Airline Economics Review

Dr. Peter P. Belobaba
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Lecture Outline

1. Basic Airline Profit Model

2. Air Travel Markets
   - Origin-Destination Market Demand
   - Dichotomy of Airline Demand and Supply

3. Demand Models

4. Airline Competition
   - Market Share/Frequency Share Model

5. Airline Pricing Practices
   - Differential Pricing Strategies
1. Basic Airline Profit Model

Operating Profit = Revenues - Operating Expense

Operating Profit = RPM x Yield - ASM x Unit Cost

• The use of individual terms in this profit equation to measure airline success can be misleading:
  – High Yield is not desirable if ALF is too low; in general, Yield is a poor indicator of airline profitability
  – Low Unit Cost is of little value if Revenues are weak
  – Even ALF on its own tells us little about profitability, as high ALF could be the result of extremely low fares (yields)

• Airline profit maximizing strategy is to increase revenues, decrease costs, but the above terms are interrelated.
Additional Airline Measures

• **Average Stage Length**
  - Average non-stop flight distance
  - Aircraft Miles Flown / Aircraft Departures
  - Longer average stage lengths associated with lower yields and lower unit costs (in theory)

• **Average Passenger Trip Length**
  - Average distance flown from origin to destination
  - Revenue Passenger Miles (RPMS) / Passengers
  - Typically greater than average stage length, since some proportion of passengers will take more than one flight (connections)

• **Average Number of Seats per Flight Departure**
  - Available Seat Miles / Aircraft Miles Flown
  - Higher average seats per flight associated with lower unit costs (in theory)
2. Air Travel Markets

• City-pair market
  – Demand for air travel between Boston and Chicago

• Airport-pair market
  – City-pair demand disaggregated to different airports BOS-O’Hare and BOS-Midway
  – Parallel air travel markets

• Region-pair market
  – Demand between entire Boston metropolitan area and Chicago metropolitan area
  – Additional parallel airport-pair markets including Providence and Manchester to O’Hare and Midway
Distinct and Separate O-D Markets
Air travel demand is defined for an origin-destination market, not a flight leg in an airline network:

- Number of persons wishing to travel from origin A to destination B during a given time period (e.g., per day)
- Includes both passengers starting their trip at A and those completing their travel by returning home to B (opposite markets)
- Typically, volume of travel measured in one-way passenger trips between A and B, perhaps summed over both directions

Airline networks create complications for analysis of market demand and supply:

- Not all A-B passengers will fly on non-stop flights from A to B, as some will choose one-stop or connecting paths
- Any single non-stop flight leg A-B can also serve many other O-D markets, as part of connecting or multi-stop paths
Joint Supply to O-D Markets

BOS-IAH Flight
Top O-D Markets By Volume

Average Bookings

IAH
MEX
LAS
HNL
PHX
MSY
CUN
PVR
ACA
SJD
SAT
ABQ
SFO
BZE
LAX
CZM
ZIH

GUM
Dichotomy of Demand and Supply

- Inherent inability to directly compare demand and supply at the “market” level

- Demand is generated by O-D market, while supply is provided as a set of flight leg departures over a network of operations

- One flight leg provides joint supply of seats to many O-D markets
  - Number of seats on the flight is not the “supply” to a single market
  - Not possible (or realistic) to determine supply of seats to each O-D

- Single O-D market served by many competing airline paths
  - Tabulation of total O-D market traffic requires detailed ticket coupon analysis
Implications for Analysis

- Dichotomy of airline demand and supply complicates many facets of airline economic analysis

- Difficult, in theory, to answer seemingly “simple” economic questions, for example:
  - Because we cannot quantify “supply” to an individual O-D market, we cannot determine if the market is in “equilibrium”
  - Cannot determine if the airline’s service to that O-D market is “profitable”, or whether fares are “too high” or “too low”
  - Serious difficulties in proving predatory pricing against low-fare new entrants, given joint supply of seats to multiple O-D markets and inability to isolate costs of serving each O-D market

- In practice, assumptions about cost and revenue allocation are required:
  - Estimates of flight and/or route profitability are open to question
3. Demand Models

- Demand models are mathematical representations of the relationship between demand and explanatory variables:
  - Based on our assumptions of what affects air travel demand
  - Can be linear (additive) models or non-linear (multiplicative)
  - Model specification reflects expectations of demand behavior (e.g., when prices rise, demand should decrease)

- A properly estimated demand model allows airlines to more accurately forecast demand in an O-D market:
  - As a function of changes in average fares
  - Given recent or planned changes to frequency of service
  - To account for changes in market or economic conditions
Airline Demand

