) ARIMA models require a large amount of historical data in order to produce accurate results. (Khashei et al., 2009) Thus in our analysis we test the number of airlines, 130, to check historical data development including 11,244 observations within a 100-month period of time. The sample size and length of time period seem to be sufficiently large to produce stable results.

As shown in Figure 2, the graph represents the development of passenger transportation for 130 airlines from January 2001 to April 2009. The Vertical Axis displays the average number of RPK value, and the horizontal axis depicts the time period. The figure presents one hundred months of historical data. It shows that in April 2002 the IATA airlines average representative from our dataset carried 1,120,000 passengers. In April 2009 the service quantity improved by expanding to 2,120,000 passengers. To conclude, 1,000,000 more passengers were carried from the graph than at the beginning of the study period. Therefore, it can be expected that in the future on the average 10,000 passengers more will utilize the service every month. This significant finding based on the descriptive analysis supports the first hypothesis that we face “increasingly growing number of passengers and variable revenue streams from seasonal traffic in the airline market”. Since the descriptive analysis is to define the main features of a compilation of data in quantitative terms rather than forecast the future value of historical data, therefore, as a next step we apply regression analysis to make quantitative predictions of passenger transportation by utilizing its past information.

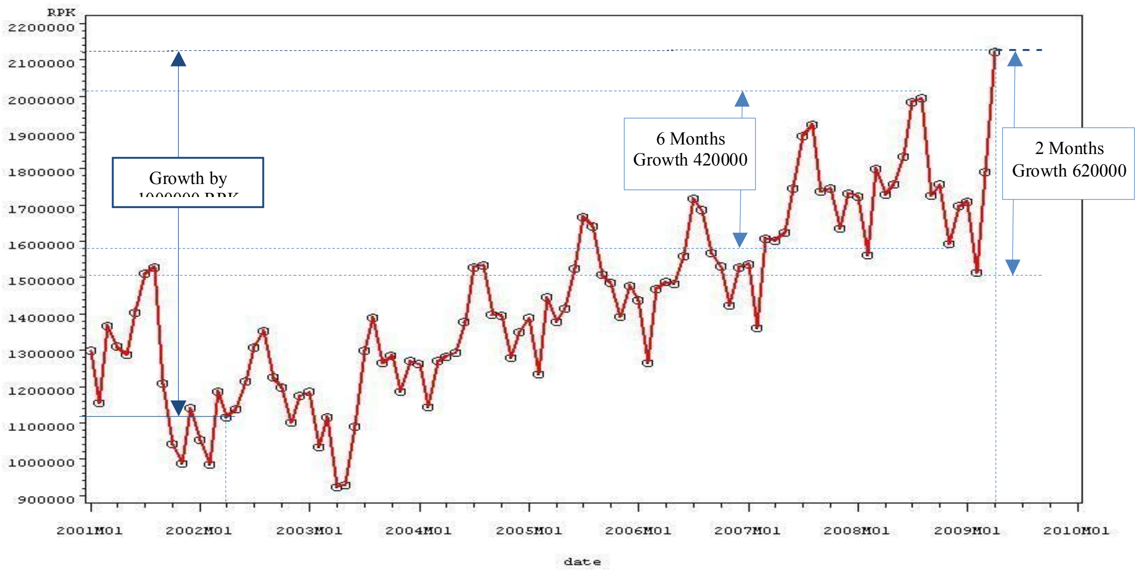

Figure 2. Development of average passenger transportation for 130 airlines, 2001-2009[10]

Based on this result, using air transportation around the world requires new technology, and proper prediction analysis application to make the process smoother, safer, and more profitable. Hence to prove the theory and develop a First Hypothesis we must first establish whether or not our data is non-stationary, after which we can continue Time Series Data analysis for further investigation. In the Figure 2.2 the circles illustrate monthly numbers of RPK.

We presume that our data has a tendency of certain characteristics to increase and

[10] Source: IATA Statistics (2009), Appendix 4, Table 4.B, RPK average.

decrease value of Passenger Transportation.

Table 5. Augmented Dickey-Fuller test for Passenger Transportation

Null Hypothesis: RPK has a unit root			
Exogenous: Constant, Linear Trend			
		t-Statistic	Prob.
Augmented Dickey-Fuller test statistic		-2.894005	0.1696
Test critical values:	1% level	-4.066981	
	5% level	-3.462292	
	10% level	-3.157475	

Therefore, we assume that the data has a trend and there will be a positive relationship between the perceived ease of use of the Augmented Dickey–Fuller (ADF) test case #4 (with intercept and trend), to find out whether or not our data is stationary. Hence, we apply unit root test, and the test result is reported in Table 2.5. As we can see in Table 2.5, the Null Hypothesis states that RPK has a unit root. Therefore, we assume that our Passenger Transportation data is non-stationary. The ADF statistics is -1.71, so we cannot reject the null hypothesis at critical level (even at 10% level). Therefore, we can conclude RPK has a unit root, and our time series data approach is justified.

We argue that a statistical systems application can make the process smoother, safer, and more profitable. Consequent to our methodology, eight regional divisions of our data were identified. Figure 3 reveals the development of growth in air passenger transportation for eight regions described in IATA (2009. The regions include: Africa, Asia, Central America/Caribbean, Europe, Middle East, North America, South America, and Southwest Pacific. The historical growth rates for the period of 100 months are distinguished in the graph. Therefore, like in Figure 2, it is based on the 100 months period from January 2001 to April 2009 at the horizontal axis, but the vertical axis regional year-on-year growth rate for each of the regions. Regional data are based on a constant year-on-year sample of airlines.

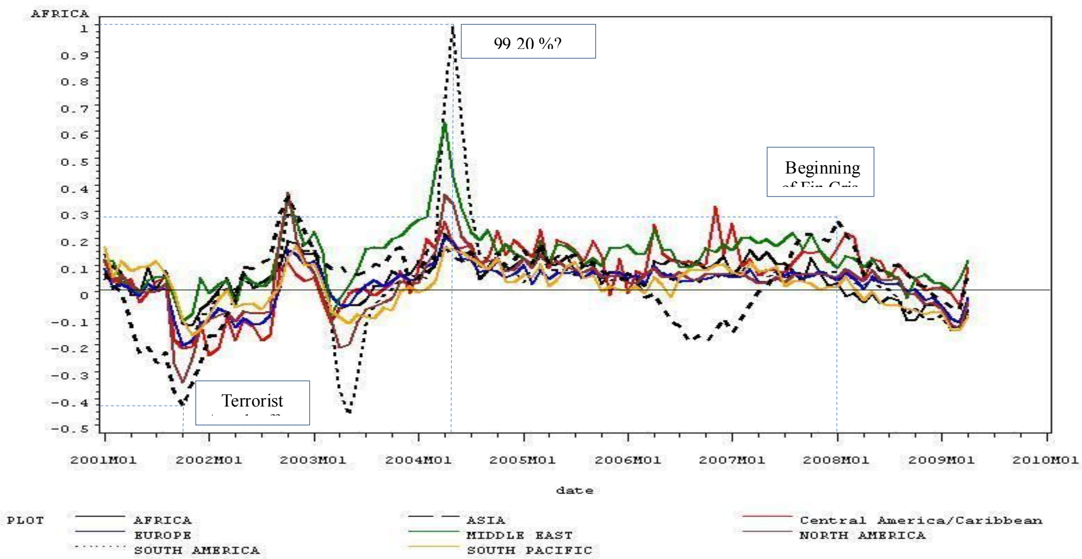

Figure 3. Regional development of air passenger transportation, 2001(01)-2009(04)[11]
Source: IATA Statistics (2009)

We have also created a regional development graph for each region. However, due the large number of graphs, these are placed in Appendix 1. Therefore, after analysis, we indentified that Figure 3 has unique features pertinent to this study that contribute to the potential usefulness for hypothesis testing and to obtain a proper result. At first it was difficult to conclude as to why RPK in Asia increased to 99.2% in the summer of 2004 as well as in other countries, albeit less significantly. Eventually, we realize that air passenger movement was highly effected by 46 countries' citizens going to 28th Olympics Games in Athens (Greece).

The future prediction potential of this study can bring great economics results for a regions achievement. Kavetsos (2009) argues that widely proclaimed economic benefits of hosting major sporting events have received substantial criticism by economists and have been shown to be negligible, at best. We state that the knowledge about sudden unexpected

[11] **Separate graphs for the individual regions growth rates is available in the Appendix 1, Figure 3A through 3.H.**

large RPK increase will make airlines' managers' decision process quick, exact, and perfectly conforming the requirement at the time. It can maximize profit in many companies connected with air transportation industry.

Brueckner (2003) argues that even small-town business leaders and government officials sometimes complain that inadequate airline service is an obstacle to local economic development. Global approach for regional transportation is useful and recommended not only for particular country but also to non-governmental organizations like United Nation, Organization for Security and Cooperation in Europe, World Bank, etc. In order to fill the gap we will perform prediction of development of regional and global RPK growth rates in the next part of this section.

In order to test new ideas, we apply a comparison of several PT transportation companies by their characteristics. The comparison is made with respect to the same period of time as a significant factor for an airlines' development. Compared in respect to the RPK, three clusters of airlines development have been relatively unexplored. The clusters are the 4 largest joint service, the 4 worst joint service, and the 4 single service passenger airlines. Due to interesting RPK layout, different trend developments for different airlines, and to test our second hypothesis we consider specialized passenger transportation air companies[12]. The largest joint service companies are Lufthansa, Air France, American Airlines and Japan Airlines.[13] All three clusters were tested at the same period: January 2006 to December 2008. Specialized PT companies are identified to be Myanmar Airways, Sata International, Bangkok Airways and Macedonian Airlines. We investigate how these airlines develop over time and by size, both monthly and yearly.

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[12] The companies carry only passenger and no goods transportation involved, see Table 3.

