


# **A Study of Airline Profitability Determinants**

**by**

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## Introduction

A number of factors threaten the meeting of demands and safety in one sector that is particularly important to world business flows and the economy. The airline industry has faced a shortage of necessary factors, increasingly difficult situations preventing the balance of supply with a market demand almost impossible to predict, and cutthroat competition that creates critically low or the absence of profits necessary to an industry that must only improve to continue its increasingly important role in the world's economic system.

In the next ten years, the number of air travelers will triple, creating the necessity of technical progress and efficiency advancement. This will only occur in industries of profit gainers; if there is no profit to be gained in a market, the incentive to advance and beat the current competition doesn't exist.

A well known and studied issue directly related to the significant expected increase in the need for air travel and a threat to supply now and in the future is the lack of runway use slots at major airports. To give an idea and a technical perspective, at Chicago's O'Hare International Airport, there is runway utilization once about every 30 seconds. Chicago is a hub for multiple major U.S. carriers, meaning multiple airlines are timing arrivals to feed outbound flights, often at certain peak hours of the day. Congestion creates pressure to build entirely new airports at major cities but there are many objections. Due to noise pollution, airports must be upon land much greater than runways, which are often two miles long. The need for this land sends the whole project into rural areas far from city centers. Environmentalists are angered due to noise, traffic, air and water pollution, adding the arduous situation that the airlines and airports face. With this and the increasing airline traffic, the laws of supply and demand force a raise in the price of airport landing slots, a huge U.S. \$10,000 at Tokyo's Narita Airport for a 747, (Japan Times, 2000) eating away at airlines' vulnerable profits. Profits, and their determinants, the incentive for entrance, activity and the advancement of efficiency and technical progress necessary in this industry are what I will be concerned about most. Without comfortable profits, the major airlines providing the transportation means of goods and human resources and being the critical part of the U.S. and the infrastructure

of the globe that they are, won't have the means to progress to meet exponentially growing demand, and more importantly, do so safely.

### Industry Background

The early airline industry and regulation of it evolved quickly from the time of the first flight. In 1920's, regulation commenced with the U.S. government awarding contracts to the first airlines for carrying mail. The mail brought in more revenues than anything else in the early years for airlines, and the Post Office and the Interstate Commerce Commission were key factors in the forming of the industry. Failure of existing regulations lead to the formation of the Civil Aeronautics Board (CAB) in 1938.

#### *Regulation*

In the Civil Aeronautic Act of 1938 (followed by the Federal Aviation Act in 1958), the CAB was given the authority to award routes, regulate fares and assure safe operations among airlines running interstate service. Some of the major aspects of the Act were as follows:

- (1) Encourage air transport systems for present and future needs of domestic and international commerce, postal service and national defense and promote competition extent enough to do so;
- (2) Preserve advantages of air transportation, safety, economic conditions, and relationships of air carriers;
- (3) Promote efficiency at competitive prices, without unjust discriminations or destructive competitive prices; and,
- (4) encouragement of politics to foster growth in the civil aeronautics industry

In order for an airline to begin service in a new point to point market, whether a new or operating firm, it was required to obtain the rights from the CAB. Carriers had to show that their running of the new route was in the public interest and that it would not harm incumbent firms in the market. This proved to be an arduous and costly process and could take up to 24 months depending on the route, the number of carriers wishing to enter the market and the number of incumbent firms. (O'Connor, 2001)

CAB was also the authority for agreements between individual carriers, mergers, acquisitions, and was also the authority at the time of investigation of unfair methods of competition and practices. Under regulation, through general economic growth as well, the airline industry experienced tremendous expansion from the time of the start of regulation to the late 1970's.

The aircraft world saw the jump from the old standard 21-seat propeller driven DC-3 to the now standard 600-seat Boeing 747. From this time period, the number of domestic passengers in the U.S. increased from one-million to 267-million, the number of revenue-passenger-miles from 533 million to 219 billion, and the number of airline employees from 13,000 to 300,000. (O'Connor, 2001)

In the mid 70's, a combination of the oil crisis, leading to high fuel costs and the introduction of wide body jets, which led to overcapacity significant fare increases. Though the CAB had maintained safety, technological growth, and reasonable profits, it had not been effective in maintaining low prices. All this led to arguments for reform in the industry and was the beginning of the change to the present situation.

### *Deregulation*

In 1975 single deregulation bill was introduced by the Ford administration and led to the airline deregulation act of 1978. Arguments against the act were much like those mentioned earlier here, such as concerns for safety, industry concentration, predatory pricing and competition, and the ability to finance newer and efficient fuel equipment. However, they did very little to slow the process of deregulation.

The theme of deregulation was to bring about objectives of efficiency, innovation and low prices in a competitive environment as well as continuing to provide service to small communities. Restrictions were completely eliminated by 1981 and by 1984 there was no regulating board. Replacing regulations were standards that airlines be willing, able and fit to serve the routes that they had decided to. Thus, regulatory barriers to entry into the market were significantly removed significantly upping competition.

(Graham,1995)

### *Deregulation and consumers*

Profits depend largely upon consumers actions which are dependent upon how they perceive what they are consuming. With this, and the fact that deregulation made for major changes in the industry, I first look at its effects on consumers. Assuming that customers are looking for certain characteristics in anything they consume, we must establish this in our industry and look at respective changes. Consumers demand inexpensive, safe flights that run frequently with good service. We now have four characteristics.

Supporters of deregulation argue that the market performs better than in did in regulated times, certainly it is more competitive. With the competition leading to many discount fares, more frequency, and more markets through hub and spoke networks, Morrison and Winston who have done extensive airline research and analysis that in the first five years of deregulation found that consumers saved around six billion dollars annually, in nominal terms, a third of which coming from the discount fares. Such fares were targeted by sophisticated pricing management systems at leisure travelers who fly at odd times and will stay at destinations longer. Those in the business world weren't gaining from fare reduction so much, but were benefiting from increased frequency.

Much of this was short lived however, as low fares and high frequency please consumers but do not increase operating profit. Seeming like only a problem for the airlines, the suppliers, long term negative affects on consumers proved to exist. A crowd-pleasing carrier who ran, low fares, 'no frills' high frequency turned vulnerable with in a very short period of time. We can see a certain background situation where fares will be lowered and frequency increased for competition but quite the opposite occurring for the purpose of the airlines' survival.

Quality and changes in quality are difficult to judge as quality is not a quantitative field. However, most consumers and observers from both sides have recognized a loss in the quality of air travel service.

Upon quality, many arguments have been made stating that cut costs due to competitiveness and with new firms entering often, cuts in airline safety measures have been known to occur. However, arguments are hard to prove due to the difficulty in reading into safety statistics due to the tiny number of airline fatalities. The lowering of

safety quality tends to be the noticing of measures taken, as the statistics have little change to show and U.S. airlines have the best record in the world for safety. (Graham, 1995)

Though the industry became deregulated, the Federal Aviation Authority is required to certify airworthiness of equipment, control flights coming in and out of airports, monitor maintenance doings and other factors related to operations.

### *Deregulation and Competition*

Shortly after deregulation, a large number of firms entered the market with mostly negative results. The entrants offered low fares and many direct flights, but fewer amenities than the established carriers such as minimal food service and space between seats. The intensified competition led to very low survival rates for new entrants. Simply enough, many failed, filed bankruptcy or were acquired by previously existing regulated airlines. Of the 22 airlines that entered the market shortly after 1979, 13 carriers went bankrupt, six were acquired by other airlines, one withdrew from service and two remain. (Williams, 1993)

When the new firms offered low fares, the incumbents matched the prices and created a situation where operating costs were not being met. With the ticket prices the same, consumers generally chose the older more established companies. The new competition in the market caused firms with any strength to employ strategies and operation strategies causing controversy, including mergers, acquisitions, frequent flyer programs, computer reservation systems, and hub and spoke networks. These practices were designed to protect incumbents from the high number of new entrants in the early 1980's. Before deregulation, the CAB rarely permitted mergers, never among large carriers. Deregulation created an industry in which mergers and acquisitions seemed (still currently) necessary to survive with the absence of the competition. (Pitt, Norsworthy, 1999)

### *Hubbing*

The other major response by the airlines to intensified competition as discussed before are hub and spoke networks. A hub generally refers to any large airport offering

multiple connections or acting as a base for an airline. However, behind this is that a hub acts as an airline's interchange through which one or two carriers run waves of flights.