- Demand for carrier flight $f$ of carrier $i$ in OD market $j$ is a function of:
  - Characteristics of flight $f$
    - Departure time, travel time, expected delay, aircraft type, in-flight service, etc.
    - Price
  - Characteristics of carrier $i$
    - Flight schedule in market $j$ (frequency, timetable), airport amenities of carrier, frequent flyer plan attractiveness, etc.
  - Market characteristics
    - Distance, business travel between two cities, tourism appeal
  - Characteristics (including price) of all rival products:
    - Other flights on carrier $i$
    - Flights on other carriers in market $j$ (carrier and flight characteristics)
    - Competing markets’ products (other airports serving city-pair in $j$, other transport modes, etc.)
Next to price of air travel, most important factor affecting demand for airline services:
- Access and egress times to/from airports at origin and destination
- Pre-departure and post-arrival processing times at each airport
- Actual flight times plus connecting times between flights
- Schedule displacement or wait times due to inadequate frequency

**Total trip time** captures impacts of flight frequency, path quality relative to other carriers, other modes.
- Reduction in total trip time should lead to increase in total air travel demand in O-D market
- Increased frequency and non-stop flights reduce total trip time
- Increases in total trip time will lead to reduced demand for air travel, either to alternative modes or the “no travel” option
Total Trip Time and Frequency

\[ T = t(\text{fixed}) + t(\text{flight}) + t(\text{schedule displacement}) \]

- Fixed time elements include access and egress, airport processing
- Flight time includes aircraft “block” times plus connecting times
- Schedule displacement = \((K \text{ hours} / \text{frequency})\), meaning it decreases with increases in frequency of departures

• This model is useful in explaining why:
  - Non-stop flights are preferred to connections (lower flight times)
  - More frequent service increases travel demand (lower schedule displacement times)
  - Frequency is more important in short-haul markets (schedule displacement is a much larger proportion of total \(T\))
  - Many connecting departures through a hub might be better than 1 non-stop per day (lower total \(T\) for the average passenger)
Simple Market Demand Function

• Multiplicative model of demand for travel O-D per period:

\[ D = M \times P^a \times T^b \]

where:
- \( M \) = market sizing parameter (constant) that represents underlying population and interaction between cities
- \( P \) = average price of air travel
- \( T \) = total trip time, reflecting changes in frequency
- \( a, b \) = price and time elasticities of demand

• We can estimate values of \( M, a, \) and \( b \) from historical data sample of \( D, P, \) and \( T \) for same market:
  - Previous observations of demand levels (\( D \)) under different combinations of price (\( P \)) and total travel time (\( T \))
Multiple Demand Segments

<table>
<thead>
<tr>
<th></th>
<th>Business Air Travel Demand</th>
<th>Personal Air Travel Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Class</strong></td>
<td>$D_{fb}$</td>
<td>$D_{fp}$</td>
</tr>
<tr>
<td><strong>Coach Class</strong></td>
<td>$D_{cb}$</td>
<td>$D_{cp}$</td>
</tr>
<tr>
<td><strong>Discount Class</strong></td>
<td>$D_{db}$</td>
<td>$D_{dp}$</td>
</tr>
</tbody>
</table>
Demand Models by Segment

Demand Functions for Business Travel

\[
D_{fb} = M_b \quad I_f \quad P_f^{a1} \quad T_f^{b1} \quad P_c^{c1}
\]

\[
D_{cb} = M_b \quad I_c \quad P_c^{a1} \quad T_c^{b1} \quad P_f^{c1}
\]

Where

\(M_b\) = the market sizing parameter for business travel demand (constant)

\(I_f, I_c\) = constant image factors for first and coach class services

\(P_f, P_c\) = prices of first and coach class services

\(T_f, T_c\) = total travel times for first and coach class services

\(a1\) = price elasticity of demand for business travelers

\(b1\) = time elasticity of demand for business travelers

\(c1\) = cross-elasticity of business travel demand for first class service with respect to the price of coach class service, and vice versa
Demand Functions for Personal Travel

\[ D_{cp} = M_p \ I_c \ P_c^{a2} \ T_c^{b2} \ P_d^{c2} \]

\[ D_{dp} = M_p \ I_d \ P_d^{a2} \ T_d^{b2} \ P_c^{c2} \]

Where

- \( M_p \) = the market sizing parameter for personal travel demand (constant)
- \( I_c, I_d \) = constant image factors for coach and discount class services
- \( P_c, P_d \) = prices of coach and discount class services
- \( T_c, T_d \) = total travel times for coach and discount class services
- \( a2 \) = price elasticity of demand for personal travelers
- \( b2 \) = time elasticity of demand for personal travelers
- \( c2 \) = cross-elasticity of personal travel demand for coach class service with respect to the price of discount class service, and vice versa
4. Airline Competition

- Airlines compete for passengers and market share based on:
  - Frequency of service and departure schedule on each route served
  - Price charged, relative to other airlines, to the extent that regulation allows for price competition
  - Quality of service and products offered -- airport and in-flight service amenities and/or restrictions on discount fare products

- Passengers choose combination of flight schedules, prices and product quality that minimizes disutility of air travel:
  - Each passenger would like to have the best service on a flight that departs at the most convenient time, for the lowest price
• Rule of Thumb: With all else equal, airline market shares will approximately equal their frequency shares.