[13] Largest airlines around the world in 2007 are indicated in Appendix 4, Table 4. F. Source: IATA (2009)

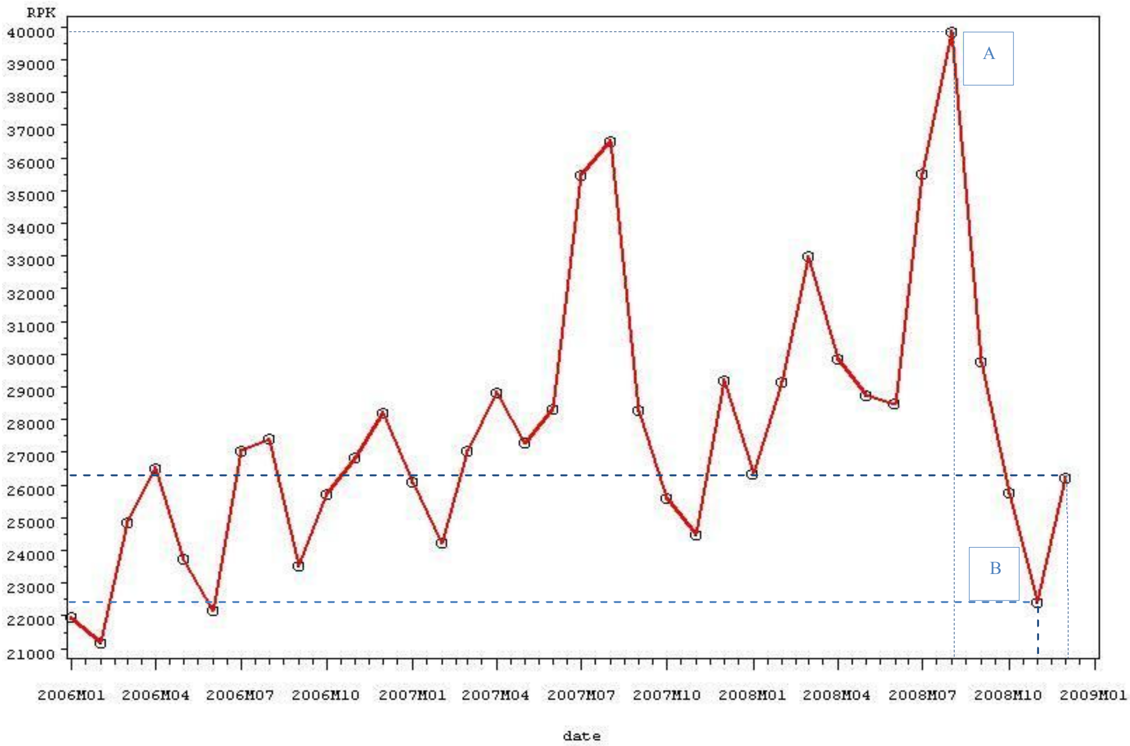

Figure 4. Development of specialized passenger air transportation service (represented by Myanmar Airways, Sata International, Bangkok Airways, Macedonian Airlines) over 2006(01)-2008(12). Source: IATA Statistics (2009)

The average of revenue passenger kilometers achieved by the cluster of four specialized passenger companies for the period January 2006 to December 2008 is depicted in Figure 4. The horizontal axis indicates the time period, and the vertical axis provides the evidence of RPK total numbers for all four airlines. The largest number of RPK (40,000) is achieved just before the financial crisis in August 2008 (point A). Then the financial crisis significantly affected them as other airlines in the market in 2008, and RPK decreased to 17,500 in November (point B). There are four figures presented separately depicting the historical performance of the specialized passenger transportation companies in the Appendix 2 (Figure 2.A, B, C and D). The airlines noticed in August 2008 RPK=17,400 better result than in January 2006.

In the next step, we compare the result in above with the four, worst-resulting joint service air companies from our set of 130 airlines. They are classified as the worst airlines by mean analysis of development of their air transportation. The ranking are shown in Appendix 4, Table 4.C, and separate figures of each airlines number: Appendix 3 (Figure3A, B, C, D).

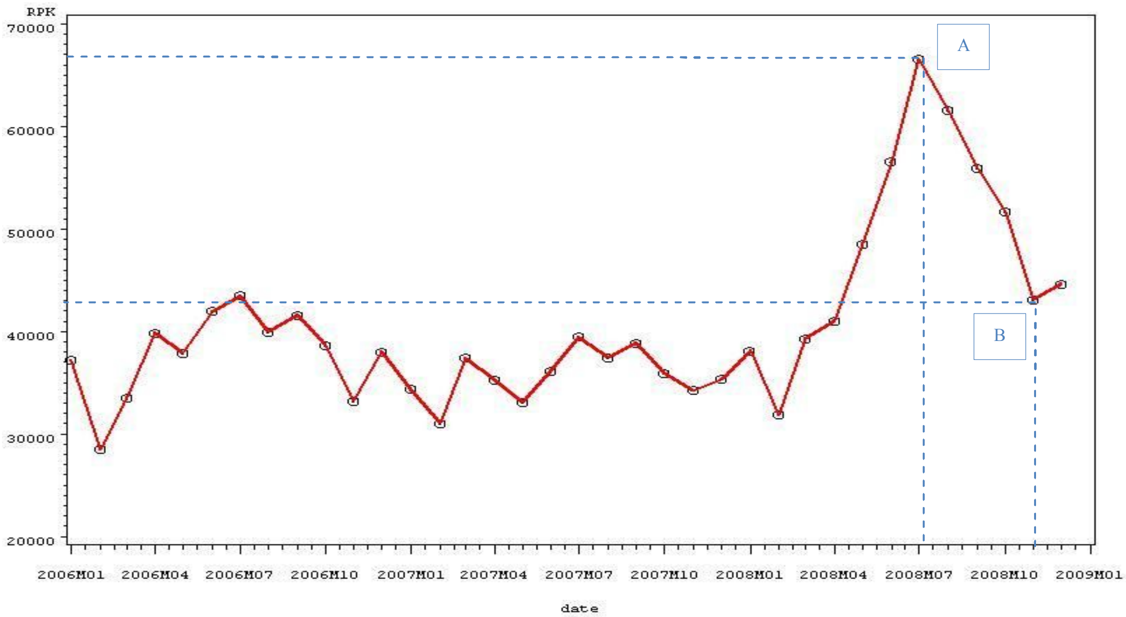

Figure 5. Development of average PTK for the four worst (Air Tanzania, Luxair, FlyLAL, and Hawaiian Airlines) joint service companies, 2006(01)-2008(12). Source: IATA Statistics (2009)

Figure 5 shows the historical development of passenger transportation by the four joint service airlines namely the Air Tanzania-TC, Luxair-LG, FlyLAL-Lithuanian Airlines-TE, and Hawaiian Airlines-HA. Even if these airlines also carry goods in this investigation we consider only their passenger transportation service. The biggest RPK value (almost 67,000) among the abovementioned 4 airlines is achieved in July 2008 (point A). Then, the financial crisis badly impacted them as almost all of the airlines in the market in 2008, and in this case RPK decreased to 43,000 in November (point B). This time the airlines noticed a 30,000 higher RPK (until point A, the highest level) compared with the beginning of testing period.

As shown in Figure 6 and Table 1 we identify the largest four airlines: Deutsche Lufthansa – LH, Air France – AF, American Airlines – AA, and Japan Airlines – JL. The result of each airline is also presented in the Appendix 4 (Figure: 4.A through 4.D).

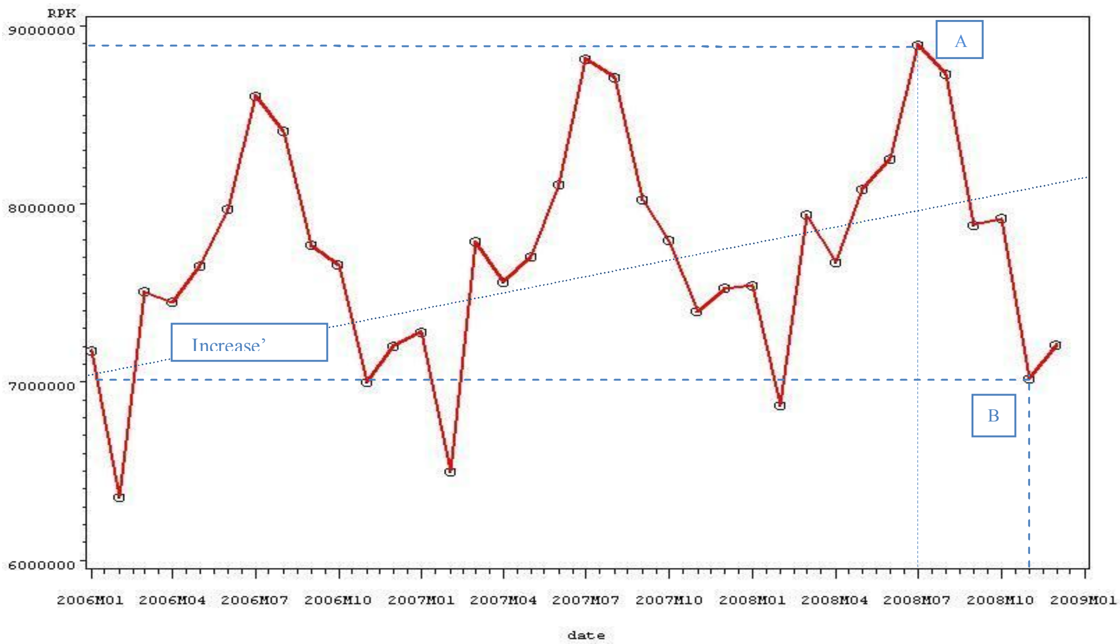

Figure 6. The development of the average PT of the largest joint service air transportation companies (Lufthansa, Air France, American Airlines and Japan Airlines), 2006(1)-2008(12). Source: IATA Statistics (2009)

Likewise in this graph we apply the same indication for horizontal and vertical axis. For obvious reasons the scale of RPK is much bigger than in previous cases. The largest result for the largest airlines (8,900,000) is comparable to the combined accumulated statistics of the worst and specialized airlines from Figures 4 and 5, in July 2008 (point A). Under the financial crises the largest airlines achieved, in November 2008, more than 7,000,000 RPK (point B). Reinhart (2008) highlighted that defaults in emerging market economies tend to rise sharply when many countries are simultaneously experiencing domestic banking crises. However the largest airlines, as we can see in Figure 6, had no significant PT consequences resulting from the financial crises. Stable and increasing RPK trend was observed for the largest airlines. After having reviewed the literature in this respect, we presume that the joint service time series analysis of the airline industry has been relatively unexplored.

Figure 7 shows three representative clusters of specialized and joint airlines' services. The Horizontal Axis indicates a three-year time period, whereas the vertical axis highlights the 3 different RPK segments. Particular axis option for number of carried passenger was applied due to the significant size differentiation between the largest joint service, worst joint service and specialized airlines clusters values.