Several times per day, a large number of flights from the same carrier are timed to arrive within a short time frame, and minimal period is allowed for traffic interchange and then an equivalent large number of flights from the carrier depart. The purpose of this is to maximize the number of city pair markets with a minimal number of flights.

To link each of six east coast cities with each of six west coast cities would require 36 separate flights, but with a hub between the flights providing an interchange, the 36 markets can be serviced with only 12 flights, six arriving from the east and later six departing for the west.

After deregulation, nearly all major U.S. carriers utilized this principle, starting from major airports where arrivals and departures were already controlled by certain carriers, such as in Dallas-Fort Worth, Chicago and Atlanta. Due to the distances traveled in the United States, carriers desire for regional dominance in combination with services throughout the nation, most carriers developed multiple hubs. An effective hub must have certain characteristics. It must be located to minimize flying times and costs, and heavy traffic patterns in certain areas make two locations absolutely dominant as hubs in the U.S., Chicago (United, American) and Dallas-Fort Worth (American, Delta). But, as the main reason for establishing a hub is market protection, a hub must provide close-to-monopoly market share for its carrier. Finally, the hub must have sufficient facilities such as runway slots, terminal space and gates and apron space.

As hubbing depends upon waves of flights arriving and departing, it demands a large number of runway slots compressed into short time periods. Though contributing heavily to airlines efficiency and survival after deregulation, there are disadvantages to hubbing. In many cases, airlines reaching to be in the market for every major traffic flow in the U.S. and mergers have led to the development of too many hubs. In the early 1990's, USAir acquired Piedmont, and with it Dayton and Baltimore hubs, thereby competing with itself in Pittsburgh and Philadelphia. The problem with slowing operations at unprofitable hubs is that the capacity has to be distributed elsewhere or parked, which incurs overheads. Perhaps a better solution was executed by Delta in Dallas Fort-worth, when smaller turbo-props were substituted for Jets whenever possible.



Though efficient in that it links multiple markets on single flights, there is an inefficiency in hubbing in that the distance traveled from one point to another in a market will be much greater when going through a hub. This also incurs two or three times the airport usage costs, and adds to fuel costs as take offs and landings are particularly consumptions. Be it a carrier uses the hubbing principle, high costs are paid due to the rise in demand for runway slots and terminal space, especially in cases of shared hubs. Be it they don't hub, it's almost impossible to remain competitive.

The alternative to this is to mention the only current airline operating on a point to point structure and continually making profits in the 1990's. Southwest Airlines runs mainly short haul routes at high frequency, eliminating the need for ground turnaround speed and timing of flights leading to lower costs from equipment and labor. With this, Southwest maintains 65 percent market share in it's top 100 markets. (Graham, 1995)

That leaves the airline industry as it is today, a free highly complete marketplace. With lower barriers to entry than before, new competitors jeopardize the profits of firms in an industry that is a critical part of our infrastructure.

## Literature

### *Rate of Return Study*

In the late 1980's Steven A. Morrison and Clifford Winston did a study of individual airline rates of return determinants to in order to study how some airlines make it through financially difficult times better than others. The study had a time frame of 1970-1988 and was intended to follow through into the 1990's but due to various conditions, including slow economic growth, middle east tensions and sharp airline capacity increases, the study was held to the specified time frame. Applying the framework of a study done by Ann F. Friedlaender, Ernst R. Berndt, and Gerald McCullough on railroad performance, they sought to come up with a structural model of airlines rates of return and then find profitability effects of individual influences by seeing what would happen to the most profitable airlines by applying the characteristics of the not so profitable and vise-versa.

Variables thought to decrease returns included, employee compensation, fuel price maintenance costs and other costs. Characteristics used as variables included were

actions at hubs, flight distances, load factors, route density and one factor we didn't discuss, a dummy variable representing the use of a computer reservation system(CRS). At the time, a CRS wasn't nearly as common as it is now. In a model today, it's assumed that our subjects have CRS. Any of these latter variables are thought to increase return rates. A second dummy variable used and additional coefficient examined the effect the level of education and experience of the airlines' managers had on profitability.

In finding the coefficients of the variables, all were found to have the expected signs and have "reasonable statistical precision". As a matter of interest, a significant positive coefficient was that attached to the length of haul variable, showing that the long hauls are efficient, will keep costs per passenger down and bring in returns. The unit cost of fuel had a significant negative coefficient and is one major cost of airlines. One final discovery in the model was the importance of the managers' backgrounds. By swapping characteristics of airlines of different return rates, it was found that the least profitable airlines would have experienced significant profit increases having had the educated and experienced management teams of the airlines with the highest return rates. Many airlines did better than others due to the use or CRS systems, and lower levels of costs, but the only factor that was consistently better among the most profitable airlines were that they had superior management teams.

The study also took a much needed look at the effects of deregulation on profit taking (or losing for that matter in the industry.) In comparing a deregulated 1983 airline industry with a regulated 1977 system, much to our surprise, profits were found to be \$2.5 billion (1977) dollars greater in the deregulated world than if the industry would have been still regulated.

Later, Morrison and Winston extended their study by using 1978 data to predict 1988 airline profits had the industry still been regulated. This was ideal as it was the last year in their study, and the economy was at a similar position of the business cycle in both years. To execute the study, the two adjusted the variables of profit determinants from the 1978 study to create what was a non-existent 1988 regulated airline industry. Using these variables, they found rates of return and converted them into 1988 profits. Fares were found by updating what is known as the Standard Industry Fare Level (SIFL) calculated by the Board of Transportation. It was assumed that the notion of regulation or

not would not have an effect on fuel costs or maintenance expenses, so these variables kept their 1988 values. Average compensation was increased a small amount upon regulation's effects on wages. The variables reflecting effects of operating characteristics were not changed more than the minimal amount, as only a minimal amount of change was found leading up to the change in regulatory policy. Load factor actually increased a substantial amount, but this was thought to be due to fare deregulation.

Unknown what to do was the situation regarding the variable attached to the hub characteristics, as our researchers were trying to create a 1988 regulated situation, where as hub concentration was the answer to deregulation in the industry. Due to this and that the variable, and the effect of hub activities on profitability (for the purpose of the study) were extremely small, the actual 1988 variable was used. Also unchanged from deregulated to the new model were the variables regarding the effects of managerial style and the use of CRS systems.

Upon this, the model of a 1988 still regulated airline industry showed a bringing in of less returns do to higher worker compensation and efficiency loss offsetting higher ticket prices. It was calculated against the what was current deregulated 1988 environment that airlines gained over \$2 billion from deregulation.

More competition should lower profits for the individual firm. The explanation given by Morrison and Winston involves airlines' incentives. Under competition and lack of a regulatory environment (particularly fares), airlines' have the incentive and opportunity to minimize costs and be efficient when attempting to maximize load factors. Without regulation, airlines faced competition, but also the opportunity to jump into markets with profit to be made, abandon those without, and maximize efficiency of inputs.

It seems however that for the purpose of the study, data was used from surviving airlines. These were the profitable firms, opposed, of course to the alternative, who did not survive.

