The University of Texas at Dallas
School of Management

Demand and Revenue Management
Metin Cakanyildirim
Associate Professor

Adolfo Echeverria
Vanessa Leon

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Objective

The purpose of this report is to analyze the revenue management applications in the airline industry. We will first list key revenue management decisions, as well as important issues and constraints regarding those decisions. Then we will explore the characteristics of air travel demand, its drivers and trends. Our analysis will give special attention to the demand-price relationship. For this purpose, we will track pricing trends on six American Airlines flights over a month. We have selected three destinations with medium to large capacity airports; two on each destination. The destinations chosen are Miami, New York and San Francisco.

The analysis will entail observation of the data behavior and of correlation between flights on adjacent airports and among all airports. Based on these findings, we will formulate hypotheses regarding the factors that affect the demand-price relationship as possible further research topics. Finally, we will tie our results with a discussion of pricing in the airline industry, and hurdles to price optimization.
Introduction
Air travel has altered the way we live and conduct business by shortening travel time and altering our concept of distance, making it possible for us to visit places once considered remote. Despite its ups and downs, air travel remains a large and growing industry. It facilitates economic growth, world trade, international investment and tourism; therefore, it is central to the globalization taking place in many other industries. See Figure 2

Between 1938 and 1978, the air transportation system was managed by the government. The Civil Aeronautics Board (CAB) controlled entry, exit, pricing of airline services, and methods of competition, as well as inter-carrier agreements, mergers, and consumer issues [1]. This regulatory structure was deemed ineffective, at a time when the worldwide rise in oil prices made transportation efficiency a national concern, and economic analyses emphasized the potential gains from deregulation. The Airline Deregulation Act partially shifted control over air travel from the political to the market sphere. The main purpose of the act was to remove government control over fares, routes and market entry of new airlines from commercial aviation. As a result, competition intensified, passenger volume soared, and prices fell.

Airline pricing practices changed dramatically after deregulation. Carriers were now free to set prices in a manner more consistent with consumers’ preferences for air travel and their sensitivity to prices and restrictions. Revenue management then emerged in the US airline industry as an attempt to maximize profits by selling the right seats to the right customer at the right time for the right price [2]. This concept has been successfully implemented not only in the transportation sector, but also in other industries like hospitality, car rental, and electricity generation.

American Airlines is a major airline in the US, and the world’s largest in passenger miles transported. Founded in 1934, it is the principal subsidiary of AMR Corporation. By the end of 2008, American provided scheduled jet service to approximately 150 destinations throughout North America, the Caribbean, Latin America, Europe and Asia [3]. American Airlines is headquartered locally, in Dallas/Fort Worth.

Historically, American Airlines has pioneered several policies that have ultimately affected the industry’s basic structure and standard practices. In the late 1960s, American introduced the first computerized airline reservation system, SABRE, a major innovation in information systems that revolutionized marketing and distribution in the travel industry. The airline then began developing the concepts of revenue management, laying the foundation for what would evolve into a highly sophisticated automated system for managing flight reservations. In 1977 American introduced “Super Saver” fares, the first program of deep discounts offered to leisure travelers. Finally, in 1981 the airlines launched the first frequent flyer program, which became very successful in encouraging brand loyalty to an airline by offering a bonus to customers for accumulating miles on its system.
Key revenue management decisions in the airline industry

Revenue management is only applicable to industries where there is a fixed amount of perishable resources available for sale, and where different customers are willing to pay a different price for those resources. In the airline industry, capacity is regarded as fixed because there is a limited amount of seats in a plane, and changing what aircraft flies a certain service based on the demand is extremely uncommon. Resources are said to be perishable because after a time limit has passed, they stop being valuable. In other words, when the aircraft departs, the unsold seats cannot generate any revenue. Finally, since willingness to pay varies across different markets (business versus leisure travelers, for example) fare classes are created to allow passengers to pay different prices for the same seat according to their needs. For instance, a price-sensitive customer will be willing to accept some restrictions (advance purchase requirements, cancellation penalties, minimum stay conditions and schedule limitations) in order to receive a discounted fare.