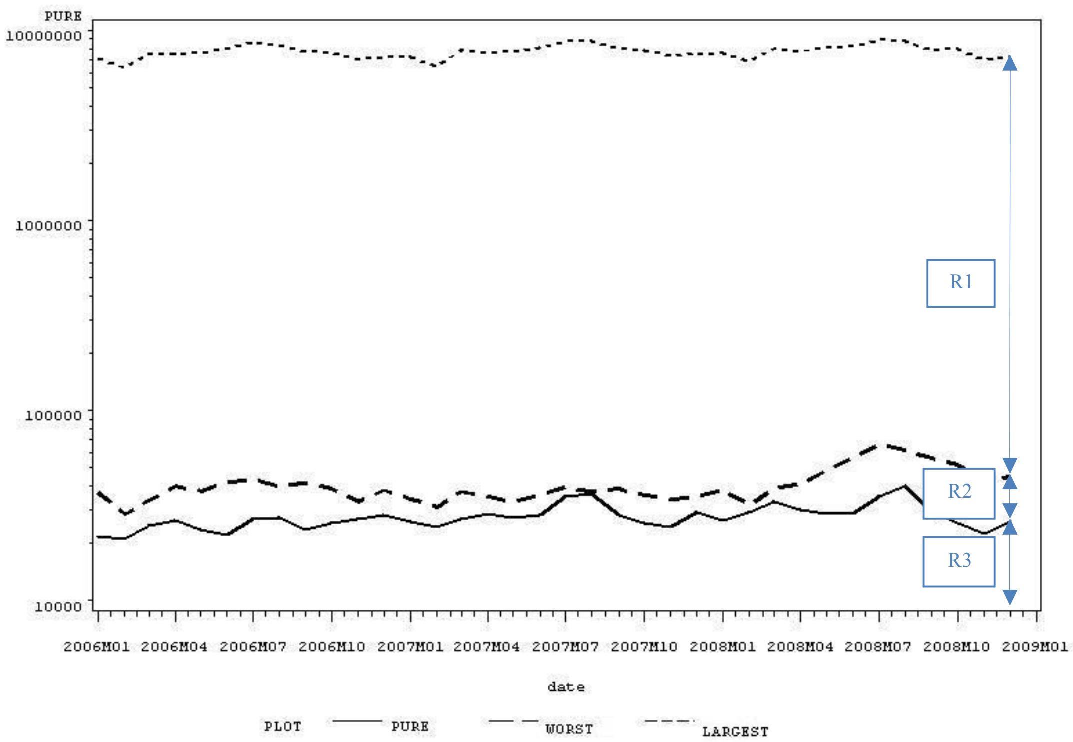

Figure 7. Service provision by the largest joint, worst joint, and specialized passenger transportations airlines. Source: IATA Statistics (2009)

The gap is much more significant between the largest and the worst (R1) than between the largest and the worst (R2) and the largest and specialized (R3) clusters. Moreover, there is a substantial difference of RPK value between the largest and the worst, while that between the worst and the specialized is not as large. There is around 7 million RPK value difference (R1) between the largest, and the worst found in Figure 7. The Worst joint service airlines cluster achieved a significantly better result than the specialized passenger transportation cluster. Thus the worst and specialized clusters were analyzed to test our second hypothesis about the term existence in the competitive airline's market.

In terms of our results we decided to apply a test for heterogeneity. This test examines whether the apparent differences between the studies are significant enough to bias the outcome and conclusion of the airlines time series analysis. We examine two clusters: the worst joint service air companies and specialized passenger transportation companies. Additionally, heterogeneity test and ease of computation made this trial a highly favorable test to be used in time series data. Cheonga (2010)

In terms of averages, the largest cluster is far different from the other two groups. Therefore, to check heterogeneity, we implement means and variance comparison test only between the specialized and the worst groups. The test result is reported in Table 6.

Table 6. Heterogeneity test result based on mean and variance comparison between the specialized and the worst performed passenger transportation airlines.

Two-sample t-test with unequal variances						
Variable	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Specialized	36	27657.35	696.7895	4180.737	26242.79	29071.91
Joint	36	7721935	102039.9	612239.6	7514783	7929088
Combined	72	3874796	459373.4	3897913	2958832	4790761
Difference		-7694278	102042.3		-7901434	-7487122
difference= mean(spec)-mean(worst)			t= - 75.4028			
Ho: diff = 0			Satterthwaite's degrees of freedom = 35.0033			
Ha: diff < 0			Ha: diff = 0		Ha: diff > 0	
Pr(T < t) = 0.0000			Pr(|T| > |t|) = 0.0000		Pr(T > t) = 1.0000	

Variance ratio test						
Variable	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Specialized	36	27657.35	696.7895	4180.737	26242.79	29071.91
Worst	36	7721935	102039.9	612239.6	7514783	7929088
Combined	72	3874796	459373.4	3897913	2958832	4790761
Ratio = stddev(pure)/stddev(worst)			F = 0.0000			
Ho: Ratio = 1			degrees of freedom = 35, 35			
Ha: Ratio < 1			Ha: ratio != 1		Ha: ratio > 1	
Pr(F < f) = 0.0000			2*Pr(F < f) = 0.0000		Pr(F > f) = 1.0000	

To conclude the result of test for heterogeneity, means and variance comparison (Table 6) our null hypothesis that worst joint service airlines and specialized airlines RPK value' means and variance are same is rejected. Moreover both variance and means of specialized group is smaller than that of the worst airline group.

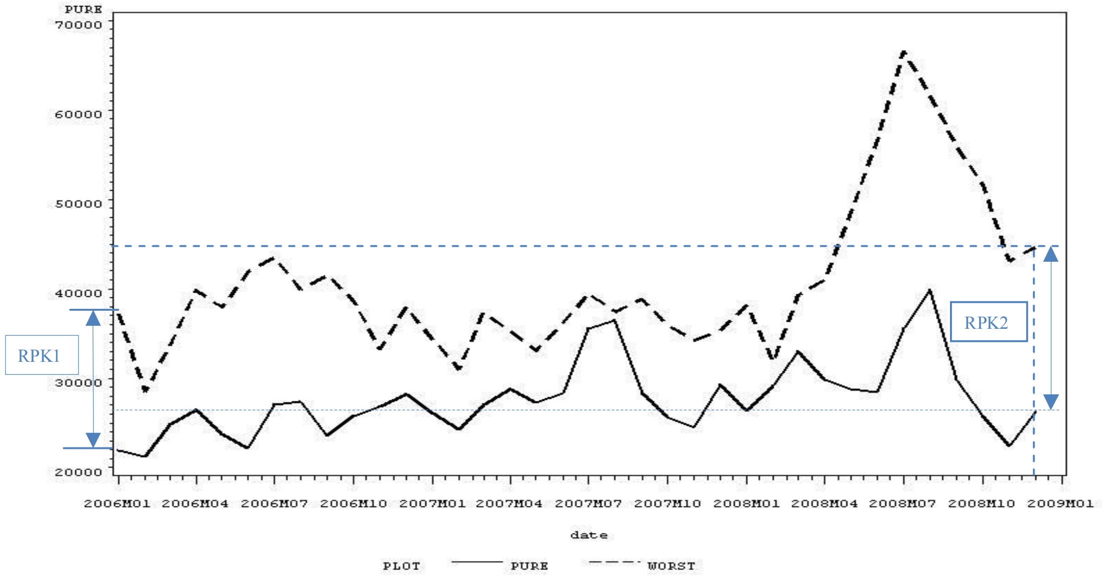

Figure 8. Comparison of average passenger transportation service between the worst joint and specialized airlines. Source IATA (2009)

Picture 8 shows the RPK1=1500 difference between the worst and specialized groups at the beginning of test period (01 January 2006), and RPK2=1900 at the end of tested period (30 December 2008). Moreover, to compare the specialized and worst joint passenger' transportation airlines seasonality effect and lag structure we decide to identify the Cointegration relationship between them.

Table 7. Cointegration test for the worst joint and specialized airline groups.

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.
None	0.210709	11.31554	15.49471	0.1928
At most 1	0.100822	3.507049	3.841466	0.0611
Trace test indicates no cointegration at the 0.05 level				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.210709	7.808487	14.26460	0.3985
At most 1	0.100822	3.507049	3.841466	0.0611
Max-eigenvalue test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

Therefore we apply the Johansen Cointegration Test. Although, cointegration traditionally refers to a long-standing relationship between variables, our particular data is divided monthly. Hence the time period of a 3-year span includes 36 observations, which enables us to properly interpret the results. In the case of the null hypothesis' rejection there is no cointegration vector as the result in Table 7 shows.

Eventually, our rejection of the hypothesis occurred at the 5% level of significance, and we concluded that there is no similar movement between the specialized and joint services. Therefore, in the above test, no cointegration vector and no long-standing relationship is found. There are no similarities to be found between the specialized and the worst joint service passenger' transportation airlines activities. Finally, we decided neither to proceed with the lag structure investigation nor the casual relationship. Nevertheless, to put it together, the worst joint service airlines' result of carrying passengers is much better than the result of specialized best practice airlines. Thus, there will be a positive relationship between perceived benefit of performing joint passenger and goods transportation services in airlines together.

6. Forecasting of the Future Service Level

In order to select the appropriate model specification, we need to determine the orders in the seasonal ARIMA model. We follow the procedure in the Section 4.1 using the ACF and PACF plots. In this paper, we use ARIMA $(0,1,1)\times(0,1,1)12$ as the final model for measuring the prediction performance of the model. The main purpose of fitting ARMA schemes is to project the series forward beyond the sample period. Johnston (1997)

In our study the sample period of interest to us is the passenger transportation air companies' data indicated in the Figure 2. The figure shows the correlation matrix for the number of passengers carried by the IATA airlines during the period from 2001 to 2009. Another line of research on the adoption of using regression analysis could be examination by individual airlines to see how passenger transportation develops over time. In this research we consider a set of 130 Airlines, and check their future development. Then we divide our passenger dataset regionally to check regional development, and to make quantitative predictions based on past values (Figure 9).

In this section we demonstrate how the methods of forecasting ARMA processes can be adapted to forecast the future values of revenue passenger kilometers. Brockwel (1996) The main purpose is to examine the exact future growth rate of passenger transportation and find evidence of maximization of profit of individual airlines and the corresponding regions. The prediction analysis procedure with proper data ensures 95% of a prediction confidence interval to ease the assessment of achievement of objective of the companies and their performance. Kingston (2003)

Thus, based on the preceding evidence of the increasingly growing number of passengers, and theoretical background, the air company's managers can sensibly create and process decisions faster, more exactly, and with greater aptitude conforming to the requirements of any given time, referring to our first hypothesis.

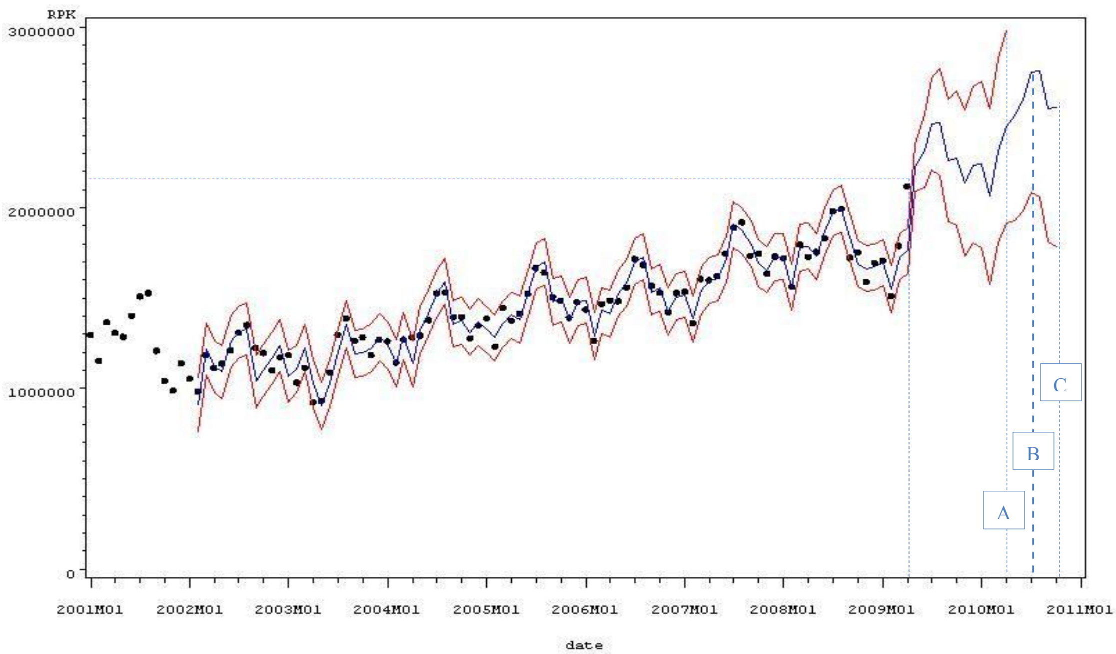

Figure 9. Average observed (2001(01)-2009(04), predicted (2002(02)-2010(10) and confidence intervals of passenger transportation of the 130 airlines.