### *NAS Performance Study*

Other more recent studies conducted on the industry examine not only the industry itself, but interestingly enough, the methodology used to study the industry. Mark Hansen, David Gillen and Reza Djafarian-Tehrani for the Institute of Transportation studies conducted research in 2000 relating benefits of US airlines, as a function of costs and performance, with given improvements of the U.S. National Airspace System (NAS) based on quarterly statistics of 10 US domestic airlines. Their goal was to capture the much needed benefits of improvement in airlines performance and cost savings in a not-so-profitable industry from improvement in NAS in a different methodology than those in common use. General current methodology presents industry benefits in a single dimension; usually only delay and cost savings from decreasing delays are observed as airlines' benefits upon a NAS improvement. The authors of this study claim that benefits from NAS improvements are 'multidimensional', such that not merely are reduced delays and cost savings are benefits, but that the result of the benefit depends on specifics of the benefit outcome. For example, it is hypothesized that, delay time and delay cost have not a linear relation, as a 40 minute delay probably has not the same cost as 40 one minute delays as the former of which is much more liable to cause disruptions in ground operations, gate, crew and other assignments and other traffic. With this, delays end up as combinational; one half-hour delay can cause trouble among the scheduling of other airlines among multiple airports, where as 30 one minute delays should not cause a major problem.

Other factors found not to be considered by current methodology in estimating benefits of NAS improvement would be the so called 'padding' used by airlines to try to prevent major problems of delays and the effects thereof, incurring costs. These would be things such as adding extra fuel, financing bigger block and slot times and having more input factors readily available such as crew and aircraft.

To estimate economic value of improvements in NAS (reduction of these stated incurred costs) was found to be almost impossible due to "a complete absence of information", thus creating "critical gaps in knowledge at a time when massive investments in the system are being contemplated". Hansen considers a number of possibilities to fill these gaps. The first of which could be detailed simulation of airlines

responses to operation irregularities and costs, whose necessary addressing of major disturbances such as reassignments of crew and aircraft rerouting were found to not be currently possible to be of use for their purpose. Another possibility would be to simply survey airline personnel with a number of situations in order to estimate utility functions of NAS performance. This was rejected due to the inability to accurately bring in monetary values of changes in NAS performance, (as a query would require a choice of also money, not just flight operations), the inability to find personnel knowledgeable about the airline as a whole, and the inability to find personnel who would not be biased towards their interests opposed to the airline as a whole.

Thus, a third response to fill the "critical information gaps" was focused upon. This approach consists of estimating airlines' cost variables and outputs with NAS performance variables. Thus, instead of simply relating NAS improvements, consisting of public and private investments resulting in better performance, (mostly less delays and cancellations) with delay and cancellation costs, the model estimated in the study here is to relate these air system improvements with all costs of airlines, hence including these costs incurred by 'padding' or adding extra factors in case of irregular system behavior. Cost was defined as a function of the lowest cost at which it can produce a given set of outputs (Y) given prices paid for inputs. (P). The function also represents the cost of acquiring the optimal set of inputs (X\*) given the former two factors, such that,

$$Cost_{it} = P_{it} \cdot X^*(Y_{it}, P_{it}), \text{ or } C(Y_{it}, P_{it}),$$

where "i" is the airline and "t" is the period.

Considering that the previous equation is of "optimal" amounts, it is found to be long run. A short run equation is that with fixed capital ( $K_{it}$ ), and the operational experience during the given time period, ( $N_{it}$ ), which is based on variables such as delay, delay times and variance and canceled flights. Thus, the operation cost function is said to be  $O(Y_{it}, P_{it}, Q_{it}, K_{it}, N_{it})$ . Measurement of NAS performance consisted of variables such as average delay, variability and the rate of flight cancellations. Results of the study conclude what was hypothesized, that poor performance of the National Air System increases not only delay costs of airlines and the costs involved, but operating costs in general. Of the

many “dimensions” of NAS performance, the variable driving airlines’ costs up the most was the ‘disruption’ variable, opposed to ‘delay’ in previous ‘single dimension’ models. The model also seemed to indicate that maintaining flights with long delays are more efficient than canceling them all together. Finally, the model puts what is thought to be a more accurate value of benefits to airlines from improved performance, as with this study, again, gains are not just from reduced delays, but reduced costs. From significantly reduced NAS performance, Hanson [et al.] estimate industry gains of \$1-4 billion annually. Observers of the study are left with the question of how much disruption, -the key cost driver- is avoidable through technology and the work of humans, and how much is beyond control, such as weather.

## Conceptual Background

### *Main Variables*

The industry going through regulation policy changes, growth, different business cycles, strategies, different competition levels, failures and successes has been studied. With the industry as it is, going into certain growth and now in the new century, we assume its worth looking at another model. To do so, it is worth looking in to some of the major determinants of profits in this industry more in depth, starting with yield and the management of as promised earlier.

### *Revenue*

Yield is the revenue received by a carrier per passenger kilometer. Naturally, it seems a higher yield would bring in higher profits, but there are possibilities where this doesn’t hold true. With a high amount of fixed costs, the management, paying less and less attention to the yield, have the obligation to fill empty seats. This is done by attracting the customer, or offering more and more discount fares which would lower the revenue per passenger kilometer, and therefore, lower the yield. Thus, there is a battle between maximizing capacity use to offset fixed costs (if an airplane is flying, it might as well be full) and keeping the revenue up per passenger. Maximum profits cannot be achieved with maximum yield, nor maximum revenue (as this usually means maximum costs), but achieved with the best possible combination of both given the circumstances.

Thus, a new concept, yield management, became popular with airlines in describing the delicate computer assisted process of determining the number of discount fares to be made available while protecting the ever-important yield.

In this, we can visualize a theoretical relationship between yield and the profits that airlines turn. If a yield is particularly low, an airline is taking in low revenues per passenger using its service. No matter how many passengers it's serving or the lessening of empty seats, in comparison to the sacrifice of perhaps, lower ticket prices, the revenues gained will be slim. Alternatively, perhaps the yield for an airline is especially high. Per passenger served (a per cost unit, more or less) revenues are high, however, high yields are achieved through higher ticket prices, perhaps suggesting that there is a better alternative for the shopping consumer. Finally a moderate yield should theoretically be a reflection of a ticket price reasonable to consumers and a reasonable profit per unit served to the airline, thus, it is highly possible that the relationship between yield and profit is not linear.

With this we can propose, that at a given cost, profit is a function of yield and load factor, or,

$$\Pi = TR - TC \text{ where, } TR = f[y, Lf]$$

where (y, Lf) are inversely proportional.

As the market is competitive, keeping prices low but having high costs keep firms in the industry looking for an amount in fares to cover costs and turn some profit, thus, the later of our yield barring situations should produce the most profits.

#### *Supply Side: Costs*

As the yield is to revenue, seat-kilometer-costs are to costs. It is, quite simply, the cost of a seat being carried for one kilometer. To managers, this is what represents the cost for one unit of output. Also used is the term 'cost per revenue-passenger-kilometer', usually simply referred to as 'passenger kilometer'. Revenue is attached to due to the fact that in rare cases, passenger may be carried for free, or at a very significant discount, such as employees and their families. Needless to say, firms want to minimize costs. Airlines face recurring situations making this difficult to do; it would be appropriate to look at some of these and see the response, or what should be. The first of which is the

short haul problem. Much like the yield needs to be protected when calculating revenues, so do the seat mile costs. This can become disastrous when serving markets consisting of short distances. First of all, terminal rates be it passengers or cargo are going to be the same whether the flight is 200 miles or 2500 miles, making it so the shorter flight creates a situation with little distance to spread these costs out. Other point costs include fuel consumption at take-offs and landings. If an airline is doing one round of porting on the longer flight, needless to say, these costs are much lower per seat-mile. The same will go for landing and terminal use fees.