Yield management is especially relevant in the airline industry because fixed costs are relatively high compared to the variable costs. The less variable cost there is, the more the additional revenue earned will contribute to the overall profit. Therefore, an important revenue management decision is figuring out how many seats to sell in each class on every flight. This is known as setting booking limits, and these are adjusted as time goes on. For instance, if the system sets a limit and then sees that a flight is booking faster than predicted, it will decrease the lower class booking limit because demand is higher than expected. On the other hand, if the flight is selling slowly the system may open up more cheap seats to stimulate demand so that no seats remain unsold. However, in order to maximize revenues it is very important to optimize resource utilization by ensuring inventory availability to customers with the highest expected net revenue contribution and extracting the greatest level of ‘willingness to pay’ from the entire customer base. For this purpose, airlines keep a specific number of seats in reserve to cater to the probable demand for high-fare seats [4].

For an airline, revenue management entails establishing overbooking policy, allocating discount fares, and managing traffic (demand). Overbooking means deliberately selling more seats on a flight than those that are actually available. This policy aims to compensate for passenger cancellations and no-shows, which averages about 50% of all flight reservations. Even on sold-out flights, it is estimated that 15% of seats would be unfilled in the absence of overbooking. However, this policy has the risk of incurring a cost. If the number of passengers that show up exceeds the flight capacity, the airline has to re-route and compensate the inconvenienced passengers. Hence, for each flight, it is necessary to set the level of overbooking so that the expected revenue gained from filling an additional seat is balanced against the expected cost of overbooking.

Overbooking alone is not enough to achieve revenue management goals because the process is complicated by the multiple fare classes and discounts offered in the flight. If a passenger inquires about the availability a discounted fare in a particular flight, the airline has to weigh the odds of selling an additional full fare seat later versus the certainty of selling the discount fare now. Since the probabilities affecting these tradeoffs shift as the time of the flight approaches, the calculations have to be
continually updated. Therefore, a discount allocation process needs to be set in place in order to
determine the number of discount fares offered for a given flight.

Airlines operate in a hub and spoke system. This means that passengers from flights coming from
various origins on spokes of a network are routed through an intermediate location (a hub) to change
planes and be delivered to their final destination. This practice is advantageous to both airlines and
passengers, because it allows airlines to service more locations with fewer planes, and passengers get
better services by being routed to less heavily occupied markets. Because of the hub and spoke system,
any flight could potentially include passengers from many destinations and who paid many different
fares. If revenues were to be maximized across the entire network of flights, then the imposition of
controls for reservations for any single flight had to take into account passenger demand on connecting
flights. Traffic management is the process of controlling reservations by passenger destination and origin
in order to provide the mix of markets (single flight versus multiple connecting flights) that maximizes
profits.

The operation of a revenue management system in the airline industry is then a very complicated
process that requires a massive database stored in a powerful computer system that needs to support a
variety of complex models and optimization methods.
Demand drivers and trends
There are many variables that influence the potential sales of airline seats and cargo capacity. Of all these factors, price has received the most attention since deregulation. The law of demand tells us that as price increases, the corresponding quantity demanded falls, and as prices increase demand falls. This makes sense, as people ordinarily will fly more at lower prices than at higher prices, but that is only assuming that all other factors remain equal. We will discuss the demand-price relationship in more depth in the next section, but for now we will review those demand drivers that are not related to price. The major nonprice determinants of demand in the airline industry are:

Preferences of passengers.
These are all real or perceived differences that relate to a passenger’s inclination for one airline over another. A change in passenger preferences favorable to an airline, possibly resulting from advertising, will mean that more tickets will be demanded at each price over a particular time period. Alternatively, an unfavorable change will cause demand to decrease. Preferences can include an airline’s image, perceived safety record, on-time reliability, serviced provided by the airline, type of aircraft flown, and frequency of departure. The latter variable in particular rates very high among customers because it adds flexibility to their travel plans.

Number of passengers.
Improvements in flight connections or population growth will increase the number of passengers in a market, which will result in an increase in demand. Conversely, fewer potential passengers will be reflected by a decrease in demand.