As shown in Figure 9 we can recognize air transportation revenue of passenger volume, and also predicted RPK values. The figure displays prediction results from the ARIMA process, monthly divided the number of kilometers traveled by all passengers during testing period. At the same time we obtain a measure of sales volume of passenger traffic. Pietersz (2006)

As indicated in the Figure 9, the time period is displayed along the horizontal axis spanning from 2001 to 2011, and the volume of passengers carried by sample of airlines is indicated on the vertical axis. The black points indicate historical data on monthly bases for the period of 100 months. The result of forecasting process is displayed by the dark line. The line reveals clear forecast number of passengers for whose transportation air carriers receive commercial remuneration. The 2 brighter lines represent the forecasting intervals' upper and lower boundaries. The distance between interval lines becomes wider as we predict farther in future. In order to obtain precise results we forecast only until October 2010 (point C), which is fully sufficient for airline market requirements. Additionally, it is possible to test prediction performance of the model. This can be done by the confrontation predicted and observed values.

We assumed that the reason that the prediction interval increases so sharply was due to the former period of Financial Crisis (FC). The anomaly of the sudden acute rise in RPK has historical accumulating reason of carrying 620,000 RPK [14] during two months afterwards. There was already the precedence with the air transport accumulation of the number of passengers preceding the Terrorist Attack of 9/11. Thus, considering Kingston (2003) who argues a 95% confidence rating in the Development of Stochastic Artificial Neural Networks for Hydrological Prediction, here adopted for our airline research, we can likewise be confident in our prediction results with ample historical evidence. Note that ARIMA forecasted only RPK=330,000 units more during the 2 months growth.

To assess the prediction performance of the model we calculate Prediction Error (PE) for passenger transportation by the following formula:

$$PE_{it} = (Y_{it} - \hat{Y}_{it}) / Y_{it} \qquad (8)$$

where Y is observation value and $\hat{Y}$ prediction value for airline i in period t. The result proves Kingston (2003) about 95% confidence rating theory and the Table 4.E was placed in the Appendix 4.

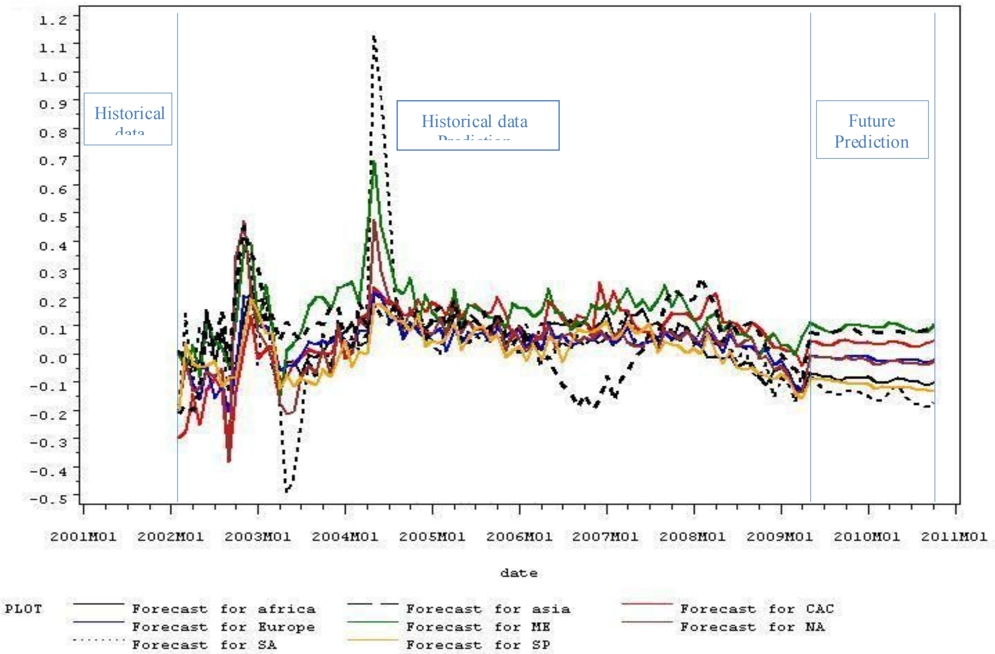

Figure 10. Development of regional air passenger transportation, sample of 130 airlines[15]

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[14] See Figure 2.

[15] We did not indicate historical data due to a better picture of eight regions' prediction view.

The Figure 10 displays the average regional development of 130 air transportation companies. The graph indicates on its vertical axis the percentage predicted growth of regional passenger transportation and a horizontal axis with a time period of January 2001 until January 2011.

The findings are of practical significance for the sample of airlines, and it could be applied for individual air transportation companies, or particular regional study. The regional sample is tested using the ARMA model procedure. The main motivation behind this task is to understand regional growth and to predict development of the revenue passenger kilometers in the regions. The collected data for the regional study is received from IATA 2009.

The Monthly International Statistics (MIS) were divided into two parts. The first section contains regional year-on-year growth and includes growth rates for each of the regions. Regional data is the total for each region dependent upon the carrier's country of registration/place of business. The regions are defined in the Monthly Traffic and Capacity Statistics Manual. The second regional year-to-date growth includes cumulative growth for each of the regions. Cumulative growth is constructed based on all carriers participating in MIS (reporting carriers plus estimates for missing data). As this item contains estimates, in both cases the percentage changes over the previous years are shown. (IATA, 2009)

In order to maintain suitability for our analysis we decided to use regional year-on-year growth for further regional investigation. Likewise in the global passenger analysis we apply the tested period at the horizontal axis, and RPK, this time in percentage of passengers carried by sample airlines in the region at the vertical axis. Regional year-on-year growth includes growth rates for each of the eight regions. Eight lines with different shapes in the Figure 9 indicate historical data observed in the regions on monthly bases for the period of 100 months, and a prediction for the 18 subsequent months.

The unique features of this research is that it contributes to the creation of new ARIMA modeling to prove our hypothesis, and it contributes to the literature and has implications for the industry. The strength of this research is thus in the methodology's uniqueness, the large panel data with 11,244 observations and practical significance of the expected results. In contrast, the vulnerability of airlines caused by unpredicted events like financial crises can serve as financial obstacles for our results.

Airline industry innovation and modernization is very expensive, and due to safety reasons, also time consuming. Additionally, a second weakness is the fact that the information technology data quality precludes us from testing the full effect of ICT application in the air companies. Nevertheless, the prediction idea allowed us to create a precise model for future revenue passenger kilometers for individual air companies, sets of airlines' groups (alliances) or regions. It can positively impact localities', countries' or regions' economic development.

7. Summary and Conclusions

Relationships between airlines' profit maximization and our study based on selected specification and estimation of models' prediction of future development is significantly close. A number of observations can be offered from the results of time series analysis of passenger transportation industry of this study. First, the ARIMA model approach due to its possibility to process regular seasonal fluctuations corresponds well to the airlines' passenger transportation market expectations and tools needed for forecasts. Second, since April 2002, 130 main airlines' revenue passenger kilometers' significantly improved by expanding to 2,120,000 carried passengers in April 2009. Hence, our investigation revealed 1,000,000 RPK more than at the beginning of testing period. Thus, in the future it can be expected that an anticipated average of 10,000 more passengers will utilize the world airlines services every month.

This fact supports our research problem that an increasingly growing number of passengers using air transportation around the world could create more problems in the future, and that is why it requires new technology. Therefore the growth, the average number of carried passengers equals nearly 120,000 passengers annually. Moreover, this number does not include the remainder of IATA 160 airlines, and other non-consolidated airlines companies. Nevertheless, the fact must be taken under consideration by airline policy makers to implement strategies to increase the possibility for using airports and build bigger fleets of aircraft in the foreseeable future. Alternatively, methods must be developed to reduce the business travelling frequencies.

In order to approach the problem we recommend statistical systems application and IT solutions to make the process smoother, safer, and more profitable. Additionally, after the adaptation of ARMA forecasting processes, the results will guide top managers of passenger transportation companies through problems of investment level decisions, sunk cost problem, and provide a timetable for future spending. Third, after this analysis we presume that prediction set of regional air passenger transportation has unique features that contribute to the potential usefulness for hypothesis testing and to obtain proper result. Thus, we state that the knowledge about sudden RPK increase will make airlines' managers' decision-making processes quick, exact, and perfectly conforming to the requirements of the time. Additionally, it can maximize the profits of many companies connected with the air transportation industry.

The fourth consideration indicates that compared with the RPK, three different clusters of airlines development associated with the time period have been relatively unexplored. We found out, that the worst joint service airlines' result of carrying passengers is much better than the result of specialized best practice airlines. Moreover, in general, specialized passenger transportation airlines stay at the market for a shorter period of time. Therefore, there will be a positive relationship between the perceived benefits of use for joint passenger transportation and goods transportation services.

Additionally, large airlines' RPK results are not much affected by sophisticated finance turmoil compared to the smaller passenger transportation companies. And again: the joint service airlines' air transportation systems are able to cope with the 21st century watershed much better than specialized best practice airlines.

With ARIMA modeling we can understand individual airline or regional growth and are able to predict revenue passenger kilometers development in the region. Moreover, concerning prediction analysis it is possible to prove the prediction accuracy by the confrontation of predicted and historical values. Additionally, the prediction procedure with proper data ensures 95% of prediction confidence for future development of the airlines.

Eventually, the prediction of future market can bring great economical results for macroeconomics of the regions. The unique features of this research are that it let us precisely predict future revenue passenger kilometers for the individual air companies, clusters of interesting airlines' group (alliances), or their specific regions. It can positively support the local countries' or regional economic development. To summarize, it means that global prediction approach for regional air transportation is useful and recommended not only for one particular economy of nations but also to nongovernmental organizations like the United Nations, the Organization for Security and Cooperation, World Bank and for other similar global policy maker agencies.

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Appendix

A.1. Regional growth development (in %) of revenue passenger transportation (130 airlines' data). Source: IATA Statistics (2009)

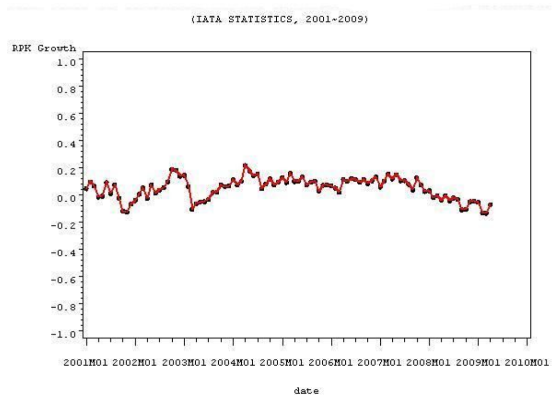

Figure 1.A. Development of Africa regional Air PT, 2001(01)-2009(04).