• But there is much empirical evidence of an “S-curve” relationship as shown on the following slide:
  – Higher frequency shares are associated with disproportionately higher market shares
  – An airline with more frequency captures all passengers wishing to fly during periods when only it offers a flight, and shares the demand wishing to depart at times when both airlines offer flights
  – Thus, there is a tendency for competing airlines to match flight frequencies in many non-stop markets, to retain market share
MS vs. FS “S-Curve” Model
\[
\text{MS}(A) = \frac{\text{FS}(A)^\alpha}{\text{FS}(A)^\alpha + \text{FS}(B)^\alpha + \text{FS}(C)^\alpha + \ldots}
\]

where

\begin{align*}
\text{MS}(i) &= \text{market share of airline } i \\
\text{FS}(i) &= \text{non-stop frequency share of airline } i \\
\alpha &= \text{exponent greater than 1.0, and generally between 1.3 and 1.7}
\end{align*}
5. Airline Prices and O-D Markets

• Like air travel demand, airline fares are defined for an O-D market, not for an airline flight leg:
  – Airline prices for travel A-B depend on O-D market demand, supply and competitive characteristics in that market
  – No economic theoretical reason for prices in market A-B to be related to prices A-C, based strictly on distance traveled
  – Could be that price A-C is actually lower than price A-B
  – These are different markets with different demand characteristics, which might just happen to share joint supply on a flight leg

• Dichotomy of airline demand and supply makes finding an equilibrium between prices and distances more difficult.
Price Elasticity of Demand

• Definition: Percent change in total demand that occurs with a 1% increase in average price charged.

• Price elasticity of demand is always negative:
  – A 10% price increase will cause an X% demand decrease, all else being equal (e.g., no change to frequency or market variables)
  – Business air travel demand is slightly “inelastic” (0 > \( E_p \) > -1.0)
  – Leisure demand for air travel is much more “elastic” (\( E_p \) < -1.0)
  – Empirical studies have shown typical range of airline market price elasticities from -0.8 to -2.0 (air travel demand tends to be elastic)
  – Elasticity of demand in specific O-D markets will depend on mix of business and leisure travel
Implications for Airline Pricing

• Inelastic (-0.8) business demand for air travel means less sensitivity to price changes:
  – 10% price increase leads to only 8% demand reduction
  – Total airline revenues increase, despite price increase

• Elastic (-1.6) leisure demand for air travel means greater sensitivity to price changes
  – 10% price increase causes a 16% demand decrease
  – Total revenues decrease given price increase, and vice versa

• Recent airline pricing practices are explained by price elasticities:
  – Increase fares for inelastic business travelers to increase revenues
  – Decrease fares for elastic leisure travelers to increase revenues
Time Elasticity of Demand

• Definition: Percent change in total O-D demand that occurs with a 1% increase in total trip time.

• Time elasticity of demand is also negative:
  – A 10% increase in total trip time will cause an X% demand decrease, all else being equal (e.g., no change in prices)
  – Business air travel demand is more time elastic (Et < -1.0), as demand can be stimulated by improving travel convenience
  – Leisure demand is time inelastic (Et > -1.0), as price sensitive vacationers are willing to endure less convenient flight times
  – Empirical studies show narrower range of airline market time elasticities from -0.8 to -1.6, affected by existing frequency
Implications of Time Elasticity

• Business demand responds more than leisure demand to reductions in total travel time:
  – Increased frequency of departures is most important way for an airline to reduce total travel time in the short run
  – Reduced flight times can also have an impact (e.g., using jet vs. propeller aircraft)
  – More non-stop vs. connecting flights will also reduce T

• Leisure demand not nearly as time sensitive:
  – Frequency and path quality not as important as price

• But there exists a “saturation frequency” in each market:
  – Point at which additional frequency does not increase demand
Theoretical Pricing Strategies

• For determining prices to charge in an O-D market, airlines can utilize one of following economic principles:
  – Cost-based pricing
  – Demand-based pricing
  – Service-based pricing