Financial status and income level of passengers.
This non-price determinant relates to the state of the economy, and hence the level of profits in businesses and passengers’ personal income. Air transportation is very sensitive to fluctuations in the economy. During a recession, when there is higher than normal underemployment and decreased factory orders, both business and pleasure travelers will be flying less. Figure 1 shows a 4% drop overall in outbound trips by Americans in 2008, attributable to the weakening dollar and the deepening financial problems caused by the credit crunch. On the other hand, when the economy is booming, businesspeople travel extensively and workers are not hesitant to make air travel plans [5].
Availability of substitutes.
In aviation transport, multiple levels of substitution can be distinguished. First, different carriers compete with each other on the same route. If a competitor raises its price, all other things being equal, you will prompt passengers to switch to your airline, and the reverse is also true. In the case of homogeneous transport services, the level of competition is higher, which implies higher price sensitivity of demand. On the other hand, when services of different quality are offered, demand will be more rigid. Next, if alternative transport modes that provide similar qualities are available in a given market segments, they can also be considered as substitutes. Geographic characteristics such as seas and mountain ranges and flight distance of a trip affect the possibilities of substitution. Finally, destinations with similar characteristics can be substitutes for each other. If a passenger finds substitute location that has higher utility for the price requested, he or she might change the travel destination [6].

Prices of complementary goods.
There are expenses related to air travel that could affect the decision to travel altogether. For example, if the prices of lodging and car rental rise considerably, a price-sensitive leisure traveler might decide to reschedule the trip.
**Passengers’ expectations with respect to future prices.**

If passengers believe the prices of plane tickets will rise, that may prompt them to buy now. Conversely, expectations of falling prices will tend to decrease the current demand for tickets.

**Safety Concerns**

Safety concerns such as terror threat can severely decrease the demand for air travel. After the 9/11 attacks, for example, airlines lost billions because significant numbers of travelers were afraid for months, opting instead to use other means of transportation or to just stay home. Figure 3 illustrates how both inbound and outbound travel in the US shows a consistent increase in numbers until 2001, where inbound travelers decreased by about 9% from 2000, and outbound travelers decreased by 3%. The number of travelers in both areas continues to decline until 2004. Figure 3 shows how major airlines in the US were affected in several performance metrics during the month of the attack.

![Inbound and Outbound US Travel](image)

*Figure 2 Inbound and Outbound US travel*
While demand changes in air travel can be attributed to the aforementioned factors, there are also noticeable trends in the industry. Demand typically varies by season, day of the week, and time of the day. These trends reflect the differential requirements of the two basic segments of the airlines’ customer base: leisure and business travelers. Leisure travel tends to be discretionary, highly seasonal, peaking at holiday and vacation periods, but adaptable with respect to the day and time of departure. In contrast, business travel tends to be of shorter duration, less seasonal, and less flexible in terms of accommodating to weekday and hourly scheduling options. Accordingly, the demand leisure travel tends to be more price-sensitive than for business travel.
Pricing
The airline industry makes use of dynamic pricing in order to maximize profit. Dynamic pricing is a set of techniques used to maximize profit while at the same time allow for the proper allocation of reservation seats for lower paying customers.

Many airlines practice dynamic pricing by opening and closing different fare classes on their flights. For example, on a busy flying day like Saturdays and Sundays prices will increase, and prices will drop on slow demand days like Tuesday through Thursday [1].

American Airlines successfully used dynamic pricing back in 1985 against the threat imposed by People Express. People Express would offer a no-frills service at discounts down to 70% of AA. American Airlines response was to create a Super Saver fare with the condition that customers would book two weeks in advance. These created a self-imposed discrimination from the customer, and prevented customer complaints for different prices for the same seat. We researched this two-week “rule”, and will present results later. In addition to the Super Saver fare, AA also reserved some seats for the passengers that would book within two weeks of departure. This allowed capturing both the price sensitive customers and the high-paying ones [4].

Dynamic pricing makes very difficult (or impossible) to define a reference price. One day or one flight before or after can have a difference of hundreds of dollars for the same destination. This can be easily proved by looking at the website of AA, and shopping for price and schedule: a price matrix will show up will prices days before and days after, as shown in Figure 4. On the example below, the Monday flight is the expensive one at $366, whereas the cheapest flight at $166 happens in a Sunday. It is our deduction that weekend travel represents a disincentive for business people who prefer to fly on business days.

Southwest Airlines has a similar price and schedule matrix. Figure 5 shows an example of same day price variation from $137 to $298. This represents price difference of $161, which is more than the lowest price for the same flight at a different time. This pricing would be advantageous for a person returning home to Fort Lauderdale; however, for a non -resident this would represent an extra night stay at a hotel. Perhaps this is a self-imposed barrier that compensates for the lower price.