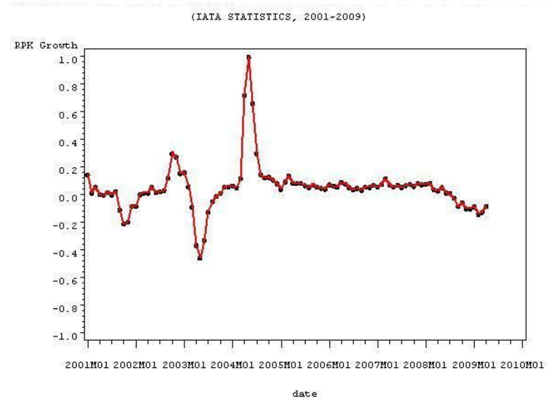

Figure 1.B. Development of Asia regional Air PT, 2001(01)-2009(04).

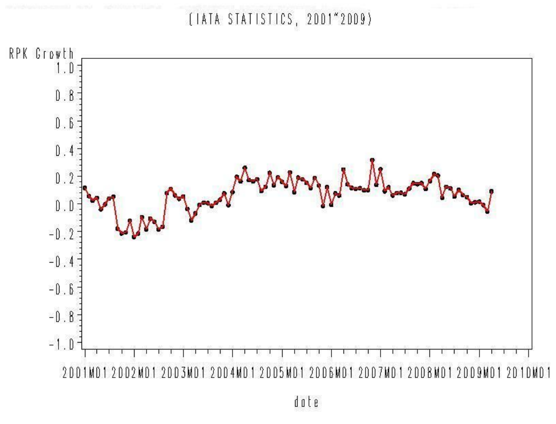

Figure 1.C. Development of America/Caribbean regional Air PT, 2001(01)-2009(04).

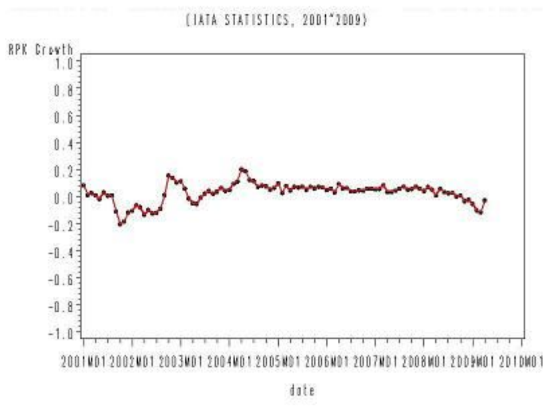

Figure 1.D. Development of Europe regional Air PT, 2001(01)-2009(04).

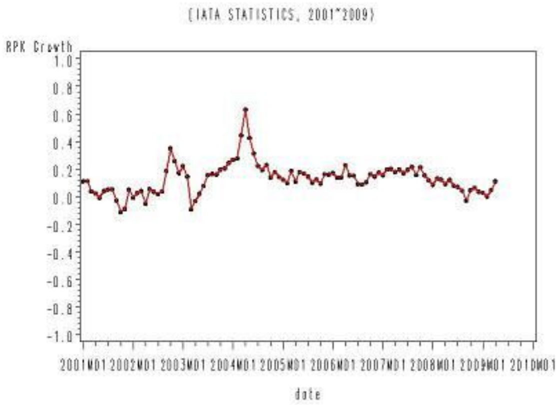

Figure 1.E. Development of Middle East regional Air PT, 2001(01)-2009(04).

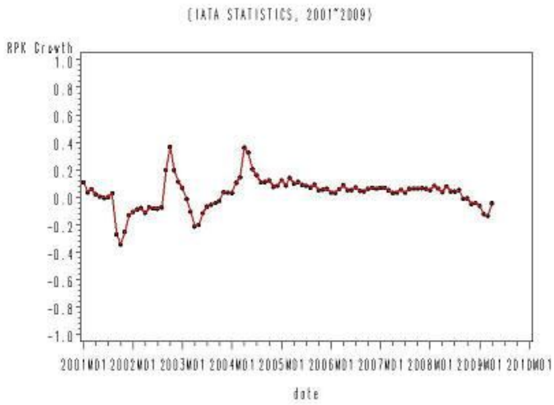

Figure 1.F. Development of North America regional Air PT, 2001(01)-2009(04).

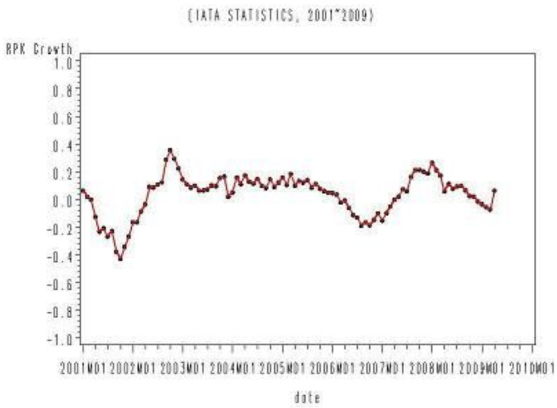

Figure 1.G. Development of South America regional Air PT, 2001(01)-2009(04).

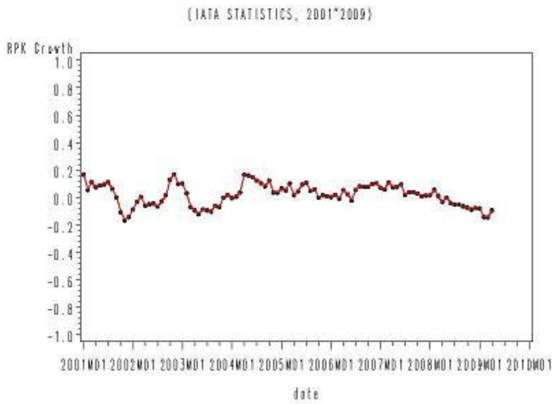

Figure 1.H. Development of Southwest Pacific regional Air PT, 2001(01)-2009(04).

A.2. Development of revenue passenger kilometers (RPK) for the best four specialized passenger transportation Airlines (Myanmar Airways, Macedonian Airways, Bangkok Airways and SATA International), 2006(01)-2008(12). Source: IATA Statistics (2009)

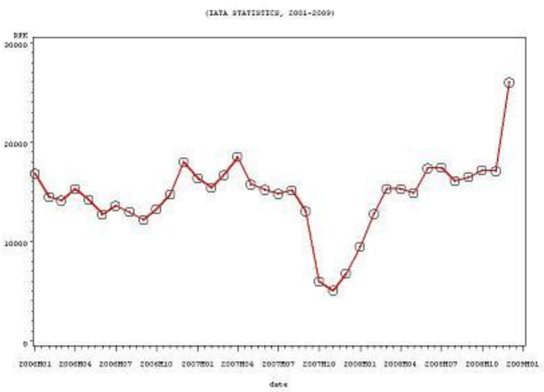

Figure 2.A. The development of Myanmar Airways (PT) Air Transportation Company, 200 (61)-2008(12).

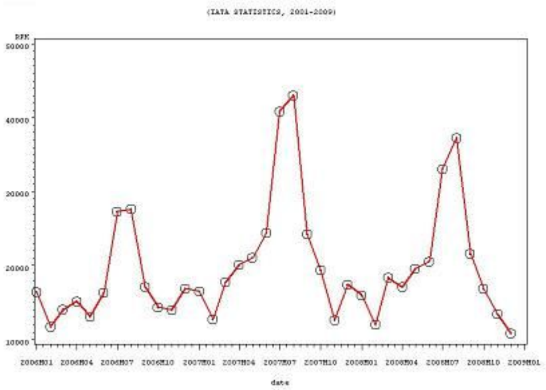

Figure 2.B. The development of Macedonian Airways (PT) Air Transportation Company, 2006(1)-2008(12).

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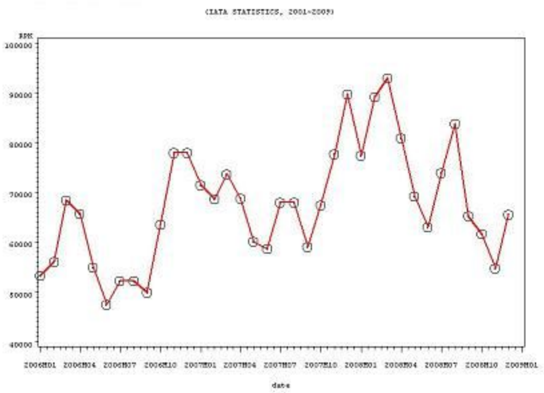

Figure 2.C. The development of Bangkok Airways (PT) Air Transportation Company, 2006(1)-2008(12).

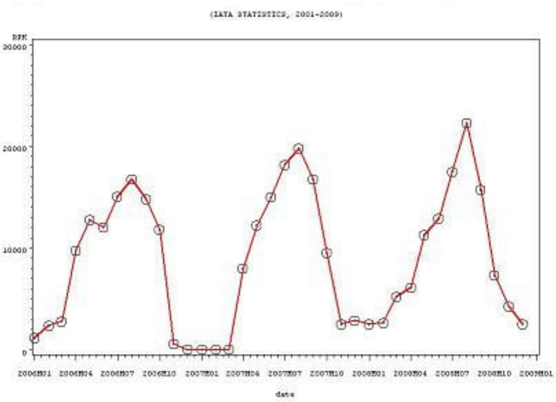

Figure 2.D. The development of SATA Airways (PT) Air Transportation Company, 2006(1)-2008(12).

A.3. Development of Revenue Passenger Kilometer (RPK) for the four, worst (Air Tanzania, Luxair, FlyLAL, Hawaiian Airlines) joint service air transportation companies, 2006(01)-2008(12). Source: IATA Statistics (2009)

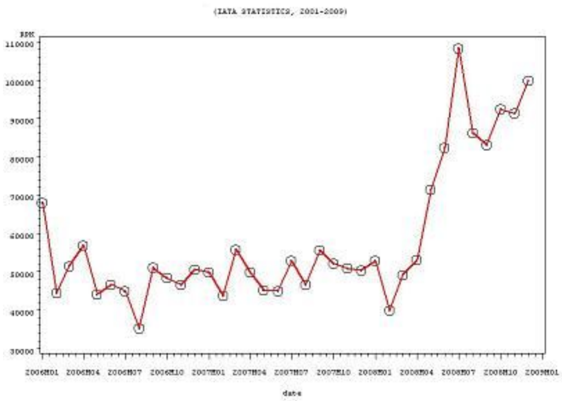

Figure 3.A. Development of RPK for the Hawaiian joint service air transportation company, 2006(01)-2008(12)

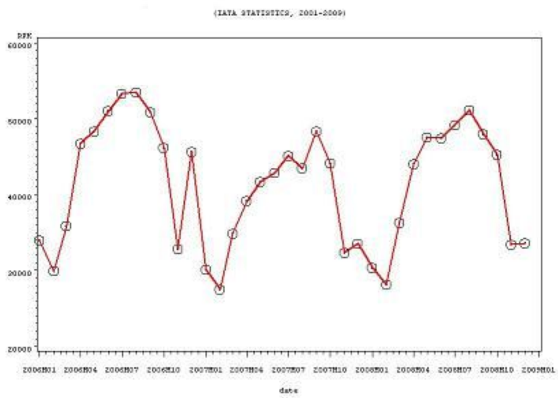

Figure 3.B. Development of RPK for the LUXAIR joint service air transportation company, 2006(01)-2008(12)