Above all of this, fares must be kept low on short trips as an airline must take in to account a travelers opportunity cost, going on the ground, and they must be kept high to pay for to pay for fixed costs. Perhaps this explains supply concerns developing among more sparsely populated destinations and why many smaller and shorter routes are running on subsidies.

This problem is also seen on short routes of large cities. For example, USAir's major hub is in Philadelphia, creating the short haul problem in the West Coast/New York market with the connection from the hub to the New York location.

Much like yield and profit relationship, if we see that an airline route is too long, we see profits drop due do the necessity of lowering passenger loads to maximize fuel efficiency. On extra long hauls, we can see the cost per passenger mile increase towards the end of a journey due to the fuel problem, so not very often are extra long flights operated. (O'Conner 2001)

Another issue is realizing that minimizing costs means minimizing costs per unit input and maximizing use per unit input, or, minimizing cost per output. This is done by maximizing use of current inputs. Basically this can be looked at as any generic airline. If there are two carriers, America's United and Thailand's Thai Airways serving the San Francisco-Tokyo market we'll find their production functions to be the same. In Thailand, wages are low, so most industries are labor intensive where as in the U.S. industry is capital intensive. When flying 400 people from San Francisco to Tokyo in 9 hours, they are both going to use a Boeing 747 priced the same, they both use the same amount of fuel that they bought from the same company at a market price(which could



vary a little based upon bargaining abilities), and they both pay the same expensive fees at both airports.

The big difference comes in as the industry standard, wages. High wage capital intensive nations ability to compete in a homogeneous industry with Southeast Asian nations paying low wages is questioned. The answer comes in management and factor usage. It has been found that management in high wage nations are more effective at the key to minimizing costs, the scheduling of inputs. Looked at constantly by managers and airlines economists are the questions: How many hours per month, per salary unit are the crew flying? Of 24 hours, how many of those are in the air on average for expensive aircraft that are constantly being charged depreciation? These need to be safely maximized in order to be in a lucrative business. Aircraft and crew must be utilized to a reasonable maximum, but again, as we found that a yield too high may not fill empty seats, an aircraft in the air 20 out of 24 hours (this would actually be rather unfathomable compared to a good rate of 10 or 12 hours) (O'Conner, 2001) probably won't be putting the capacity to best use. It would be poor managing to maximize aircraft utilization with low load factors. Thus, might the term 'seat-utilization' be suggested?

In order to balance all of this an airline wants to have in its possession the necessary factors, and no more. Labor can be hired, fired, imported, exported with less difficulty than other matters. Fuel can be acquired simply with capital and reasonable political relations. Slots at airports are an issue, but the industry is currently in operation only the future bringing major problems. The problem with having the correct amount of inputs is buying airplanes. The other factors already exist and are just being 'released' in a sense (humans, oil) as needed, but aircraft need to be ordered and built in large numbers taking enough time to bring about the need for predicting with precision future demand of air travel, which depends on many, many factors including the economic state, the state of business, peoples' personal demands, the state of substitutes (mostly the rail in our previous discussion) and sometimes future political relations making it quite an arduous task.

Once a carrier has airplanes, efficient utilization involves scheduling. This involves the sorting out of many factors. A scheduler must consider markets, how large they will be and how much they will change with the day of the week and the time of

day. Markets consist of local, thru and intermediate traffic. Some airports will have shortages of slots and time constraints or curfews. Scheduling a stop for maintenance or refueling must be such that the location is the point of origin for the next route to be flown. Thus a balance of aircraft utilization, load factor, crew utilization, availabilities of aircraft and other factors, and scheduling much be achieved to minimize costs, thus maximizing profits. A discussion on costs wouldn't be complete with out a little extra attention towards airlines' biggest costs, labor and fuel. Both present major problems besides the fact that they are the two major costs the airlines face. Attacking these a the root of the problem is key for the airlines' to be profit takers.

### *Labor Issues*

One of the key problems with labor and labor costs is simply the power that airline employees can hold over their firm. Opposed to the level in most industries, the level of skill and responsibility involved in any task that is part of airline operations is of the highest. Dealing with wages and contract must reflect this and the fact that airline operations occur at all times, 24 hours a day 365 days a year an that employees are located and even moving all around the nation and the world.

Knowing this, almost all airline employees in industrialized nations are part of unions. Unions are based upon the individual task group, such that mechanics, pilots, stewardess and so on all have separate unions. A problem in one group however involves a problem for all as if one group strikes, this shuts down operations, taking away the necessity for operations of the other groups. Airlines cannot keep their products in inventory to hold over and limp through the strike. When service stops, there is nothing to be sold. As well as knowing this, labor unions know peak seasons for airline service, increasing bargaining power to critical levels.

Besides using the human resources that are cooperating efficiently as mentioned before, the airlines have benefited and survived by laws and agreements protecting them. Among these particularly important are the 1926 Railway Labor Act and the Mutual Aid Pact of the late 1950's Not originally designed for airlines (as the name suggests), the act calls for 3rd party mediation in the event of a major labor dispute by one National

Mediation Board (NMB). Such situations have been moved to arbitrators because of the lack of success in mediation, however both parties must agree to any final decision by an arbitrator, making this step a difficult one to take. The mutual aid pact, a 1958 agreement originally in the trucking industry is not much of a factor in the present, but worth our minimal attention. Here, truck companies worked together to see that any firm whose operations halted due to strikes received profits realized by operating firms as a direct result of the stoppage. One year after this occurred, the four major airlines existing at the time, United American, TWA and Eastern signed a similar pact approved by the Civil Aeronautics Board. This however, didn't last upon consistent protest of unions. The main argument was that a carrier receiving payments whilst not operating would be likely to stay in that situation longer. The mutual aid pact in the airlines didn't survive deregulation and was ended in 1978.

The major tool that airlines used in the 1990's and currently with their labor cost problem, threats, and for improvement of labor efficiency is to tie their incentives to workers'. This is done by ownership. A stake in the profitability of the airline (or then again, the lack thereof) is an incentive to work harder and boost worker morale. Employees pay for shares through wages, benefits and work rules spread over a number of years.

Finally, the labor issues in the industry have seen corrections upon two major instances of market correction, the first of which occurred with Continental Airlines in 1983. After filing bankruptcy, they continued under chapter 11 laws breaking what was the current union contract. Under new lower wages, unions protested but Continental legally continued in its new reorganization. This was a one time case however, changes in bankruptcy laws now require proof of the necessity of certain reorganization strategies in order to do so. The other major instance was with Eastern airlines failure in the early 1990's. This contributed to more passive union psychology and the desire for workers to contribute to the success of their carriers.

### *Fuel and Rent*

Bought, sold and burned up in all of this is fuel. We've seen fuel prices vary as long as we've been flying. Political conditions in the Middle East could always send the price up, and due to a time uncertain when the world's supply of petroleum will cease, this will be the direction of fuel costs in the future. Airlines answer this like any cost problem, increased efficiency. Amazingly enough, airlines have the same gas mileage as a passenger car. This is good as a airline often has well over 200 people on board, but in another way seems poor, as a traveling aircraft has no ground friction to deal with and scientifically should be much more efficient than an automobile. In answering the fuel efficiency situation, airlines do what is financially reasonable to keep a relatively new fleet in service, as newer aircraft are more fuel-efficient. Though expensive, efficiency pays for itself over time. On a smaller financial scale, airlines often consider the purchase of new, more fuel efficient engines to use with existing aircraft. Other than this, airlines can only be efficient in their operations, obtain high load factors at existing prices and minimize short routes that have minimal miles and revenues per fuel consuming take-offs and landings. Finally, in a discussion of costs to airlines, we must include the cost of airplanes. Airlines face an extraordinary cost of one airplane, much less many planes to complete a fleet, and they face the challenge of deciding the number of planes necessary, certainly no more, precisely meet market demand. Carriers meet this challenge in similar ways that public often do with their homes and their cars, most of the current operating commercial airline fleets are leased or rented, often with future ownership rights. We leave the complexity and the spectrum of the debt instruments to the lawyers and accountants.