The two examples below only show how a price-conscious customer may also use this dynamic pricing information to better schedule flights depending on day and time of the day.
Figure 4 Price and schedule matrix for American Airlines

Figure 5 Price and schedule matrix for Southwest Airlines
Pricing Drivers

Four price drivers have been identified, competition being one of them. It is worth noting that SWA has been the major price driver in terms of competition for any airline when it enters a specific market.

Competition – The Southwest Effect

Competition among airlines was traditionally a pricing driver. One airline would set a low price, and the rest would follow suit with the consequence of price wars [8]. One special case about pricing in the airline industry is Southwest Airlines. SWA business model discards the typical hub and spoke system of service – where most flights concentrate along spokes, concentrated to the hub at the center -. Instead, SWA specializes in dense, short-hauls markets where it can provide frequent service. As a consequence, it is not uncommon for a long-distance traveler to make or two stops along the way to the final destination if the destination involves a long distance flight.

SWA has been one of the largest competition price drivers for almost every airline it competes with. The term “Southwest Effect” has been used in the industry since 1993 to describe the increase in travel to a particular location when SWA enters the market [9]. SWA entry into a new market makes the competitors lower their prices, thus changing their pricing model.

Oil Prices

Rising oil prices in 2008 had a profound effect in the way airlines set their prices and allocated their costs. One dramatic case of the effects of this was Aloha Airlines, ATA, and Skybus Airlines all closing their doors and ceasing operations within a seven day window. These combined actions left 4,450 people jobless [10].

Again, Southwest Airlines was the exception to the rule. During Q1 2008, SWA paid $1.98 per gallon of fuel, when AA paid $2.73 and United paid $2.83 in the same period using hedging. Hedging is a financial strategy where airlines protect themselves by locking prices at a certain rate. If prices increase above the lock price, they gain. If the prices drop below the set price, the airline can either go for the lower price [11].

After the events of September 11, 2001, air travel dropped significantly thus causing most of the airlines to operate at a loss. This caused banks and traders to question the credit worthiness of many airlines, and causing airlines not to be able to hedge. The exception here was southwest with its high-productivity, low-costs model. They were the only major carrier with enough credit-worthiness to be allowed to hedge. It has been calculated that since 1999 hedging has saved Southwest $3.5 billion. In Q1’08 hedging gains of $291 million dwarfed its $34 million profit.
Labor
Employee-related expenses such as salary and pensions are the highest cost factor for any airline — accounting for a third of costs. The relationship is not very straightforward. For example, in 2005 SWA has the highest paid pilots per hour than any legacy airline (~$190 vs. ~$160 for AA); a senior flight attendant can make upwards of $100,000 versus United’s $50,000. Southwest also has a profit sharing plan. Yet, despite all these, SWA is more profitable than any other major carrier.

Even though it is claimed that labor is a price driver, this seems to hold mainly for legacy carriers. Apparently budget airlines have been able to keep good control on their labor costs. At least they do not seem to have the burdens of old-fashioned pension plans. [12].

Market Segmentation
For pricing purposes we can segment the airlines into traditional (AA, Delta, Continental, etc.) low-budget (Southwest).

Low-budget airlines have a well defined target market which is the budget conscious travel. They typically sell no-frills seats, no classes and no advance boarding. This guarantees the shortest time on ground, and the highest time on the air moving passengers.

Traditional airlines go after two types of customers: the profitable, last-minute or business oriented traveler, and the budget traveler [13]. These traditional – or legacy – carriers have to struggle competing with the low-budget airlines for customers that will cover costs. They also compete with other legacy airlines for high-end customers who will provide profits.
**Research Model**

For our research we checked the prices for departing flights from DFW to a total of three locations [10, 11, 12, 13, 14], with two adjacent airports in each location. The raw data may be found in appendix A.

The controlled variables under consideration were:

1. Destination → New York area, San Francisco area, Miami area
2. Time of the day → Around noon
3. Day of the week → Wednesday
4. Availability of direct flights → All flights were non-stop

The airports chosen for this research were:

- NY LaGuardia airport (LGA)
- NY JFK airport (JFK)
- San Francisco airport (SFO)
- San Jose airport (SJC)
- Miami International airport (MIA)
- Fort Lauderdale airport (FLL)

For comparison purposes, the distance between each airport, and the driving time among them was investigated and recorded as shown in Table 1. Given the short distance between paired airports, we will analyze the effect of this variable on the prices.