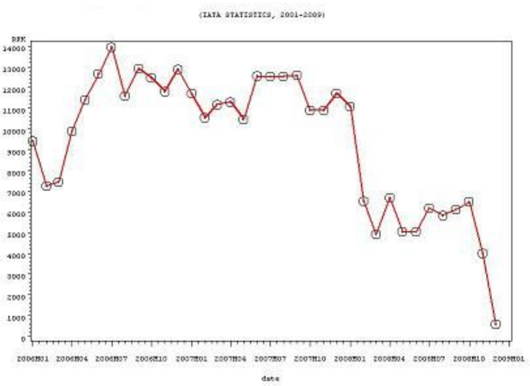

Figure 3.C. Development of RPK for the Air Tanzania joint service air transportation company, 2006(01)-2008(12)

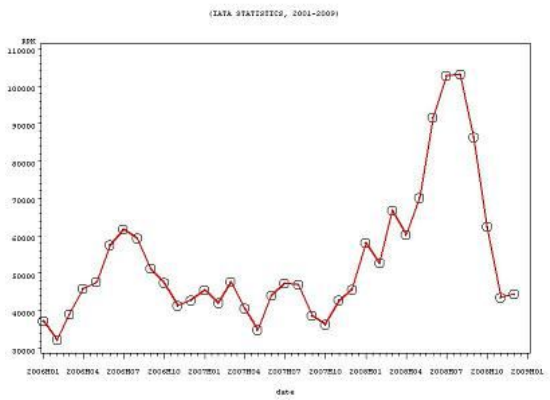

Figure 3.D. Development of RPK for the FLYLAL joint service air transportation company, 2006(01)-2008(12)

A.4. Average of 4 largest[16] joint service transportation airlines development between, Jan2006 and Jan2009 (36 months)

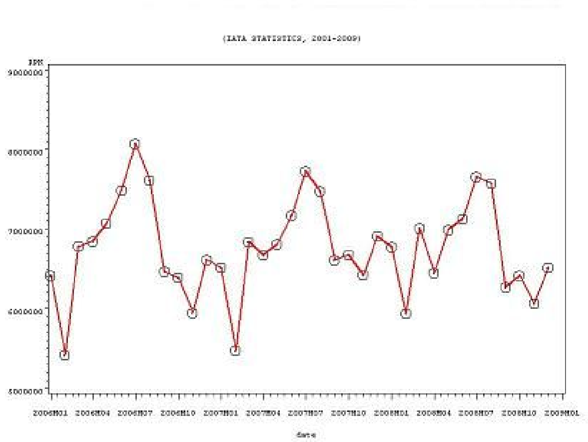

Figure 4.A. Development of RPK for the American Airlines joint service air transportation company, 2006(01)-2008(12)

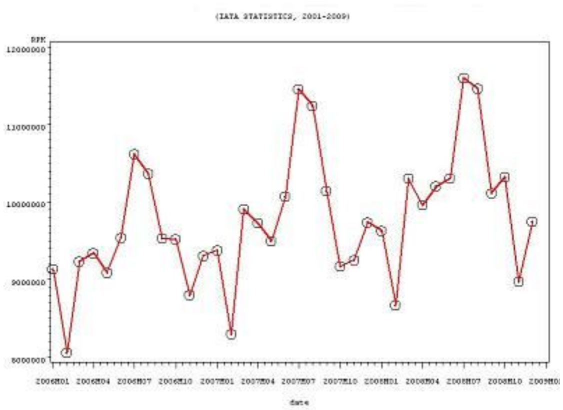

Figure 4.B. Development of RPK for the Air France joint service air transportation company, 2006(01)-2008(12)

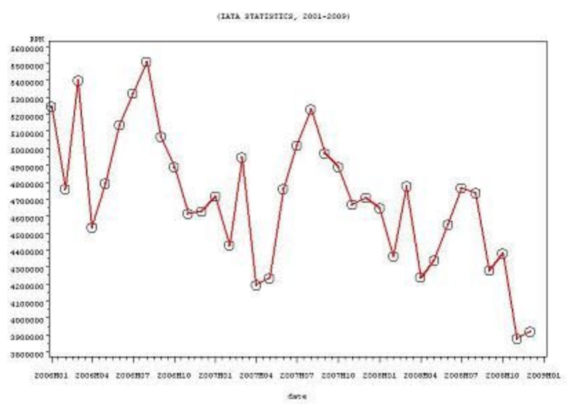

Figure 4.C. Development of RPK for the Japan Airlines joint service air transportation company, 2006(01)-2008(12)

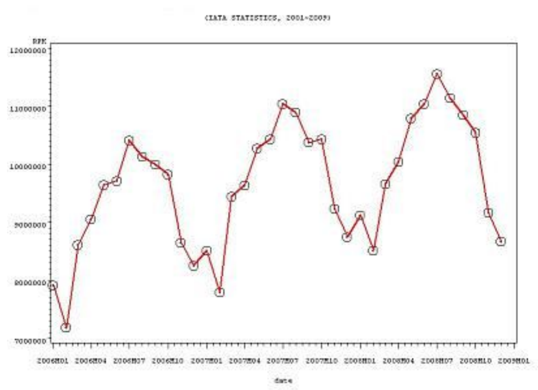

Figure 4.D. Development of RPK for the Lufthansa joint service air transportation company, 2006(01)-2008(12)

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[16] Only RPK was considered for the classification

Table 4.A. IATA airlines (160 in total) with assigned codes (of which 130 airlines used in this research)

Numb	Code	Airline Name	Passenger transportation	Goods transportation	Airlines qualified for research
1	5X	United Parcel Service Company (UPS)	-	+	1
2	8M	Myanmar Airways Int.	+	-	1
3	9W	Jet Airways (India) Private Limited	+	+	1
4	A3	Aegean Airlines S.A.-Aviation Limited Company	+	+	1
5	A4	Southern Winds	+	-	
6	AA	American Airlines Inc.	+	+	1
7	AC	Air Canada	+	+	1
8	AF	Air France	+	+	1
9	AI	Air India Limited	+	+	1
10	AM	Aeromexico	+	+	1
11	AR	Aerolíneas Argentinas	+	+	1
12	AS	Alaska Airlines Inc.	+	+	1
13	AT	Royal Air Maroc	+	+	1
14	AV	Aerovías del Continente Americano S.A. (Avianca)	+	+	1
15	AY	Finnair Oyj	+	+	1
16	AZ	Alitalia-Linee Aeree Italiane S.p.A.	+	+	1
17	BA	British Airways p.l.c.	+	+	1
18	BD	bmi (British Midland)	+	+	1
19	BE	Jersey European Airways (UK) Limited	+	+	
20	BI	Royal Brunei Airlines	+	+	1
21	BR	Eva Airways Corporation	+	+	1
22	BT	Air Baltic Corporation SIA	+	+	1
23	BU	SAS Scandinavian Airlines Norge AS	+	-	
24	CA	Air China Limited	+	+	1
25	CE	Nationwide Airlines (Pty) Limited	+	-	1
26	CI	China Airlines	+	+	1
27	CM	Compañía Panamena de Aviación, S.A. (Copa)	+	+	1
28	CO	Continental Airlines, Inc	+	+	1
29	CP	Canadian Airlines International Ltd.	+	+	1
30	CS	Continental Micronesia, Inc.	+	+	1
31	CU	Cubana de Aviación S.A.	+	+	1
32	CV	Cargolux Airlines International S.A.	-	+	1
33	CX	Cathay Pacific Airways Ltd.	+	+	1
34	CY	Cyprus Airways, Ltd.	+	+	1
35	CZ	China Southern Airlines	+	+	1
36	DL	Delta Air Lines, Inc	+	+	1
37	E5	Samara Airlines	+	+	1
38	EG	Japan Asia Airways Co. Ltd.	+	+	
39	EI	Aer Lingus p.l.c.	+	+	1
40	EK	Emirates	+	+	1
41	EL	Air Nippon	+	+	1
42	ER	Astar Air Cargo	-	+	
43	ET	Ethiopian Airlines Corporation	+	+	1
44	EY	Etihad Airways	+	+	
45	FF	Tower Air, Inc.	-	-	
46	FG	Ariana Afghan Airlines Co. Ltd.	+	+	
47	FI	Icelandair	+	+	1
48	FM	Shanghai Airlines	+	+	1
49	FV	Rossiya - Russian Airlines	+	+	1
50	FX	Federal Express Corporation	-	+	1

51	G3	Gol Airlines	+	-	
52	GA	Garuda Indonesia	+	+	1
53	GF	Gulf Air Company G.S.C.	+	+	1
54	GT	GB Airways	+	+	1
55	HA	Hawaiian Airlines	+	+	1
56	HM	Air Seychelles Ltd.	+	+	
57	HP	America West Airlines, Inc.	+	+	1
58	HU	Hainan Airlines Company Limited	+	+	1
59	IB	Iberia, Líneas Aéreas de España S.A.	+	+	1
60	IN	Macedonian Airlines-MAT	+	-	1
61	IR	Iran Air, The Airline of the Islamic Republic of Iran	+	+	1
62	IX	Air India Charters Limited	+	-	
63	JJ	TAM Linhas Aéreas	+	+	1
64	JK	Spanair	+	+	1
65	JL	Japan Airlines	+	+	1
66	JM	Air Jamaica	+	+	
67	JP	Adria Airways	+	+	1
68	JU	Jat Airways	+	+	1
69	KA	Hong Kong Dragon Airlines Ltd.	+	+	1
70	KC	Air Astana	+	+	1
71	KE	Korean Air Lines Co. Ltd.	+	+	1
72	KF	Blue1 (Blue1 Ltd.)	+	-	
73	KJ	British Med. Airways	+	+	
74	KL	KLM Royal Dutch Airlines	+	+	1
75	KM	Air Malta p.l.c	+	+	1
76	KQ	Kenya Airways Ltd.	+	+	1
77	KU	Kuwait Airways Corporation	+	+	1
78	KZ	Nippon Cargo Airlines	-	+	1
79	LA	Lan Airlines S.A	+	+	1
80	LB	Lloyd Aéreo Boliviano S.A. (LAB)	+	+	1
81	LC	Varig Logistica S.A.	-	+	
82	LG	Luxair	+	+	1
83	LH	Deutsche Lufthansa A.G.	+	+	1
84	LO	Polskie Linie Lotnicze (LOT)	+	+	1
85	LX	SWISS International Air Lines Ltd	+	+	1
86	LY	El Al Israel Airlines Ltd.	+	+	1
87	LZ	Balkan Bulgarian Airlines	+	+	
88	MA	MALEV p.l.c. - Hungarian Airline Public Ltd. Co.	+	+	1
89	ME	Middle East Airlines AirLiban S.A (MEA)	+	+	1
90	MF	Xiamen Airlines	+	+	1
91	MH	Malaysia Airline System Berhad	+	+	1
92	MI	Silkair (Silkair (Singapore) Private Limited)	+	+	1
93	MK	Air Mauritius	+	+	1
94	MM	SAM	+	+	
95	MS	Egyptair	+	+	1
96	MU	China Eastern Airlines	+	+	1
97	MX	Compañía Mexicana de Aviación S.A. de C.V. (Mexicana)	+	+	1
98	NH	All Nippon Airways	+	+	1
99	NI	PGA - Portugália Airlines	+	+	1
100	NT	Binter Canarias, S.A. Unipersonal	+	+	1
101	NW	Northwest Airlines, Inc.	+	+	1
102	NX	Air Macau Company Limited	+	+	1
103	NZ	Air New Zealand Ltd	+	+	1
104	OA	Olympic Airlines S.A.	+	+	1
105	OK	Czech Airlines - CSA	+	+	1
106	OM	MIAT Mongolian Airlines	+	+	1
107	OS	Austrian	+	+	1
108	OU	Croatia Airlines	+	+	1

