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The Determination of Load Factors in the Airline Industry

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Load factor is a measure of efficiency and therefore most commonly used to describe performance of airlines. This paper models load factors as a function of nine potential variables. Data were obtained for seven major airlines in Iran and the period of study is from 1997 to 2006. The results obtained suggested that companies should increase their investment in computerized reservation systems, improve on their operation planning, change in management style and have more control in managing their airlines. The government of Iran should also maintain or continue giving subsidy in order to improve load factors and hence the performance of Iran Airlines.

Field of Research: Operation Management

1. Introduction

Passenger load factor or sometimes simply called load factor is a measure of an airline's passenger carrying capacity. It is also known as a measure of efficiency and hence most commonly used to describe the performance of an airline. Achievement of high load is deemed essential for airline's profitability and it is interesting to investigate factors that are expected to affect load factors. Furthermore, knowing these factors would help organizations or companies make more effective decisions and planning. These decisions or planning could include providing training, changing the mind-set among airline staff, increasing the number of travel agencies or changing the practices in their management, increasing human resource, increasing investment in advertising, and many others that can improve the performance of these companies. This paper focuses on estimating load factors of the aircrafts in Iran. Duliba, Kauffman and Lucas (2001) modeled the impact of load factors using five variables. These variables are the number of travel agencies using each computerized reservation system, average length in miles of all of the airline's flight between city-pairs, number of departures for each carrier, advertising expenses for each carrier and the change in vehicle miles as a control variable for industry growth.

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In this paper, we consider four additional variables to be included in the model. These variables are type of organization of travel agencies, subsidy, inflation rate and number of seats, after taking into consideration Iran's political, social, cultural and economic situation. Variables that contributed in explaining the load factor in this study can then be used as input variables in measuring performance.

2. Literature Review

There have been a number of studies of the airline industry, however, only a few have tried to estimate load factor although this variable is normally used to describe the performance of an airline. Higher load factor is also associated with higher productivity levels (Caves et al, 1981). Duliba, Kauffman and Lucas (2001) estimated load factor for the American airline industry using the number of travel agent locations using each computerized reservation system; the average length in miles of all of the airline's flights between city-pair; number of departures for each carrier; advertising expenses, and the change in vehicle miles, the first difference at time t of total air transport industry vehicle miles. They found that number of departures for each carrier and advertising expenses were significant, whereas computerized reservation system, the average length in miles of all of the airline's flights between city-pair and the first difference of total air transport industry vehicle miles were not significant in explaining load factor for the American airline.

Pegels and Yang (2000) evaluated the impact of the cognitive and demographic characteristics of top management team (TMTs) on the strategic assets acquisition performance in organizations. They tested a model for domestic air transportation industry in the USA. This model contains *load factor* as dependent variable and available seat miles, available ton miles, total assets; and advertising expenditures as independent variables. In another study, Hernadez and Salgado (2005) measured cost performance of the European Airline Industry. They considered fifteen airlines and data from 1984 to 1998. They estimated two models for cost functions. In one of the cost functions they use prices of four inputs: energy, labor, materials and capital. In the variable cost function, they substituted the price of capital by the number of planes as a proxy of the size of the company. As the vector of production is an aggregate measure of the real vector, they have added a set of variable to qualify the production in order to introduce more information about the production characteristics of the different carries. These variables are: the average stage length (measured as number of kilometers divided by the number of departures.), which is a measure of the average length of trips, the load factor and the number of routes served.

In conclusion, there are a few variables that can be taken into account in explaining load factor in the study of airlines. These variables include computerized reservation system; the average length in miles of all of the airline's flights between city-pair; number of departures for each carrier; advertising expenses, and the change in vehicle miles. Besides these variables, this study includes some other variables in the Iran case. One of the important variables is the type of organization of travel agencies, which undertake the task of selling the airline tickets. In Iran, tickets should be booked through travel agencies. There are two kinds of airline travel agencies. One of them is the agency which works for the airline which belongs to the Iranian government and we classify these agencies as governmental organizations. Travel agencies can also be independent of the airline, which means independent people undertook to establish a travel agency with their own capital. These types of travel agencies are classified as private organizations. The airlines have no direct control in terms of management over the agencies.