With all of this, we see that for a given revenue, profit will depend also on costs, or,

$$\Pi = TR - TC, \text{ and } TC = f(Q, j, F, L, M, Fee, R, Use)$$

### *Demand Side*

Whenever discussing the economics of anything, we hope a serious perspective will take into account the GDP. Unneeded to be said, GDP plays one of the major roles in determining airline demand, and therefore medium for a correct capacity estimate and a determinate of airline profitability. Simply enough, aggregate demand for air transport is based highly upon economic activity, growth and decline. Therefore, a simple but definite positive relation to form would be that of GDP and revenue passenger kilometers (RPK). Mentioned with the downfall of eastern airlines and a major cause for airline alliances were the troubled times of the early 1990's for the industry. This was a time of recession in the U.S. and European economies.

Working with a larger market and larger demand theoretically means better profitability. A lower GDP is an economic slowdown, resulting in a weakening of the necessity for business travel, and additionally, consumers' disposable income. This lessens the demand for air travel, leading to more empty seats, less efficiency and less profits. On the other hand, a higher GDP does quite the opposite, filling seats and adding to efficiency and profits. However what would occur if a carrier couldn't meet the demand for it's services? Its possible, if one season produced particularly high demand, a carrier that couldn't meet it may lose some of its consumer base to an airline that could. A key idea to the relationship between GDP and profits is not only the demand for air travel, but the prediction of demand. If a carrier over-predicts demand, it may be left with empty seats and overhead leading to profit losses.

Underestimating demand would lead to a high load factor in the present, but a possible loss in consumer base in the future. Thus, bringing GDP into the equation as a determinant of demand and therefore a revenue factor, we the key variables that determine the profitability of an airline.

As profit is a function of revenue and cost, or  $\Pi = TR - TC$ , with examination of revenue and cost, a profit consisting of major determinants for airlines would be as,

$$\Pi = f(GDP, Y, Lf) - f(Q_j, F, L, M, l, R)$$

## Methods

To examine the relationship between profit and its determinants, observations from a number of North American, European and Asian airlines were collected. The sample was then edited to include only those who offered data for all components necessary to contribute to the models to be made.

Profit is a function of the revenue components and the cost components, or

$$\Pi = R(GDP, Y, Lf) - C(Q_j, F, L, M, l, R)$$

where, as expected, *GDP* is the GDP of the nation hosting the year-airline during the year, *Y* not output (as most economists assume with *Y*), but the yield, *Lf* is the load factor, *F* is cost paid for fuel *L* is labor costs, *M* is maintenance costs *l* is landing and other airport use fees, *R* is the rent paid for aircraft use and *Use* is level of use per input.

In an economic function, one other component should be added. It is possible for anyone doing anything in a reasonably democratic nation allowing capital mobility to invest their capital where they wish. The same goes for one running a major airline, and if more profit isn't being taken than if investors into an airline were investing at the next best opportunity, than what will stop them from doing so? Thus, we add in the opportunity cost leaving,

$$\Pi = R(GDP, Y, Lf) - C\{Q_j, F, L, M, l, R, ret(investment)\}$$

Where *ret* is the rate of return in the industry with the next highest returns and *investment* is the investment of the airline after operating costs. Using nearly the same sample, though edited a minimal amount based upon data availability, formulation of an economic model leaves,

$$\begin{aligned}
 PROFIT_i = & C + \beta_1 LOAD_i + \beta_2 LOAD_i^2 + \beta_3 YIELD_i + \beta_4 YIELD_i^2 + \beta_5 UAPK_i + \\
 & \beta_6 ULABOR_i + \beta_7 UFUEL_i + \beta_8 UMAIN_i + \beta_9 UFEE_i + \beta_{10} URENT_i + \beta_{11} GDPCH_i + \\
 & \beta_{12} W_i + \beta_{13} X_i + \beta_{14} Y_i + \beta_{15} Z_i - ret(investment) + \varepsilon_i
 \end{aligned}$$

where

$LOAD_i$	the percentage of the available seats for sale on operating flights for the given airline that are filled
$LOAD_i^2$	is the load factor multiplied by itself in case of a non-linear relationship
$YIELD_i$	is the revenue per passenger mile
$YIELD_i^2$	is the revenue per passenger mile squared in case of a non-linear relationship
$UAPK_i$	is the average number of seat kilometers available per airplane
$ULABOR_i$	is the average cost of labor in wages, salaries and benefits per worker
$UFUEL_i$	is the average cost of fuel and taxes per gallon
$UMAIN_i$	is the average cost of maintenance per airplane
$UFEE_i$	is the average cost of runway and terminal fees per 200 seats going 2000 kilometers
$URENT_i$	is the average cost of renting or leasing one airplane for the year-airline
$GDPCH_i$	is the change in GDP, in percentage in real dollars from the previous year
$W_i$	is a dummy variable for 1998
$X_i$	is a dummy variable for 1999
$Y_i$	is a dummy variable for 2000
$Z_i$	is a dummy variable for 2001
$\varepsilon_i$	an error term

$LOAD$  is the percentage of seats filled on an airplane in operation. This is a critical factor in determining revenue, therefore profits. As the costs of operating a flight

from one point to another are going to be almost the same despite the load factor, an airlines objective is to concentrate on maximizing the ratio of filled seats to empty ones.

Unlike selling a manufactured product or a utility, a seat on an airline cannot be stored for later sale when the demand increases. When the gates to a flight are closed, so is the opportunity to sell empty seats, lost forever, along with the costs incurred in offering those seats, for which there will be no revenue. Thus, having a higher percentage of seats filled will mean higher revenue, offsetting costs and increasing profits; LOAD should have a relatively high value positive coefficient.

The LOAD variable is a major determinant and included in the economic model. As we discussed before, on long haul flights in order to maximize fuel efficiency it may be best to not have the load factor completely maximized, thus, it is possible that load does not have a linear relationship with profit, so we have included  $LOAD^2_1$ . It seems a reasonable expectation would be for both of the coefficients to come out positive.

YIELD, the average revenue per passenger kilometer can be achieved simply by selling tickets at high prices. After all, if even a few exceptionally expensive tickets are sold, the revenue for each of those passenger kilometers will be high. If this occurs, the general air traffic consumer will fly the carrier that's cheaper, sending profits down for our high yield carrier. However, its assumable that no reasonable profit desiring airline will do this, so a maximum profit should be achieved with a high yield, but only after a high load factor. Thus, YIELD should positively contribute to profits, but not as much as LOAD. In the suspected case that YIELD does not have a linear relationship with profit,  $YIELD^2$  is added to the model.

Its quite possible that these variables LOAD and YIELD and their squares are endogenous, being effected by market ticket prices, the state of the economy and other factors, thus not meriting ordinary least squares. To address this, three extra equations much like the one stated previously are estimated, one excluding YIELD, one excluding LOAD and one excluding both.

Though they seem to be the most endogenous, all other variables are effected by many things at all times. Fuel prices depend on political situations, availability, demand, contracts, hedging, decisions made by fuel vending bodies (OPEC, GCC) and an unlimited number of other factors. Maintenance costs depend on labor contracts, labor



supply, parts availability, fleet age regulations of aviation authorities and an unlimited number of other factors. All of these factors are a fractional determinant of the GDP and the economy's position in the business cycle, thus determining profitability of any firm and the amount of resources spent on variable costs and determining the number of aircraft or other inputs ordered for the next five years and boosting or causing the economy to decline again causing the continuation of an infinite cycle. Basically, it seems that the value of any variable in this model is determined by airlines' actions as well as any number of outside factors in the course of events, and that all variables and other factors constantly effect each other creating a flow like any other situation in the economy. However, it is believed that Yield and Load factor are definitely major factors in determining the profits of an airline, so the estimated equation in which they are included will be the center of the study.