<table>
<thead>
<tr>
<th>Airports</th>
<th>Distance</th>
<th>Approximate driving time</th>
</tr>
</thead>
<tbody>
<tr>
<td>NY LaGuardia airport (LGA) to NY JFK airport (JFK)</td>
<td>11 mi</td>
<td>16 min.</td>
</tr>
<tr>
<td>San Francisco airport (SFO) to San Jose airport (SJC)</td>
<td>33 mi</td>
<td>34 min.</td>
</tr>
<tr>
<td>Miami International airport (MIA) to Fort Lauderdale airport (FLL)</td>
<td>26 mi</td>
<td>36 min.</td>
</tr>
</tbody>
</table>

*Table 1* Driving distance among adjacent airports

The maps containing the routes were obtained from yahoo travel, and are shown in Appendix B.

The flights researched and their corresponding flight times are shown in Table 2.

<table>
<thead>
<tr>
<th>Destination</th>
<th>Flight #</th>
<th>Departure</th>
<th>Depart time</th>
<th>Flight time</th>
</tr>
</thead>
<tbody>
<tr>
<td>JFK</td>
<td>AA 172</td>
<td>Nov 11, 2009</td>
<td>11:30 AM</td>
<td>3 hrs, 30 min</td>
</tr>
<tr>
<td>LGA</td>
<td>AA 728</td>
<td>Nov 11, 2009</td>
<td>11:50 AM</td>
<td>3 hrs, 30 min</td>
</tr>
<tr>
<td>MIA</td>
<td>AA 1208</td>
<td>Nov 11, 2009</td>
<td>11:25 AM</td>
<td>2 hrs, 45 min</td>
</tr>
<tr>
<td>FLL</td>
<td>AA 1494</td>
<td>Nov 11, 2009</td>
<td>11:35 AM</td>
<td>2 hrs, 40 min</td>
</tr>
<tr>
<td>SJC</td>
<td>AA 1861</td>
<td>Nov 11, 2009</td>
<td>12:45 PM</td>
<td>3 hrs, 30 min</td>
</tr>
<tr>
<td>SFO</td>
<td>AA 1441</td>
<td>Nov 11, 2009</td>
<td>12:00 PM</td>
<td>3 hrs, 40 min</td>
</tr>
</tbody>
</table>

*Table 2* Flights researched
In addition to these flights, we also started recording flight activity from equivalent departing flights from Southwest Airlines (in terms of day and time). We tried to see if there was any correlation. The Southwest Airlines flights are shown in Table 3.

<table>
<thead>
<tr>
<th>Destination</th>
<th>Flight #</th>
<th>Departure</th>
<th>Depart time</th>
<th>Flight time</th>
</tr>
</thead>
<tbody>
<tr>
<td>LGA</td>
<td>SW 3090/230</td>
<td>Nov 11, 2009</td>
<td>11:50 AM</td>
<td>8 hrs, 30 min (MDW)</td>
</tr>
<tr>
<td>FLL</td>
<td>SW 2154/1511</td>
<td>Nov 11, 2009</td>
<td>12:50 PM</td>
<td>4 hrs, 35 min (AUS)</td>
</tr>
<tr>
<td>SFO</td>
<td>SW 16/2914</td>
<td>Nov 11, 2009</td>
<td>11:25 AM</td>
<td>7 hrs, 25 min (LAX)</td>
</tr>
</tbody>
</table>

Table 3 Southwest Airlines flights used for correlation

Summary of results

The Table 4 indicates the start prices, the departure-day prices and their price variation. The San Francisco flights are the ones that increased prices the most, whereas the New York prices stayed almost the same.