In Iran, the government gives subsidy to the airline depending on the airlines' operating distance. This subsidy is received by all Iranian airlines regardless of whether the airlines are government or private owned and it is called fuel subsidy. This subsidy is awarded to the companies due to the high and variant costs of fuel, repairs and maintenance. The airlines do not receive the same amount of subsidy and this amount is given depending on their operational function. Another variable that will be taken into account is the inflation rate. This variable is included to measure purchasing power of airlines' customers. Lastly, the number of seats was also taken into consideration instead of number of planes since different planes have different number of seats. Therefore, it will be better to use number of the available seats as a variable in order to remove the confusion.

3. Research Methodology

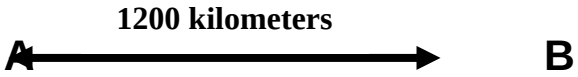
The Iranian commercial aviation came into existence in 1927 and has several private and public companies in operation. In total, there are 18 operating airlines. This paper only considers seven major commercial airlines. These airlines are Iran Air (IA); Iran Air Tour (ITA); Mahan (MA); Aseman (AA); Kish Air (KA); Caspian (CA); and Aria (ARA). The data are obtained from the Iran Airline Association for the time period from 1997 to 2006. Therefore, this study considers a panel data set where, for each point time t=1,…, T there are k=1,…,K different airlines.

The mathematical definition of load factor is as follows:

$$Load\ Factor = \sum_{i=1}^{r} \left(\frac{Number\ of\ carried\ passenger * dis\tan ce}{Avalable\ seat * dis\tan ce} \right) * 100\%$$

where *r* is the number of routes; *number of carried passenger* is the number of passengers carried in the route between two cities or stations; either in one country or two different countries; *distance* is defined as the distance between two stations and is measured by kilometer; and *available seat* is the number of available seats in the aircraft and it varies depending on the kind of aircraft.To explain the calculation of load factor, two examples are presented. In the first example, the distance between two cities has been covered by one flight and the second example the distance has been covered by two flights.

Example 1: The air distance between the two cities, A and B, is 1200 kilometers and the type of the aircraft used is Boeing 747 which has 285 seats and the number of passengers in this flight is 203.



Distance between A and B	**1200**
Number of passenger	**203**
Avalable seats	**285**

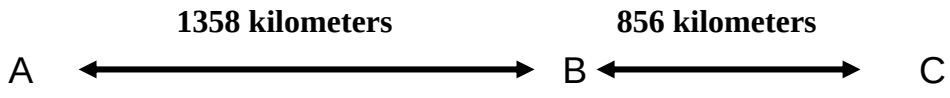
The load factor is calculated as follows:

$$Load\ Factor = \frac{Number\ of\ carried\ passenger * dis\tan ce}{Available\ seat * dis\tan ce} * 100\%$$

$$LoadFactor = \frac{203 * 1200}{285 * 1200} * 100\% = 71.22\%$$

The calculated load factor in this case is about 71%, which is a pretty acceptable value.

Example 2: Suppose a TU-154 aircraft flew between cities A to C and on its route it stopped at city B. Some passengers disembarked in city B and some passengers got on and traveled to city C from B. The aircraft left A with 130 passengers. At B, 45 passengers disembarked and 62 passengers boarded. The distance between A and B is 1358 kilometer and the distance between B and C is 856 kilometer.



$$Load\ Factor = \frac{130*1358+147*856}{160*1358+160*856}*100\% = \frac{176540+125832}{3637280+136960}*100\%$$

$$\frac{302372}{381240} = 79.31\%$$

As a result the load factor between the two cities of A & C will be about 79%. Load factor varies between 0% and 100%. The closer load factor to 100%, the better the operational function of the company would be, and the closer is load factor to 0%, the weaker the operational factor of the company would be.

In this study, we consider the model below:

$$\begin{aligned} Load\ Factor_t &= \beta_0 + \beta_1\, Computerized\ System_{t-1} \\ &+ \beta_2\, Average\ Length_t \\ &+ \beta_3\, Departures_t \\ &+ \beta_4\, Organization_t \\ &+ \beta_5\, Advertising\ Expenses_t \\ &+ \beta_6\, Subsidy_t \\ &+ \beta_7\, Inflational\ Rate_t \\ &+ \beta_8\, Number\ of\ seat_t \\ &+ \beta_9\, Change\ In\ Vehicle\ Kilometer_t + \varepsilon_t \end{aligned} \qquad (1)$$

where $Load\ Factor_t$ is the total load factors in year t; β_0 is a regression constant; $\beta_1, \beta_2, \ldots, \beta_8$ are coefficient of independent variables; β_9 is a coefficient for the control variable for industry growth and ε_t is an error term with normal distribution.