UAPK is a measurement of aircraft use and therefore a measurement of the airlines service demand predictions. Airplanes are ordered for lease 1-5 years in advance of use, so naturally demand for air travel will be taken into account upon ordering. If demand is over predicted, this figure will be low as some airplanes may not be used for a period of low demand. LOAD or  $LOAD^2$  should take this into account, but as only airplanes in operation are calculated in the load factor, UAPK is introduced.

The result for ULABOR should prove to be interesting, as when more is paid per worker, profits will surely drop, however, economic theory states that wages and prices rise and fall together. This would mean it may be more expensive to fly with a Hong Kong or Japan based airline where prices and wages are high, high prices mean more revenue and profits for the airlines. However, this is only limited as wages are one of many costs to the airlines.

Labor being the first, UFUEL should be a major negative factor in airlines profits as it is the second most expensive necessity in running an airline. UMAIN should also be very negative, it is the third largest expenditure by airlines. URENT is no different. URENT can be especially dangerous because it is contracted, a rented plane sitting on the ground due to low demand for its use still must be paid for unlike a canceled landing slot or laid off labor. UFEE should have a negative coefficient but there is one possibility that could upset this. Airlines paying high fees per airport use slot are using airports that are

particularly busy and therefore must charge such high fees for slots. High airport traffic should mean higher load factors. A slot was defined here by the amount of available passenger kilometers to account for a airplane's size. Terminal and runway use fees will highly differ between a Horizon Airlines dash-8 and a United 747.

GDPCH is a variable introduced to address the relationship between the growth of the economy and profits of airlines, giving some consideration to the demand side discussed previously. W, X, Y, and Z are to examine the economy and its relation to air travel in 1998, 1999, 2000 and 2001 respectively. Major significance and a negative coefficient is expected on the variable Z due to major instances weakening the U.S. economy at the end of the 3<sup>rd</sup> quarter of 2001.

#### *Data*

Data was mainly collected as reported on airlines' annual reports and government transportation agencies, such as the Department of Transportation and the Bureau of Transportation statistics .

From the data (see Appendix II), we can clearly see why airlines have low profits by linking comparing costs to profits and linking to load factors. About 20 percent of the samples had negative profitability, this can be explained. From annual reports, it was found that the major costs of the airlines such as fuel, labor and maintenance tend to be from about one to five billion dollars per year where as the average profit was found to be only about 372 million dollars. This means that the amount incurred as one single operating cost to an airline can be up to ten times greater than profit. This is only one cost. Total costs are often up to 25 times greater than profit, given that there is a good load factor. If the load factor is not high enough, the revenue gained will not cover incurred costs.

For example, USAirways in 1999 made \$136million in profit. This seems like a reasonable amount looking only at this figure alone, but considering that their labor costs were \$3.3 billion and their fuel costs were \$727 million, the \$136 million is not very much. Fortunately, they filled just over 70% of their seats with paying customers, so their costs were barely covered. (USAirways annual report, 1999)

In an industry of such high demand, why should there be a problem achieving high load factors to produce revenue and cover costs? The answer comes in that there is too much competition, spreading the industry too thin. The average load factor is only about 70 percent. On the average operating flight, only seven of ten seats are filled with revenue generating passengers. With profit margins as thin as they are, the competition leading to these low load factors seem actually unhealthy for the industry's advancement and survival.

Some of the other individual data averages are more interesting than others. The average salary per worker at about 61 thousand dollars per year seems high but this is explained as almost all workers in the airline industry have high responsibility, highly specialize positions. Fuel, the second greatest cost to airlines is less expensive than that purchased for a automobile in the United States, probably due to the airlines purchase in bulk, reducing price. Maintenance and Rent fees seemed high, (the average plane costing well over 2 million dollars per year to rent and maintain); it's well understood that a passenger airplane is expensive to lease, and expensive to maintain.

### *Results*

The negative coefficient on LOAD was certainly unexpected, but probably caused by the U.S. 2001-airline samples who took low profits. This should show up in their load factor observations, but instead of operating flights with low loads and incurring the costs, to address weak demand at the end of 2001, airlines cancelled flights altogether. Although costs were incurred in renting unused planes, costs were reduced in other respects. The coefficient on LOAD<sup>2</sup> is certainly a more accurate measurement of the relationship and with a higher t-statistic.

YIELD had a high positive coefficient with a reasonable significance according to the t-statistic. A high yield means more revenue per passenger kilometer, but that "more" revenue must come from somewhere. Revenue in any business comes from prices of the service or product, and a high price producing a high yield lowers the quantity demanded, sending us back to our LOAD variable. A low LOAD would mean low profits, even though a carrier may have a high yield. On the other hand a low yield would bring about the assumption that we have lower prices. The airline industry is just that, a competitive

one dropping prices to a level of that of a perfectly competitive market. In a sense, this is what we are seeing in the airline industry. In 2001, ALL NIPPON AIRWAYS made U.S. \$346million in profits. This is not much, considering that the expenditures were almost four times that on fuel alone. (ANA annual report 2001) Given all of this, and hopefully a successful load factor, the airline that can fill seats and run a reasonable operation with a higher yield, or revenue per cost of each passenger flying will be profitable. Results from YIELD<sup>2</sup> weren't quite as clear as expected. An unexpected negative sign on a low t-statistic leads to believe that with a reasonable load factor, a higher yield will contribute to higher profits.

The coefficients estimated to address the possibility of YIELD and LOAD being endogenous variables produced the same signs and generally lower t-scores.

UAPK was as we expected, airlines with more available seat kilometers (ASK) per airplane (or renting less airplanes per ASK) showed to have higher profits. This is certain to have showed especially after 3<sup>rd</sup> quarter incidents of 2001, as American carriers stopped use of a percentage of their fleets upon immediate prediction of low demand.

UMAIN and UFEE both had the expected negative coefficients, as at a given revenue or load factor, a higher marginal cost will produce less profits. In a sense, our suspicion of UFEE being a bit offset by the demand for air travel and airport use that produced the high fees could have occurred as the coefficient on UFEE is smaller than those on UFUEL or UMAIN.

UFUEL had a particularly high negative coefficient. There are probable reasons for this. Fuel is kept in inventory and all fuel being paid for is often not used immediately, unlike labor which is not kept in inventory, but is laid off if unneeded. Another explanation is that maintenance costs, and labor costs may have a relationship to the ticket and service prices through the wage - price relationship, and cost incurred through fees may have a positive relationship to the demand for air travel, therefore load factor, at the airports charging the fees. Most airlines buy their fuel at the same places, and there isn't any relationship between fuel prices going back to load factor or service prices. Thus, if the fuel price is particularly high, airlines must bear that cost with no immediate benefits.

URENT had an unexpected positive coefficient with a high t-statistic. Its possible that the consumer base does have some interaction with this variable, as it is certainly understood by the public which aircraft are new and which are old. Newer planes, to rent which is more expensive than older ones, can attract consumers and investors and could raise load factor, and therefore profits.

GDPCH had a positive coefficient but with a low t-statistic showing in the model that a null hypothesis: [ $\beta_{11} = 0$ ] could not be rejected. The coefficients marking the relationship between 1998 and 2000 and profitability were positive with a possibly significant t-statistic. The coefficients for 1999 and 2001 were statistically insignificant. An individual test was run relating profits with the variable for 2001 upon suspicion of a highly significant low coefficient for the variable. This was found.

### *Profit Maximization*

If profit maximization is attributed to a certain yields and load factor levels due to the possibility that their relationship to profit is not linear, this can be found mathematically. By setting the derivative of the profit equation with respect to the variable that we are concerned about (yield and load factor) equal to zero, and solving for the variable we can find the profit maximizing value of the variable.