• In practice, most airline pricing strategies reflect a mix of these theoretical principles:
  – Prices are also highly affected by competition in each O-D market
  – In the US, severe competition in some markets has led to “price-based costing”, meaning airlines must reduce costs to be able to match low-fare competitors and passengers’ price expectations
Price Discrimination vs. Product Differentiation

• Price discrimination:
  – The practice of charging different prices for same product with same costs of production
  – Based solely on different consumers’ “willingness to pay”

• Product differentiation:
  – Charging different prices for products with different characteristics and costs of production

• Current airline fare structures reflect both strategies:
  – Differential Pricing based on differentiated fare products
  – But higher prices for fare products targeted at business travelers are clearly based on their willingness to pay
Airline Pricing Practices

• Differential pricing presents a trade-off to customers between inconvenience and price levels:
  – Business travelers are “willing” to pay higher fares in return for more convenience, fewer restrictions on use of tickets
  – Leisure travelers less “willing” to pay higher prices, but accept disutility “costs” of restrictions on low fare products

• Economic concept of “willingness to pay” (WTP) is defined by the theoretical price-demand curve:
  – “Willingness” does not mean “happiness” in paying higher prices
  – Differential pricing attempts to make those with higher WTP purchase the less restricted higher-priced options
Differential Pricing Theory (circa 2000)

- Market segments with different “willingness to pay” for air travel
- Different “fare products” offered to business versus leisure travelers
- Prevent diversion by setting restrictions on lower fare products and limiting seats available
- Increased revenues and higher load factors than any single fare strategy
Why Differential Pricing?

• It allows the airline to increase total flight revenues with little impact on total operating costs:
  – Incremental revenue generated by discount fare passengers who otherwise would not fly
  – Incremental revenue from high fare passengers willing to pay more
  – Studies have shown that most “traditional” high-cost airlines could not cover total operating costs by offering a single fare level

• Consumers can also benefit from differential pricing:
  – Most notably, discount passengers who otherwise would not fly
  – It is also conceivable that high fare passengers pay less and/or enjoy more frequency given the presence of low fare passengers
Traditional Approach: Restrictions on Lower Fares

- Progressively more severe restrictions on low fare products designed to prevent diversion:
  - Lowest fares have advance purchase and minimum stay requirements, as well as cancellation and change fees
  - Restrictions increase the inconvenience or “disutility cost” of low fares to travelers with high WTP, forcing them to pay more
  - Studies show “Saturday night minimum stay” condition to be most effective in keeping business travelers from purchasing low fares

- Still, it is impossible to achieve perfect segmentation:
  - Some travelers with high WTP can meet restrictions
  - Many business travelers often purchase restricted fares
Example: Restriction Disutility Costs

Business Passenger Fare Structure, Eb vs. Eb, DF=1
Fare Simplification:
Less Restricted and Lower Fares

• Recent trend toward “simplified” fares – compressed fare structures with fewer restrictions
  – Initiated by some LFAs and America West, followed by Alaska
  – Most recently, implemented in all US domestic markets by Delta, matched selectively by legacy competitors

• Simplified fare structures characterized by:
  – No Saturday night stay restrictions, but advance purchase and non-refundable/change fees
  – Revenue management systems still control number of seats sold at each fare level

• Higher load factors, but 10-15% lower revenues:
  – Significantly higher diversion with fewer restrictions
Example: BOS-ATL Simplified Fares
Delta Air Lines, April 2005

<table>
<thead>
<tr>
<th>One Way Fare ($)</th>
<th>Bkg Cls</th>
<th>Advance Purchase</th>
<th>Minimum Stay</th>
<th>Change Fee?</th>
<th>Comment</th>
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<tr>
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<tr>
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<td>F</td>
<td>0</td>
<td>0</td>
<td>No</td>
<td>First Class</td>
</tr>
</tbody>
</table>
Revenue Impact of Each “Simplification”

- Fully Restricted: -0.5%
- Remove AP: -16.8%
- Remove Sat Night Min Stay: -29.6%
- Remove All Restr, Keep AP: -45%
- Remove All Restr and AP: -45%
Loads by Fare Class

- Fully Restricted: 81.6
- Remove AP: 87.8
- Remove Night Min Stay: 79.8
- Remove All Restr, Keep AP: 82.7
- Remove All Restr and AP: 88.1

Legend:
- FC 6
- FC 5
- FC 4
- FC 3
- FC 2
- FC 1
Impacts on Differential Pricing Model

- Drop in business demand and willingness to pay highest fares
- Greater willingness to accept restrictions on lower fares
- Reduction in lowest fares to stimulate traffic and respond to LCCs
- Result is lower total revenue and unit RASM despite stable load factors