109	OV	Estonian Air	+	+	1
110	OZ	Asiana Airlines Inc.	+	+	1
111	PG	Bangkok Airways Co. Ltd	+	-	1
112	PK	Pakistan International Airlines Corporation	+	+	
113	PO	Polar Air Cargo, Inc.	-	+	1
114	PR	Philippine Airlines, Inc.	+	+	1
115	PU	Primeras Líneas Uruguayas de Navegación Aérea (PLUNA)	+	-	
116	PZ	TAM Transportes Aereos del Mercosur	+	-	1
117	QF	Qantas Airways Ltd.	+	+	1
118	QK	Air Canada Jazz	+	+	
119	QM	Air Malawi Ltd.	+	+	1
120	QR	Qatar Airways Company (W.L.L)	+	+	1
121	RB	Syrian Arab Airlines	+	+	
122	RG	Varig-Viaçao Aérea Rio-Grandese S.A.	+	+	1
123	RJ	Royal Jordanian	+	+	1
124	RO	Romanian Air Transport S.A. (Tarom)	+	+	1
125	S4	SATA INTERNACIONAL	+	-	1
126	S7	Siberia Airlines (Joint Stock Company Siberia Airlines)	+	+	1
127	SA	South African Airways (SAA)	+	+	1
128	SK	Scandinavian Airlines System (SAS)	+	+	1
129	SN	SN Brussels Airlines, Sabena	+	+	1
130	SQ	Singapore Airlines Ltd.	+	+	1
131	SR	Swissair - Swiss Air Transport Co. Ltd.	+	+	1
132	SU	Aeroflot Russian Airlines	+	+	1
133	SV	Saudi Arabian Airlines	+	+	1
134	TA	TACA	+	-	
135	TC	Air Tanzania Company	+	+	1
136	TE	FlyLAL - Lithuanian Airlines	+	+	1
137	TG	Thai Airways International Public Company Ltd.	+	+	1
138	TK	Turkish Airlines Inc.	+	+	1
139	TM	LAM - Linhas Aéreas de Moçambique	+	+	1
140	TN	Air Tahiti Nui	+	+	1
141	TP	TAP-Air Portugal	+	+	1
142	TR	Transbrasil S.A. Linhas Aéreas	+	+	1
143	TU	Tunis Air	+	+	1
144	TV	Virgin Express	+	-	
145	TW	Trans World Airlines, Inc.	+	+	1
146	TZ	American Trans Air	+	-	
147	UA	United Airlines	+	+	1
148	UL	SriLankan Airlines Ltd.	+	+	1
149	UN	Transaero Airlines	+	+	1
150	US	US Airways, Inc	+	+	1
151	VB	Duo Airways Limited	+	+	
152	VH	Aeropostal Alas De Venezuela	+	-	1
153	VK	Virgin Nigeria Airways Limited	+	-	
154	VN	Vietnam Airlines	+	+	1
155	VS	Virgin Atlantic Airways	+	+	1
156	VV	Aerosvit Airlines	+	+	1
157	VX	Aerolíneas Centrales de Colombia S.A. - ACES	+	-	
158	WF	Wideroe Flyveselskap A/S	+	-	
159	XE	ExpressJet	+	+	
160	XF	Vladivostok Air JSC	+	+	

Table 4.B. Average (RPK & FTK) of the studied sample of 130 airlines.

Number	Date	FREQ	RPK_avg	FREQ	FTK_avg
1.	1/1/2001	101	1298600	101	77156.60
2.	2/1/2001	101	1154084	101	82166.97
3.	3/1/2001	102	1368730	102	93993.93
4.	4/1/2001	103	1310310	103	81665.33
5.	5/1/2001	103	1287631	103	81223.29
6.	6/1/2001	103	1403748	103	83199.76
7.	7/1/2001	104	1510736	104	81330.39
8.	8/1/2001	104	1529548	104	80176.18
9.	9/1/2001	104	1210148	104	79800.13
10.	10/1/2001	104	1042830	104	85449.26
11.	11/1/2001	103	989768	103	85526.73
12.	12/1/2001	102	1140136	102	82649.52
13.	1/1/2002	115	1054884	115	65005.11
14.	2/1/2002	115	985779	115	67028.65
15.	3/1/2002	114	1187145	114	84312.86
16.	4/1/2002	114	1115352	114	78046.63
17.	5/1/2002	115	1138387	115	79390.26
18.	6/1/2002	115	1213694	115	82866.13
19.	7/1/2002	116	1308982	116	82454.75
20.	8/1/2002	116	1353079	116	80203.20
21.	9/1/2002	114	1225394	114	84280.94
22.	10/1/2002	115	1197543	115	94078.32
23.	11/1/2002	113	1101069	113	95439.92
24.	12/1/2002	114	1173715	114	83308.07
25.	1/1/2003	116	1185563	116	72666.68
26.	2/1/2003	116	1034197	116	73320.38
27.	3/1/2003	115	1116510	115	91461.32
28.	4/1/2003	116	924595	116	79135.05
29.	5/1/2003	115	929958	115	80473.58
30.	6/1/2003	115	1091038	115	81489.86
31.	7/1/2003	115	1298880	115	82788.29
32.	8/1/2003	115	1389592	115	81647.82
33.	9/1/2003	114	1265140	114	85978.67
34.	10/1/2003	113	1286239	113	95840.66
35.	11/1/2003	115	1186147	115	94657.37
36.	12/1/2003	114	1270752	114	88444.76
37.	1/1/2004	117	1261786	117	74438.85
38.	2/1/2004	115	1144086	115	85103.56
39.	3/1/2004	115	1270435	115	97961.75
40.	4/1/2004	115	1283645	115	90361.59
41.	5/1/2004	115	1295120	115	93740.90
42.	6/1/2004	116	1379586	116	92271.57
43.	7/1/2004	116	1528755	116	95601.03
44.	8/1/2004	116	1534505	116	90551.97
45.	9/1/2004	115	1397445	115	96665.30
46.	10/1/2004	115	1396536	115	105112.40
47.	11/1/2004	115	1280093	115	98674.90
48.	12/1/2004	116	1349950	116	96312.90
49.	1/1/2005	117	1389428	117	85353.90
50.	2/1/2005	116	1234297	116	83334.40
51.	3/1/2005	115	1446056	115	101569.00
52.	4/1/2005	117	1378318	117	95026.38

53.	5/1/2005	117	1415111	117	91913.52
54.	6/1/2005	116	1525181	116	95927.73
55.	7/1/2005	117	1667347	117	98499.74
56.	8/1/2005	117	1642630	117	94083.64
57.	9/1/2005	118	1507701	118	99071.62
58.	10/1/2005	117	1484780	117	108490.20
59.	11/1/2005	115	1391953	115	107851.60
60.	12/1/2005	115	1478505	115	106663.30
61.	1/1/2006	119	1438219	119	91563.75
62.	2/1/2006	119	1265338	119	90724.95
63.	3/1/2006	118	1468808	118	112539.40
64.	4/1/2006	118	1487868	118	105477.60
65.	5/1/2006	118	1484193	118	101194.40
66.	6/1/2006	118	1560090	118	101932.70
67.	7/1/2006	117	1718282	117	105305.80
68.	8/1/2006	117	1685590	117	102822.60
69.	9/1/2006	118	1569139	118	1082840.00
70.	10/1/2006	116	1530826	116	113436.60
71.	11/1/2006	115	1424130	115	1112130.00
72.	12/1/2006	116	1529750	116	107942.00
73.	1/1/2007	117	1536861	117	95726.89
74.	2/1/2007	116	1362752	116	94478.19
75.	3/1/2007	115	1607926	115	112471.40
76.	4/1/2007	114	1601765	114	107483.90
77.	5/1/2007	114	1623688	114	107321.30
78.	6/1/2007	113	1747573	113	109619.00
79.	7/1/2007	113	1891120	113	113360.50
80.	8/1/2007	112	1921588	112	111900.80
81.	9/1/2007	113	1736502	113	116759.70
82.	10/1/2007	111	1747468	111	122577.30
83.	11/1/2007	111	1636874	111	123312.80
84.	12/1/2007	111	1731786	111	117548.90
85.	1/1/2008	113	1723755	113	104912.00
86.	2/1/2008	113	1563671	113	103335.30
87.	3/1/2008	112	1799742	112	120881.60
88.	4/1/2008	112	1730028	112	114646.10
89.	5/1/2008	114	1757610	114	111535.80
90.	6/1/2008	113	1833754	113	112136.10
91.	7/1/2008	111	1983725	111	112319.10
92.	8/1/2008	111	1994641	111	108750.60
93.	9/1/2008	109	1725489	109	107437.70
94.	10/1/2008	108	1756538	108	111401.90
95.	11/1/2008	107	1592672	107	105987.10
96.	12/1/2008	106	1697478	106	91881.89
97.	1/1/2009	103	1710170	103	82844.11
98.	2/1/2009	100	1513232	100	85299.05
99.	3/1/2009	94	1790966	94	97857.08
100.	4/1/2009	77	2121895	77	100778.30

Table 4.C. Ranking by mean of RPK for joint service air companies, 2006-2008

Number	Carrier Code	FREQ	Mean
1.	TC	36	9484.1
2.	LG	36	41292.7
3.	TE	36	53332.4
4.	HA	36	58265.0
5.	OV	36	60945.1
6.	OM	36	69272.5
7.	JP	36	72577.8
8.	OU	36	78617.5
9.	JU	36	93605.0
10.	HU	36	98727.7
11.	JK	36	172820.6
12.	A3	36	183912.9
13.	BT	36	187332.8
14.	KM	36	191797.9
15.	ME	36	191845.6
16.	KC	36	208696.8
17.	MI	36	245425.3
18.	S7	36	258744.0
19.	FV	36	259719.6
20.	AS	36	267062.8
21.	CS	36	288388.8
22.	IR	36	300643.9
23.	BI	36	320288.8
24.	MA	36	349682.5
25.	VV	36	361934.5
26.	RG	36	388490.9
27.	OK	36	504530.3
28.	OA	36	505225.9
29.	RJ	36	541124.2
30.	MK	36	550652.1
31.	LO	36	558775.3
32.	KU	36	607128.6
33.	KQ	36	627457.4
34.	ET	36	651576.4
35.	CM	36	656141.3
36.	9W	36	661548.1
37.	GA	36	666238.7
38.	AM	36	680460.2
39.	AR	36	703400.4
40.	UL	36	786383.6
41.	VN	36	813832.2
42.	MX	36	940689.5
43.	AY	36	1180137.0