<table>
<thead>
<tr>
<th>Destination</th>
<th>Start Price</th>
<th>Departure Price</th>
<th>Price Δ</th>
<th>% Price Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>JFK</td>
<td>$929.6</td>
<td>$937.6</td>
<td>$8.0</td>
<td>1%</td>
</tr>
<tr>
<td>LGA</td>
<td>$929.6</td>
<td>$937.6</td>
<td>$8.0</td>
<td>1%</td>
</tr>
<tr>
<td>MIA</td>
<td>$258.6</td>
<td>$970.6</td>
<td>$712.0</td>
<td>275%</td>
</tr>
<tr>
<td>FLL</td>
<td>$169.6</td>
<td>$366.6</td>
<td>$197.0</td>
<td>116%</td>
</tr>
<tr>
<td>SJC</td>
<td>$209.6</td>
<td>$870.6</td>
<td>$661</td>
<td>315%</td>
</tr>
<tr>
<td>SFO</td>
<td>$203.6</td>
<td>$880.6</td>
<td>$677</td>
<td>333%</td>
</tr>
</tbody>
</table>

Table 4 Prices for researched flights

A total of six cases were analyzed:

- Leg 1 – Dallas to New York
- Leg 2 – Dallas to San Francisco
- Leg 3 – Dallas to Miami
- Observation 4 – The two-week myth
- Observation 5 – The Southwest Effect
- Observation 6 – Effects of residual capacity
Leg 1 – Dallas to New York
For this case, the prices between DFW-LGA and DFW-JFK are exactly the same, as shown in Figure 6. The figure only shows one trace, but in reality they are super imposed since they are exactly the same.

We found a perfect correlation (Correl = 1) between the prices of both. This can be explained by the distance among both airports. There are only 11 miles between them, so for the average traveler this distance may not be a factor. Basically we believe that for pricing purposes LaGuardia and JFK can be considered one single destination. Based on this particular analysis, one could expect that the distance between paired airports is a guaranteed factor for prices to remain equal. We will explore this variable in cases 2 & 3.

The only thing worth noting among these prices is that during three consecutive days both destinations dipped in price from $929.60 on October 19, to $159.60 on October 21 thru 23. Then the price went back up to $934.60. This price movement represented a ~83% price variation. We were not able to explain this behavior with the limited data at hand. The only thing we can say is that a price-conscious consumer might as well check these two airports with the anticipation that there will be a sudden price change like that. Perhaps AA’s NetSaver promotion had something to do with it.

![Price Tracking for New York Area Flights](image)

**Figure 6 Price tracking for New York area flights**
**Leg 2 – Dallas to Miami**

This is the flight where we found the most discrepancies in terms of correlation and pricing, as shown in Figure 7. The correlation found between both flights was 0.63. This means that the correlation being positive, the prices increase and decrease more or less uniformly. However, the low correlation number seems to indicate that there is no tracking between these two prices.

The departure price to MIA was $970.60, and to FLL 366.60. There is a 33 mile distance between both airports, and for the price sensitive customer FLL could be a good option. However, one factor that favors travel to MIA is that it is a hub for travel to Latin American countries. MIA is also closer to more tourist attractions, such as the Florida Keys, which provides a convenience incentive.

Another factor affecting the FLL price may be the Southwest Effect explained in case 4.

![Price Tracking for Miami Area Flights](image)

*Figure 7 Price Tracking for Miami area airports*
Leg 3 – Dallas to San Francisco

Figure 8 the Dallas to San Francisco case, we calculated a correlation between prices of 0.82. This correlation tends to indicate that the prices followed each other somewhat.

It is interesting to note that even though the price difference between both flights changed towards the end of the observation period, the departing price had a $10 difference among flights (To SJC $870.60; to SFO $880.60) as shown in Figure 8. With the available data we can theorize that the prices in these two flights are dependent on each other. A possible explanation may be the 34-minute driving distance, and the fact that both airports may be equally busy in terms of business travel (SFO – San Francisco; SJC – Silicon Valley).

![Price Tracking for San Francisco Area Flights](image)

*Figure 8* Price tracking for San Francisco area flights
**Observation 1 – The two-week myth.**

We also investigated the urban legend of the two-week pricing period. It is said that price conscious travelers should buy tickets at least two weeks before departure in order to secure low prices. For this case we discarded the New York flights since they provided zero value (prices are maintained constant throughout the observation period).