The equation from the model is:

$$PROFIT = C + \beta_1 LOAD_i + \beta_2 LOAD_i^2 + \beta_3 YIELD_i + \beta_4 YIELD_i^2 + \beta_5 UAPK_i + \beta_6 ULABOR_i + \beta_7 UFUEL_i + \beta_8 UMAIN_i + \beta_9 UFEE_i + \beta_{10} URENT_i + \beta_{11} GDPCH_i + \beta_{12} W_i + \beta_{13} X_i + \beta_{14} Y_i + \beta_{15} Z_i - ret(investment) + \varepsilon_i$$

Take the derivative with respect to yield equal to zero,

$$0 = C + \beta_3 + \beta_1 LOAD_i + \beta_2 LOAD_i^2 + 2\beta_4 YIELD_i + \beta_5 UAPK_i + \beta_6 ULABOR_i + \beta_7 UFUEL_i + \beta_8 UMAIN_i + \beta_9 UFEE_i + \beta_{10} URENT_i + \beta_{11} GDPCH_i + \beta_{12} W_i + \beta_{13} X_i + \beta_{14} Y_i + \beta_{15} Z_i - ret(investment) + \varepsilon_i$$

and solve for YIELD,

$$YIELD_{maxprofit} = - (C + \beta_3 + \beta_1 LOAD_i + \beta_2 LOAD_i^2 + \beta_5 UAPK_i + \beta_6 ULABOR_i + \beta_7 UFUEL_i - \beta_8 UMAIN_i + \beta_9 UFEE_i + \beta_{10} URENT_i + \beta_{11} GDPCH_i + \beta_{12} W_i + \beta_{13} X_i + \beta_{14} Y_i + \beta_{15} Z_i - ret(investment) + \varepsilon_i) / 2\beta_4$$

The same can be done to solve for profit maximizing load factors:

$$LOAD_{maxprofit} = -(C + \beta_1 + \beta_3 YIELD_i + \beta_4 YIELD_i^2 + \beta_5 UAPK_i + \beta_6 ULABOR_i + \beta_7 UFUEL_i + \beta_8 UMAIN_i + \beta_9 UFEE_i + \beta_{10} URENT_i + \beta_{11} GDPCH_i + \beta_{12} W_i + \beta_{13} X_i + \beta_{14} Y_i + \beta_{15} Z_i - ret(investment) - \varepsilon_i) / 2\beta_2$$

Contrary to what the first model predicted, yield is more likely to have a non-linear relationship with profit than load factor. A high yield is achieved by having higher ticket prices which reduce demand for service from a given carrier charging more for tickets. Lower demand causes less seats to be sold and lower profits. Load factor should positively contribute to profits until a haul becomes so long that fuel efficiency becomes an issue which can be lowered by a higher load factor. This will have a negative effect on profits as fuel is the second greatest cost to airlines.

## Methods 2

In the previous model, it was shown that load factor is certainly the major determinant of airlines profits. This is surely one of the major factors that managers, investors, economist and airline analysts investigate when analyzing an airline or the industry as a whole. Airlines as public corporations must publish these numbers in their reports to the public, and included are the load factor and breakeven load factor as well as all cost and revenue ratios. However, it is suspected that the published breakeven load factor of a given airline is not the actual load factor to be found by a study of profit determinants, including load factor.

Thus, we look at a single airline, Continental from 1993-2001 under the model,

$$PROFIT_{continental j} = C + \beta_1 OCSM_{continental j} + \beta_2 LOAD_{continental j} + \beta_3 YIELD_{continental j} + \varepsilon_{continental j}$$

where,

j	indexes the year
OCSM <sub>j</sub>	is the operating cost per available seat mile
LOAD <sub>j</sub>	is the average percentage of seats filled on operating flights
YIELD <sub>j</sub>	is the average revenue per seat mile
ε <sub>j</sub>	an error term

OCSM was used to account for all costs, as the airlines publish in reports to the public and to minimize any omitted variable problem. At any given load and cost, YIELD will be significant, thus, is was included. Squared Load and Yield were not used for simplicity and due to the possibility that unexpected negative signs were found in the original model due to outliers form 2001 airline models. Upon estimation, all variables were statistically significant with expected signs producing a R-squared high enough such that the equation:

$$PROFIT_i = -5248.211 - 5.72OCSM_i + 82.428LOAD_i + 401.118YIELD_i + e_i$$

(1.59)                      (22.58)                      (80.4)

can be manipulated and used for our study.

Though this method, we set profit equal to zero and use our coefficients with a given year to find the breakeven load factor for that year. Using the data for the year 1998 we obtain:

$$0 = -5248.211 - 5.72(889) + 82.428LOAD_{1998} + 401.118(12.78) + e_i$$

the published breakeven load factor for that year was 61.6%, however, when we solve for LOAD<sub>1998</sub> with PROFIT = 0, we obtain a breakeven load factor of 60.41%. Is it possible that Continental in 1998 was accounting for costs that didn't exist? Perhaps another example would help.

In looking at 1997 data we obtain,

$$0 = -5248.211 - 5.72(907) + 82.428LOAD_{1997} + 401.118(12.96) + e_i$$

The published breakeven load factor for Continental in 1997 was 60% however, but in our equation, we find that  $LOAD_{1997} = 60.73\%$ . A difference of .73 seems small, but according to our equation a difference of .73% would make a \$60.17 million dollar difference in profit, as profits are reported in millions of dollars.

In looking at Delta airlines, and their published data from 2001-1991, we can form the estimate,

$$PROFIT_i = -13153.84 - 13.5407OCSM_i + 210.6822LOAD_i +$$

(2.15)                      (25.88)

$$903.3059YIELD_i + e_i$$

(315.14)

To find the breakeven load factor for delta according to their operations during these years, we form the model,

$$BREAK_{delta j} = (13153.84 + 13.54017OCSM_i - 903.8059 YIELD_i) / 210.6822$$

and for Continental,

$$BREAK_{continental j} = (5248.211 + 5.72029OCSM_i - 401.1182 YIELD_i) / 82.42$$

or for any airline,

$$BREAK_{airline j} = (C + \beta_1 OCSM_{airline j} - \beta_3 YIELD_{airline j}) / \beta_2$$

We can then compare the published breakeven load factors with the ones from our model.

In Continental's case, a one percent change in load factor is a change of \$82.42 million in profit. A one percent change in Delta's load factor is a difference of \$210.68



million in profit. The greater effect of load factor in Delta's profit taking is because Delta by far a bigger airline.

Year	<u>Continental</u>		<u>Delta</u>	
	Model	Published	Model	Published
2001	69.72	74.9	75.1	77.31
2000	66.61	67.6	65.67	65.29
1999	65.41	66.4	65.35	65.37
1998	60.41	61.6	63.29	62.94
1997	60.73	60	63.20	62.78
1996	60.79	60.7	66.33	66.91
1995	60.81	60.8	60.25	59.43
1994	62.54	62.9	67.19	67.51
1993	63.26	63.3	61.6	63.14
1992	-	-	66.07	66.13
1991	-	-	62.05	62.03

It can be seen from the model's results, that generally, both airlines publish their break even load factors too high. This could mean that they are either overestimating costs, or underestimating ticket prices or yield.

## CONCLUSION

The airline industry is one necessary for world business, industry, relations and infrastructure. No where more so than in the U.S. a nation too vast for rail service or highways to compete with airlines in the same markets. However, deregulation has opened the doors for anyone with the capital to enter as a competitor, often lowering market price and jeopardizing incumbent carriers revenues and profits and their incentives for providing a much needed part of our infrastructure. Thus, our purpose was to examine profits and their determinants that keep these carriers in service, providing infrastructure to the U.S. and the world.