The independent variables can be described below:

- *Computerized System* is the number of agencies using computerized reservation system.
- The *average length* is the average distance in kilometer of the airline's flights between the city pairs.
- *Departures* is the number of departures in a year.
- *Organization* is a binary variable where 1 denotes private organization and 0 denotes governmental organization.
- *Advertising expenses* is the sum of expenses for each airline in a year.
- *Subsidy* is the amount of subsidy in US $ given by Iran government to the airline companies.
- *Inflation rate* is the rate of increase of the average price level and given by the formula below:

$$Inflation\ Rate = \frac{\Pr ice_1 - \Pr ice_0}{\Pr ice_0} \times 100$$ where

$\Pr ice_1 = the\ current\ average\ price\ level$

$\Pr ice_0 = the\ average\ price\ level\ a\ year\ ago.$

- *Number of Seat* is the total number of seats for every airline. For example, if Iran Air tour airline has 12 aircrafts in type of TU-154 and every aircraft has 160 seats and then the number of seat for this airline is 12*160=1920 seats.
- *Change In Vehicle Kilometers* is the first difference of air transportation vehicle kilometers between year t and t-1.

Computerized System is labeled as *System Location* by Duliba, Kauffman and Lucas (2001) and it is lagged one year to take into account the learning curve of the travel agency, expecting that the full impact of automating a travel agency should be felt during the year after the automation occurs. In this paper, *Stage Length*, i.e. the average length in miles of all the airline's flights between city-pairs is represented by *Average Length,* i.e. the average distance in kilometer of the airline's flights between the city-pairs.

We computed generalized least squares solution for this model using SPSS 11.0.

4. Discussion of Findings

Figure 1 below shows that the average load factor in Iranian airline companies has increased over the years. Although the difference between the highest and the lowest value of average load factors is only 10%, this is considered to be a significant increase as far as the airline industry is concerned. The highest load factor is in the year 2006 and the lowest is in 1998. This could be due to the economic downturn during this period.

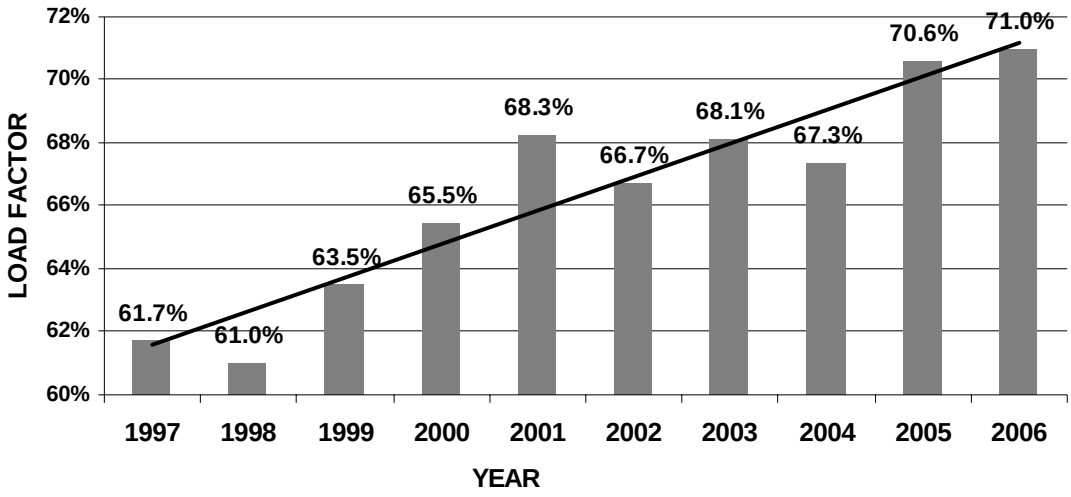


Figure 1.Average Load Factor (1997-2006)

The results of fitting Equation (1) are given in Table 1.