For the San Francisco flights we found some price variation from October 28 to October 29 (two weeks before). On October 28 the ticket price was approx 72% below final price, and in October 29 ~66% below final price. This represents an approximate 6% change in prices which could be attributed to the two-week rule. However, it was also found that one week before departure (November 5), prices increased to the final departure price for SJC, but it took three more days for SFO to get the departure price. For the San Francisco case we cannot say that there is such thing as a two-week rule. This is shown in Figure 9.

![San Francisco Price Change Chart](image)

**Figure 9 Percentage change with respect to final price – San Francisco**

For the Miami flights we found a dramatic price change more than three weeks before departure.
For the Miami prices we found that, two weeks before departure the MIA flight had already reached its departure price. Around a week before departure FLL spiked in price to 90% above its departure price, but this lasted only three days, after which it went down to its final price. Three weeks before departure MIA went from ~77% below departure price to ~22% below it.

No other significant observation was noted two weeks before departure, as shown in Figure 10.

Based on our evidence, we can conclude with confidence that the “two-week” rule for AA is nothing but a myth. The explanation we found for this is the “Ultimate Super Saver Fares” announcement from AA in January 1985. It basically marked the beginning for AA of variable pricing. AA would match people express fares with two key differences, one of which mentioned that passengers needed to book two weeks in advance to get the lower price. This is the only reference found regarding a before- and after-two week booking [7].

Lastly, we must note that at the time of writing this report SWA has been announcing a $59 special with the special condition – among others- that a 14 day advance purchase is required. This is advertised more as a special than a regular pricing scheme.
Observation 2 – The Southwest Effect
As a “last minute” research effort, we tried to see if Southwest airlines had any effect on the pricing for AA. It turns out that the price differentials are different among destinations. A summary of the price differentials between airlines is shown in Table 5 Price differentials between AA and SWA.

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Table 5 Price differentials between AA and SWA

For the flight to LGA, SWA as well as AA maintain their prices pretty much stable for the entire observation period. The only notable observation is the price delta indicated above. Figure 12 shows this behavior. In this observation SWA does not seem to have an effect on AA since AA’s prices are stable.

Price Tracking for LGA - AA vs. SWA

Figure 11 Price tracking for LGA – AA vs. SWA
For the FLL comparison shown in Figure 12, prices tend to follow each other. It is worth noting that during the days around November 5, AA increased its fares significantly around the time SWA had a price increase. Said price increased lasted three days, after which AA prices went down close to SWA final price. At the end there was a $20 price difference among both flights. The most notable fact is that it was AA who raised its prices first, and then it was SWA who had the price adjustment. This contradicts the Southwest Effect.

Figure 12 Price tracking FLL – AA vs. SWA
For the SFO flight, SWA maintained prices very stable, but AA had three price increments during the same period. AA increments were constant, and they did not reflect the erratic variations in pricing that was found in the New York area or the Miami area destinations.

At the end the price difference between both flights was $643. Figure 13 shows the price trends between these two flights.

![Price Tracking SFO - AA vs. SWA](image)

**Figure 13** Price Tracking SFO – AA vs. SWA

Given the limited information we have, we cannot make a conclusion on either hypothesis that SWA has an effect on AA prices. If any, for the FLL observation, it seems that SWA is the price follower.

One important fact to note is that AA flights are direct flights, and SWA has indirect flights. For example, the flight to San Francisco has a change of planes in L.A. and a quick stop in Arizona. This will add complexity to the correlation since there are many more factors in consideration when the plane has to have a layover (i.e. passengers that drop, new passengers, new passenger on connecting flights, etc.)
Observation 3 – Residual Capacity
Lastly, we analyzed the effects of prices on residual capacity, and this is shown in Table 6. Residual capacity is the available seats left for a particular price or class. Given the limitations of the research tools (AA website), we had a limitation of a maximum of six seats to reserve at once. We only found residual capacity data that we could track for the MIA and the SJC flights. For the rest of the flights there were at least six seats available thought the observation period. Thus, we could not detect exact residual capacity.

For the MIA flight, the correlation is 0.02477, and the correlation for the SJC flight is -0.31622. We can skeptically conclude that there is no significant correlation, whether positive or negative- between price and residual capacity. However, it must be noted the small sample size (basically one flight), and in order to make a strong claim much more samples are needed.