We found that in both initial models, load factor was the major determinant of airline profitability. A one percent change in the average load on operating flights can make a difference of tens or even hundreds of millions of dollars in profit. We also found that not accounting costs, but unit costs are the determinants of the cost function and therefore profit. Fuel was particularly important as it has does not have the macroeconomic wage and price relationship that some of the other cost variable had, it often is stored in inventories after incurring costs and it is the airlines' second greatest cost. Finally, like any firm in a marketplace, it was shown historically that airlines benefit from an expanding economy.

### *Model Limitations*

More than anything, this model suffers from the omitted variable problem. While there is no way to capture all variables that determine the profitability of airlines, we have taken the theory to create a model of airlines' major profit determinants. Upon the capturing of the relationship between airlines major profit determinants, the regression offers coefficients that show a trend, but exact numbers will vary due to outside forces often beyond the airlines' control. Most airline tickets are sold through travel agencies who related the buyers and sellers in the market for air travel. With ticket prices that can change thousands of times per day, it is often a matter of timing between fare movements and purchase times deciding which airline will make the sale, be it an incumbent firm or a new entry.

Upon expectations of questioning the non-existence of market share in the model an explanation can be offered. In studies it has been reputedly found that market share has a positive relationship with profit. However, most of the industries analyzed were more fundamental with a much broader consumer base including almost everyone, such as common household utilities. Market share in these industries is certainly positive, as everyone is consuming these services nearly 24 hours a day, not dependent on the GDP or disposable income. The airline industry is so vulnerable that market share can be an investment that doesn't pay off. High market share means a carrier has the means to provide the product being consumed, and these means such as fuel, airplanes and human resources cannot be saved, as they are either expensive or constantly incurring costs (rent,

salaries) or be stored like electricity or water. Thus these are an investment that can very well create losses if not demanded for even the shortest of periods. The relationship between market share and profits in this industry must take into account the airlines' investment into the market, by comparing market share, or customers served with the airlines inputs or costs. This is addressed by LOAD and UAPK.

This model is an example establishing a relationship between airlines profit and its determinants. Those who have directly any relationship in the actions that produce the outcome of an airline's operations must take any factor of this outcome into consideration to ensure the well being of this critical portion of our infrastructure. While rising demand in the future in part does just this, it also insures that under continuing free entry and exit in and out of the market for air travel, firms will continue to do so, eliminating stability and profits necessary to accompany necessary technological and efficiency advancement.

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website: <http://www.usair.com/>

Willams, George. The Airline Industry and the Impact of Deregulation, Brookfield, Vermont: Ashgate, 1993

## Data Appendix I

**Table 1: Methods**

R-squared: 0.71  
Adjusted R-squared: 0.58  
Included observations: 44

<u>Variable</u>	<u>Coefficient</u>	<u>Std. Error</u>	<u>t-statistic</u>
C	49152751	38403329	1.279909
LOAD	-1683615	1064263	-1.581954
LOADSQ	12703.95	7515.286	1.690415
YIELD	2093113	1776179	1.178436
YIELDSQ	-88921.09	97773.68	-0.909458
ULABOR	-39.19484	17.28674	-2.267335
UFUEL	-11129.93	15594.33	-0.713716
UMAIN	-1131.541	385.1876	-2.937635
URENT	676.9058	282.2583	2.398179
UFEE	-1072.292	493.6513	-2.172166
GDPCH	129110	272355.4	0.47405
W	563433.6	403648.3	1.395853
X	279991.7	388612.9	0.72049
Y	548036.3	474405.7	1.155206
Z	345634.1	998617.2	0.346113

*individual "z" regression:*

Z	-1890407	320017.8	-5.907193
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**Table 2: Exclude Yield**

R-squared: 0.64  
Adjusted R-squared: 0.48  
Included observations: 44

C	43152270	42460443	1.016293
LOAD	-1221938	1205373	-1.013743
LOADSQ	9232.343	8457.472	1.09162
UAPK	-468.8147	1638.484	-0.286127
ULABOR	-7.704352	15.1957	-0.507009
UFUEL	-28411.09	15344.58	-1.851539
UMAIN	-1204.663	424.031	-2.840977
UFEE	-390.1593	513.5486	-0.759732
URENT	770.2218	311.8723	2.469671
GDPCH	209057.3	301241.6	0.693986
W	228654.8	424253.1	0.538958
X	64685.13	404704.3	0.159833
Y	640618.9	516906.6	1.239332
Z	-434673.5	1062772	-0.409

**Table 3: Exclude Load**

R-squared: 0.63  
Adjusted R-squared: 0.47  
Included observations: 44

<u>Variable</u>	<u>Coefficient</u>	<u>Std. Error</u>	<u>t-statistic</u>
C	-3148552	8804420	-0.35761
YIELD	1023167	1977010	0.517533
YIELDSQ	-37697.05	109796.3	-0.343336
UAPK	812.2761	1527.666	0.531711
ULABOR	-23.47781	18.72762	-1.253646
UFUEL	-10547.67	17162.18	-0.614588
UMAIN	-800.6242	387.0793	-2.068373
UFEE	-691.2409	581.0375	-1.189667
URENT	480.1178	283.2372	1.695109
GDPCH	192052.8	306407.4	0.626789
W	515880.9	457054.7	1.128707
X	391701.4	427831.2	0.915551
Y	793094.3	520328.2	1.524219
Z	-46468.45	1124190	-0.041335

**Table 4: Excluded Yield and Load**

R-squared: 0.59  
Adjusted R-squared: 0.45  
Included observations: 44

C	1693034	1515420	1.117204
UAPK	299.432	1485.04	0.201632
ULABOR	-3.355365	14.71732	-0.227987
UFUEL	-22827.21	15361	-1.48605
UMAIN	-915.3887	385.6144	-2.373845
UFEE	-256.0085	528.6504	-0.484268
URENT	586.6312	280.0534	2.094712
GDPCH	238350.4	309217.8	0.770817
W	288223.4	439246.4	0.656177
X	229438.8	407727.5	0.562726
Y	795318.5	518444.4	1.534048
Z	-543559.9	1100570	-0.49389

**Table 5: Continental**

R-squared: 0.932  
Adjusted R-squared: 0.891

OCSM	-5.720298	1.591985	-3.593187
LOAD	82.42859	22.58856	3.649129
YIELD	401.1182	80.4059	4.988666

**Table 6: Delta**

R-squared: 0.939  
Adjusted R-squared: 0.913  
Included observations: 11

<u>Variable</u>	<u>Coefficient</u>	<u>Std. Error</u>	<u>t-statistic</u>
OCSM	-13.54017	2.157287	-6.276842
LOAD	210.6822	25.88375	8.139555
YIELD	903.3059	315.1444	2.866324

## **Data Appendix II**

**Table 7: Data Summary**

*Profit Model*

<u>Variable</u>	<u>mean</u>	<u>high</u>	<u>low</u>
PROFIT (millions)	371.97	1870	-3771
LOAD (%)	70.4	78.9	62.1
YIELD (cnts)	7.94	10.68	6.36
UAPK (millions km)	333.25	551.3	46.4
ULABOR (\$/worker)	61167.11	88190.08	43203.36
UFUEL (cnts/gal.)	64.31	95	45.9
UMAIN (000's)	1232.54	1872.46	345.07
UFEE (\$)	1329.4	1955.43	467.76
URENT (000's)	1312.58	2565.34	549.45
GDPCH (%)	3.5	4.3	1.2

*Continental*

PROFIT	433	729	-11
LOAD (%)	69.2	74.5	63.2
YIELD (cnts)	7.79	8.25	7.0625
OCSM (cnts)	5.48	5.9875	4.9125

*Delta*

PROFIT	539.27	1803	-1602
LOAD (%)	67.66	72.9	60.3
YIELD (cnts)	8.29	8.69375	7.9625
OCSM (cnts/km)	5.78	6.54375	5.3625