44.	PR	36	1196175.0
45.	GF	36	1206409.0
46.	OS	36	1483415.0
47.	TP	36	1486047.0
48.	SV	36	1496396.0
49.	SU	36	1538399.0
50.	AI	36	1552189.0
51.	US	36	1680445.0
52.	SA	36	1691374.0
53.	LA	36	1726977.0
54.	OZ	36	1792586.0
55.	SK	36	1846941.0
56.	TK	36	1911457.0
57.	BR	36	1985284.0
58.	LX	36	2081871.0
59.	CA	36	2392021.0
60.	AZ	36	2480432.0
61.	QR	36	2572824.0
62.	CI	36	2732559.0
63.	MH	36	2981698.0
64.	VS	36	3249920.0
65.	IB	36	3741353.0
66.	KE	36	4160957.0
67.	AC	36	4414640.0
68.	NW	36	4484933.0
69.	TG	36	4535929.0
70.	CO	36	4682469.0
71.	JL	36	4710126.0
72.	DL	36	5264295.0
73.	KL	36	6214480.0
74.	UA	36	6249582.0
75.	AA	36	6757272.0
76.	CX	36	6776315.0
77.	EK	36	7364023.0
78.	SQ	36	7560339.0
79.	BA	36	9436403.0
80.	LH	36	9648010.0
81.	AF	36	9772333.0

Table 4.D. Top 20 airline's international revenue passenger kilometers global summations. Source: IATA Statistics (2009)

#	Company name	ID	2000	2001	2002	2003	2004	2005	2006	2007	2007 KE=1	CAGR (%)
1.	British Airways	BA	115,088	99,887	95,469	96,661	102,86	107,47	111,34	110,32	2.15	-0.60
2.	Lufthansa	LH	87,998	85,381	87,986	90,896	103,87	107,45	109,39	116,84	2.28	4.13
3.	Air France	AF	82,482	85,378	88,885	88,965	96,958	105,51	112,69	118,11	2.30	5.26
4.	Singapore Airlines	SQ	70,795	68,822	74,172	63,816	77,082	80,988	87,646	90,900	1.77	3.64
5.	American Airlines	AA	64,739	58,717	58,783	59,733	70,036	77,812	81,129	81,324	1.59	3.31
6.	United Airlines	UA	79,797	75,894	69,704	59,451	67,484	73,377	74,578	77,709	1.52	-0.38
7.	KLM	KL	60,309	57,525	58,877	56,540	63,013	68,311	71,761	74,488	1.45	3.06
8.	Cathay Pacific	CX	47,097	44,751	49,011	42,727	57,224	65,058	71,124	74,987	1.46	6.87
9.	Japan Airlines	JL	71,949	65,013	65,866	56,549	64,626	64,499	59,913	56,775	1.11	-3.33
10.	Emirates	EK	19,413	23,126	30,170	37,010	48,749	59,299	73,903	90,529	1.77	24.60
11.	Northwest Airlines	NW	57,566	52,584	52,456	47,690	51,704	53,962	51,866	53,485	1.04	-1.04
12.	Quantas	QF	49,193	51,261	50,697	46,543	50,825	52,583	56,384	57,929	1.13	2.36
13.	Air Canada	AC	31,120	45,400	47,758	40,965	45,796	49,532	52,257	53,437	1.04	8.03
14.	Thai Airways	TG	38,676	40,584	45,084	41,731	47,480	47,150	52,625	58,243	1.14	6.02
15.	Continental Airlines	CO	34,425	32,256	34,033	33,821	41,062	46,365	51,902	56,839	1.11	7.43
16.	Delta Air	DL	42,394	39,693	38,693	34,044	40,265	45,345	54,326	63,201	1.23	5.87
17.	Korean Air	KE	36,030	33,834	37,104	35,574	41,491	44,488	47,385	51,255	1.00	5.16
18.	Malaysia Airlines	MH	32,913	30,666	32,191	32,320	37,872	42,411	37,078	36,839	0.72	1.62
19.	Iberia	IB	29,643	30,920	31,112	32,295	35,935	38,771	42,794	45,459	0.89	6.30
20.	Virgin Atlantic	VS	29,471	28,411	27,005	26,931	30,223	32,103	35,279	40,546	0.79	4.66

Table 4.E. Prediction error (PE) for average 130 passenger transportation observed (2002(02)-2009(04).[17] Source: IATA Statistics (2009)

Date	RPK_avg	Forecast	PE
2/1/2002	985779	910369	0.07650
3/1/2002	1187145	1217347	-0.02544
4/1/2002	***1115352***	***1121589***	***-0.00559***
5/1/2002	1138387	1091194	0.04146
6/1/2002	1213694	1265689	-0.04284
7/1/2002	***1308982***	***1308359***	***0.00048***
8/1/2002	1353079	1327941	0.01858
9/1/2002	**1225394**	**1039636**	**0.15159**
10/1/2002	1197543	1102101	0.07970
11/1/2002	1101069	1167101	-0.05997
12/1/2002	1173715	1235787	-0.05288
1/1/2003	**1185563**	**1064619**	**0.10201**
2/1/2003	1034197	1100556	-0.06416
3/1/2003	1116510	1226685	-0.09868
4/1/2003	**924595**	**1025311**	**-0.10893**
5/1/2003	929958	900904	0.03124
6/1/2003	1091038	1032556	0.05360
7/1/2003	1298880	1206037	0.07150
8/1/2003	1389592	1352338	0.02681
9/1/2003	1265140	1174879	0.07134
10/1/2003	1286239	1188948	0.07564
11/1/2003	1186147	1234530	-0.04079
12/1/2003	1270752	1286187	-0.01215
1/1/2004	1261786	1226687	0.027827
2/1/2004	***1144086***	***1147565***	***-0.00304***
3/1/2004	1270435	1309375	-0.03065
4/1/2004	**1283645**	**1153833**	**0.101127**
5/1/2004	1295120	1316317	-0.01637
6/1/2004	1379586	1407597	-0.02030
7/1/2004	1528755	1509654	0.01249
8/1/2004	1534505	1584489	-0.03257
9/1/2004	1397445	1332147	0.04673
10/1/2004	1396536	1354897	0.02982
11/1/2004	1280093	1323195	-0.03367
12/1/2004	1349950	1372417	-0.01664
1/1/2005	1389428	1314306	0.05407
2/1/2005	1234297	1285506	-0.04149
3/1/2005	1446056	1378369	0.04681
4/1/2005	***1378318***	***1384865***	***-0.00475***
5/1/2005	1415111	1381065	0.02406
6/1/2005	***1525181***	***1532423***	***-0.00475***

[17] **Bold numbers represent extreme values.**

7/1/2005	***1667347***	***1663286***	***0.00244***
8/1/2005	1642630	1708152	-0.03989
9/1/2005	1507701	1449953	0.03830
10/1/2005	***1484780***	***1477643***	***0.00481***
11/1/2005	***1391953***	***1394954***	***-0.00216***
12/1/2005	***1478505***	***1485611***	***-0.00481***
1/1/2006	1438219	1464515	-0.01828
2/1/2006	1265338	1304660	-0.03108
3/1/2006	1468808	1423325	0.03097
4/1/2006	1487868	1404254	0.05620
5/1/2006	1484193	1518482	-0.02310
6/1/2006	1560090	1585474	-0.01627
7/1/2006	1718282	1694364	0.01392
8/1/2006	1685590	1750881	-0.03874
9/1/2006	1569139	1501410	0.04316
10/1/2006	***1530826***	***1545610***	***-0.00966***
11/1/2006	***1424130***	***1435542***	***-0.00801***
12/1/2006	1529750	1514231	0.01014
1/1/2007	1536861	1515909	0.01363
2/1/2007	1362752	1406580	-0.03216
3/1/2007	1607926	1525697	0.05114
4/1/2007	1601765	1567813	0.02119
5/1/2007	***1623688***	***1618197***	***0.00338***
6/1/2007	1747573	1728812	0.01073
7/1/2007	***1891120***	***1895294***	***-0.00221***
8/1/2007	***1921588***	***1907124***	***0.00752***
9/1/2007	1736502	1765020	-0.01642
10/1/2007	1747468	1690374	0.03267
11/1/2007	1636874	1666733	-0.01824
12/1/2007	***1731786***	***1724739***	***0.00407***
1/1/2008	***1723755***	***1720343***	***0.00198***
2/1/2008	1563671	1583861	-0.01291
3/1/2008	1799742	1742473	0.03182
4/1/2008	1730028	1761349	-0.01810
5/1/2008	1757610	1732924	0.01404
6/1/2008	1833754	1870149	-0.01985
7/1/2008	***1983725***	***1968442***	***0.00770***
8/1/2008	***1994641***	***2006266***	***-0.00583***
9/1/2008	1725489	1828306	-0.05959
10/1/2008	1756538	1668943	0.04986
11/1/2008	1592672	1680700	-0.05527
12/1/2008	1697478	1666747	0.01810
1/1/2009	1710170	1692514	0.01032
2/1/2009	1513232	1571181	-0.03829
3/1/2009	1790966	1689653	0.05656
4/1/2009	2121895	1760792	0.17017

Table 4.F The 15 largest airlines ranked by operating revenue among 160 around the world in 2007. Source: IATA (2009).

Rank	Code	Airline Name	Operating Revenue		Operating Expenses		Operating Profit		Net Result		Operating Margin	
			2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
1	LH	Lufthansa	24,367	26,750	23,479	25,402	888	1,348	560	1,004	4%	5%
2	AF/KL	Air France-KLM	23,860	26,107	23,168	24,968	691	1,139	1,966	1,121	3%	4%
3	AA	American Airlines	20,657	22,375	21,008	21,678	-351	697	-836	167	-2%	3%
4	FX	Federal Express	20,533	22,068	18,937	20,244	1,596	1,824	964	1,164	8%	8%
5	JL	Japan Airlines	19,905	19,691	19,381	19,494	525	196	281	-139	3%	1%
6	UA	United Airlines	17,379	19,340	17,598	18,893	-219	447	-21,17	22,876	-1%	2%
7	DL	Delta Air Lines	16,112	17,127	17,309	17,093	-1,197	34	-3,798	-6,117	-7%	0%
8	BA	British Airways	14,418	15,730	13,421	14,566	996	1,164	463	1,128	7%	7%
9	NW	Northwest	12,286	12,568	13,205	11,828	-919	740	-2,533	-2,835	-7%	6%
10	CO	Continental	11,208	13,128	11,247	12,660	-39	468	-68	343	0%	4%
11	NH	All Nippon Airways	10,230	10,420	9,632	9,801	598	619	97	250	6%	6%
12	QF	Qantas Airways	9,385	10,236	8,647	9,731	739	505	515	360	8%	5%
13	WN	Southwest	7,584	9,086	6,859	8,152	725	934	484	499	10%	10%
14	KE	Korean Air	7,396	8,434	6,974	7,915	422	519	195	400	6%	6%
15	SQ	Singapore Airline	7,237	8,204	6,700	7,659	537	545	581	1,121	7%	7%

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