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Table 6 Residual capacity
**Conclusions**

Dynamic pricing, or yield management, is an extremely difficult science that requires profound knowledge of the industry where it is applied. Given our limited research tools, and the few flights analyzed, we were not able to provide significant statistical evidence that could lead to firm conclusions. However, we can make the following observations:

In our analysis of the demand-price relationship, our data illustrates how other factors affect the law of demand, as higher prices do not always translate into lower demand. There was some particularly odd behavior reflected in our data, like the previously mentioned $770 drop in both of the Dallas-New York flights, and $457 increase in the Dallas-Fort Lauderdale flight. Both of these changes lasted several days in a row, so we do not consider them outliers. We can rationalize the first incident as a Net Saver (American Airlines’ weekly fare specials that available from Tuesday to Friday on a given week), but this is harder to do for the Dallas-Fort Lauderdale case.

As we expected, we did not find any correlation between buying tickets before or after the "two-week" deadline. As explained, this is something that existed at some point, but was later dropped by AA when refining yield management methods. As of the time of writing this report, SWA is running a “limited time” special that requires 14-day advance purchase, though.

There is also no evidence that suggests am influence of the "Southwest Effect" on dynamic pricing. Only the FLL comparison might hint at some correlation, but the first mover turned out to be AA. A possible explanation could be that the Southwest Effect exists initially when SWA enters a market, and that forces other airlines to adjust their pricing models (classes, overbooking, etc). After that, perhaps there is little if any influence of SWA on the day to day pricing other airlines generate. Moreover, there is no guarantee that close proximity may influence the prices between airports as the Miami-area leg proved.

Finally, we took a look at residual capacity. We have learned that advance purchase date is not what affects the pricing of a given flight, but instead how the seats are filled. In other words, prices have more to do with booking limits, protection levels and cancellations. However, in our data we could not prove the correlation between price and residual capacity. This should be taken with a grain of salt since we were limited to two samples, but in reality the only one where we had strong numbers was the MIA flight. On the SJC flight we only saw the effects of residual capacity on one day. We have doubts about the reliability of the data available to customers in the AA.com website, as experimenting with the quantity of tickets reserved and providing elite membership information yielded inconsistent residual capacity and pricing results for a given flight. Therefore, statistically speaking we cannot accept or reject the effect of residual capacity on prices with that evidence.

As a final note it can be concluded that this research only scratched the tip of the iceberg when it come to yield management. In order to confirm the theory learned, one should select more samples, add more flight diversity, and cross-reference more variables. All this was noted after our target observation date had passed, and I began doing the data mining.
Further Research

Direct Flights
After collecting and processing all the data, we found a fatal flaw when trying to correlate AA vs. SWA prices. The business model of SWA does not follow the hub-and-spoke system; hence their flights were not direct. We would be introducing many more factors when trying to compare different models.

A new proposal would be to discard SWA, and pick direct flights from major airlines that depart from DFW. For example United Airlines has direct flights to SFO, and Delta Airlines has direct flights to JFK.

Pick additional days
We only concentrated on one day of the week (Wednesday) during four weeks. In order to enhance the research findings, we propose to pick the same flight on the same day of the week (Wednesday), and add an additional day on Friday or Saturday.

This extra day would allow comparing busy vs. non-busy days.

Cross referencing
When more dates and flights are added effects of correlation between residual capacity and price can be obtained with more confidence. Also the effect on miles flown against price can be studied.

Residual capacity
Given the known effect of residual capacity in airline pricing and the difficulties we had proving this relationship in our analysis, this is our strongest suggestion for further research.
References

11. http://www.delta.com

References for selected figures

Figure 1 http://www.docstoc.com/docs/8689657/World-Travel-Trends-Report-2009

Figure 2 http://allison.pbworks.com/f/Analysis+Submission+1.doc

Figure 3 http://create.usc.edu/research/50794.pdf
# Appendix A – Raw Data

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<td>937.60</td>
<td>937.60</td>
<td>184.00</td>
<td>970.60</td>
<td>366.60</td>
<td>346.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation:

- AA: 1.00
- 0.63
- 0.82
- 0.34
- 0.48
- 0.34
Appendix B – Route maps
Appendix C – Correlation examples

1.0  0.8  0.4  0.0  −0.4  −0.8  −1.0

1.0  1.0  1.0  0.0  −1.0  −1.0  −1.0

0.0  0.0  0.0  0.0  0.0  0.0  0.0