Table 1: Estimated Load Factor

	Coefficient	***t-Statistic***	***Prob.***
Load Factor			
Computerized System	1.683E-03	7.509	0.000
Average Length	-2.216E-08	-2.316	0.024
Departures	1.003E-05	0.899	0.373
Organization	6.211E-02	2.651	0.011
Advertising Expenses	3.602E-07	0.853	0.397
Subsidy	2.723E-08	2.284	0.026
Inflation Rate	3.172E-04	0.082	0.935
Number of Seats	-1.511E-05	-1.188	0.240
Change in Vehicle Kilometer	3.225E-08	3.959	0.000
Constant	0.505	10.04	0.000
$R^2 = 0.822$			

It can be observed that *Computerized System*, *Average Length, Governmental organization, Subsidy* and *Change in Vehicle Kilometer* are significant. However, *Departures, Advertising Expenses, Inflation Rate* and *Number of* Seats are not significant in explaining the variation in load factors. All of the significant variables have a positive relationship with load factors except for *Average Length*. This result indicates that load factor increases as the average distance in kilometer of the airline's flights between the city-pairs decreases. It should also be noted that the coefficients for *Average Length, Subsidy and Change in Vehicle Kilometer* are very small, since the unit of *Average length* and *Change in Vehicle Kilometer* are in kilometer and one kilometer is considered very short in terms of air distance. The same goes for subsidy since a USD1 subsidy is considered to be a

very small amount in helping the survival of the airlines. Taking collectively, this model explains 82% of the variation in load factors.

5. Conclusion

Unlike the case of the American Airlines, *Departures* and *Advertising Expenses* are not significant in the case of Iran Airlines. This could be due to different economic situations of Iran and United States. In Iran, the advertising expenses do not contribute to the load factor since the price of the tickets of every airline is the same and the government determines the exact price of tickets for every route. On the other hand, the number of departures per year can be well planned in advance by the airlines since more than eighty percent of the flights are domestic flights. Most of the customers use domestic flights for business, official, and pilgrimage traveling and therefore there are many regular travelers for different types of airlines. In this way, airlines can plan for the number of departures per year for each route to maximize load factors.

The two new variables included in this study are also not significant. They are *Inflation Rate* and *Number of Seats.* In Iran, even when the inflation rate is high, professionals are able to earn extra income and therefore they could afford to travel by air even during this period (despite the high price). As far as *Number of Seats* is concerned, the decision of buying an aircrafts in Iran is limited by the United States due to the economical and political sanctions and only a few aircrafts were purchased during the period of 1997 to 2006. Hence there is very little variation in the number of seats during this period. Furthermore, most of the operational function of the airlines was controlled by the Iranian government and very few of the airlines were able to purchase the aircrafts. For these reasons the two factors were not significant in explaining the variation in load factors.

In this paper, five main variables that affect the increase of load factors in Iran airlines are *Computerized System, Average Length, Organization, Subsidy* and *Change in vehicle Kilometer*. The computerized reservation system is not significant in explaining load factors as far as the United States is concerned. However, in Iran this variable is significant and this could be due to the absence of the on-line reservation system in Iran. Hence steps should be taken to increase the number of agencies using computerized reservation systems. The airlines should turn their computerized reservation system into highly successful specialized assets by investing more resources on them. The Iran Airlines should also reduce the average distance in kilometer of the airline's flights between the city-pairs since most travelers only travel in short distances. Hence airlines should plan for a shorter traveling distance, if possible.

In this study, we find that there is a benefit of being a private organization since the government has very limited control on their management in terms of planning for the routes of the flights. Hence they can plan in such a way that they

can maximize load factors. The fuel subsidy given by the government allows companies to discount the price of tickets for certain air travelers and hence has a potential in increasing load factor. Lastly, the *change in vehicle kilometers* is a control variable for the growth in business. Therefore, it is expected that as there is an increase growth in business, the load factor will increase.

In conclusion, the Iranian airlines should increase their investment in computerized reservation system and have proper operation planning. They should also consider changing the mind-set of the staff and practices in their management so that they can compete with the private organization. The government of Iran and United States should lax their control over the airline companies so that the airlines can operate better. In order to help the survival of the airline companies, the government of Iran should continue to subsidize the fuel prices.

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