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Airline Economics Review

Dr. Peter P. Belobaba

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Airline Management

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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

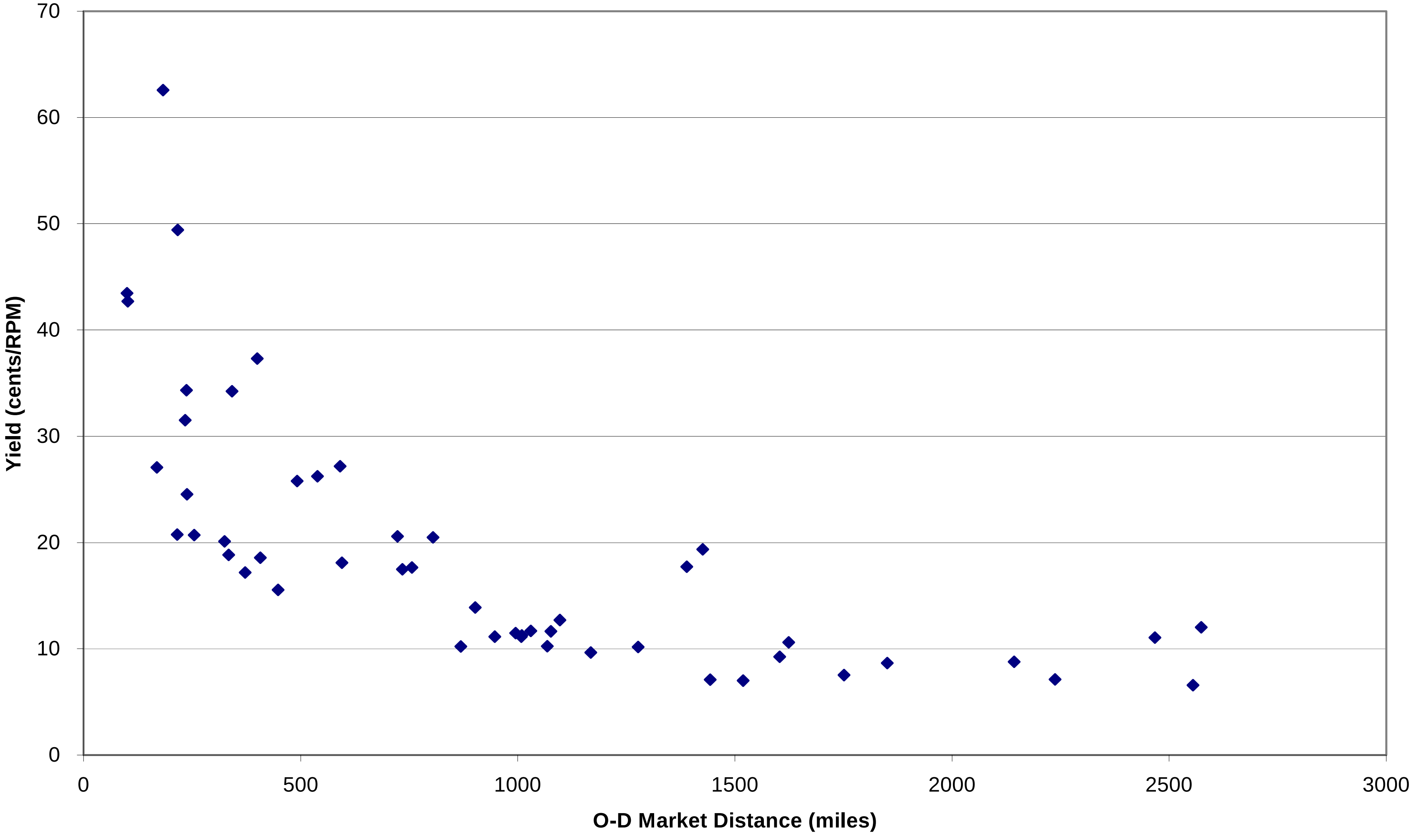
1. Basic Airline Profit Model

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.**

Yield vs. Distance -- Top 50 O+D Markets



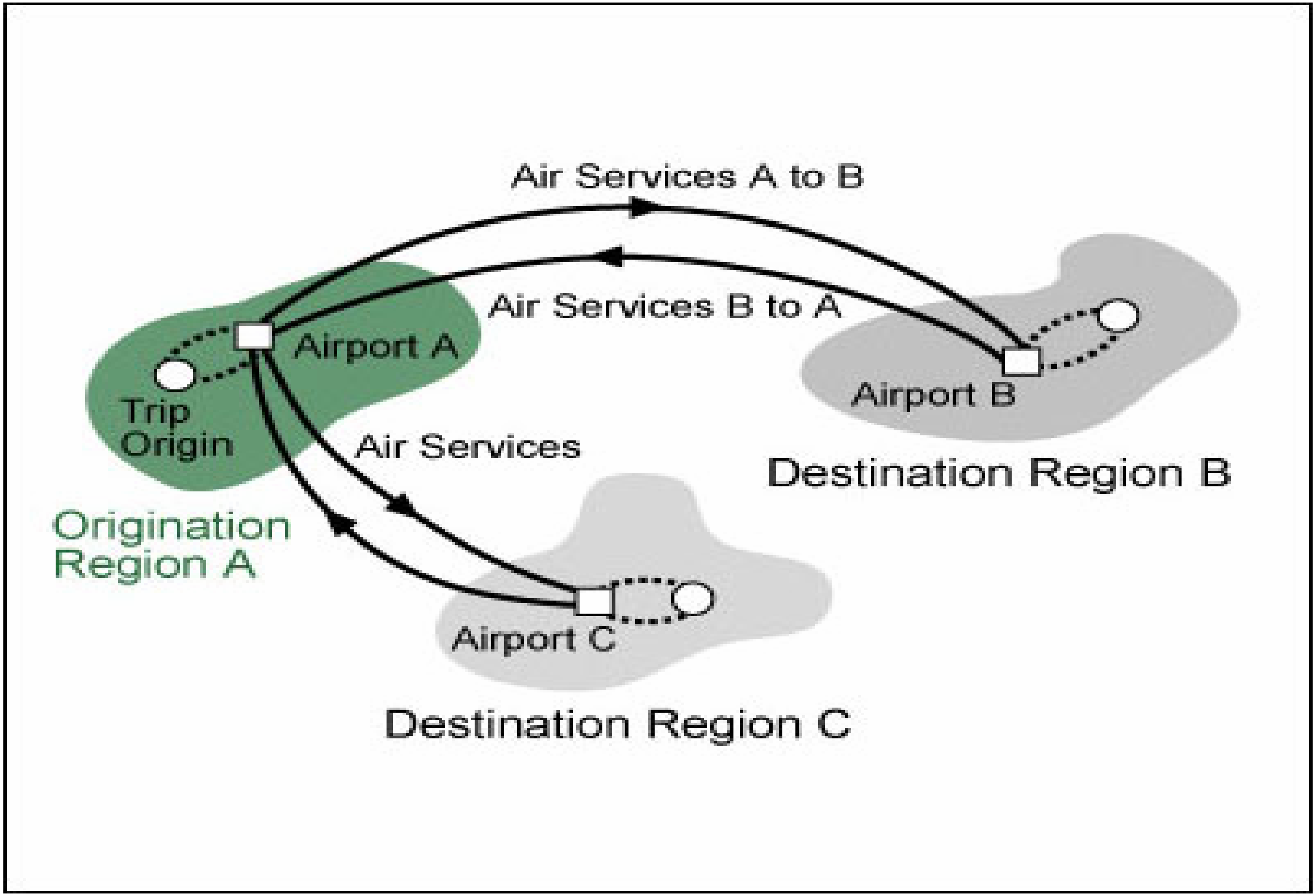
Additional Airline Measures

- **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

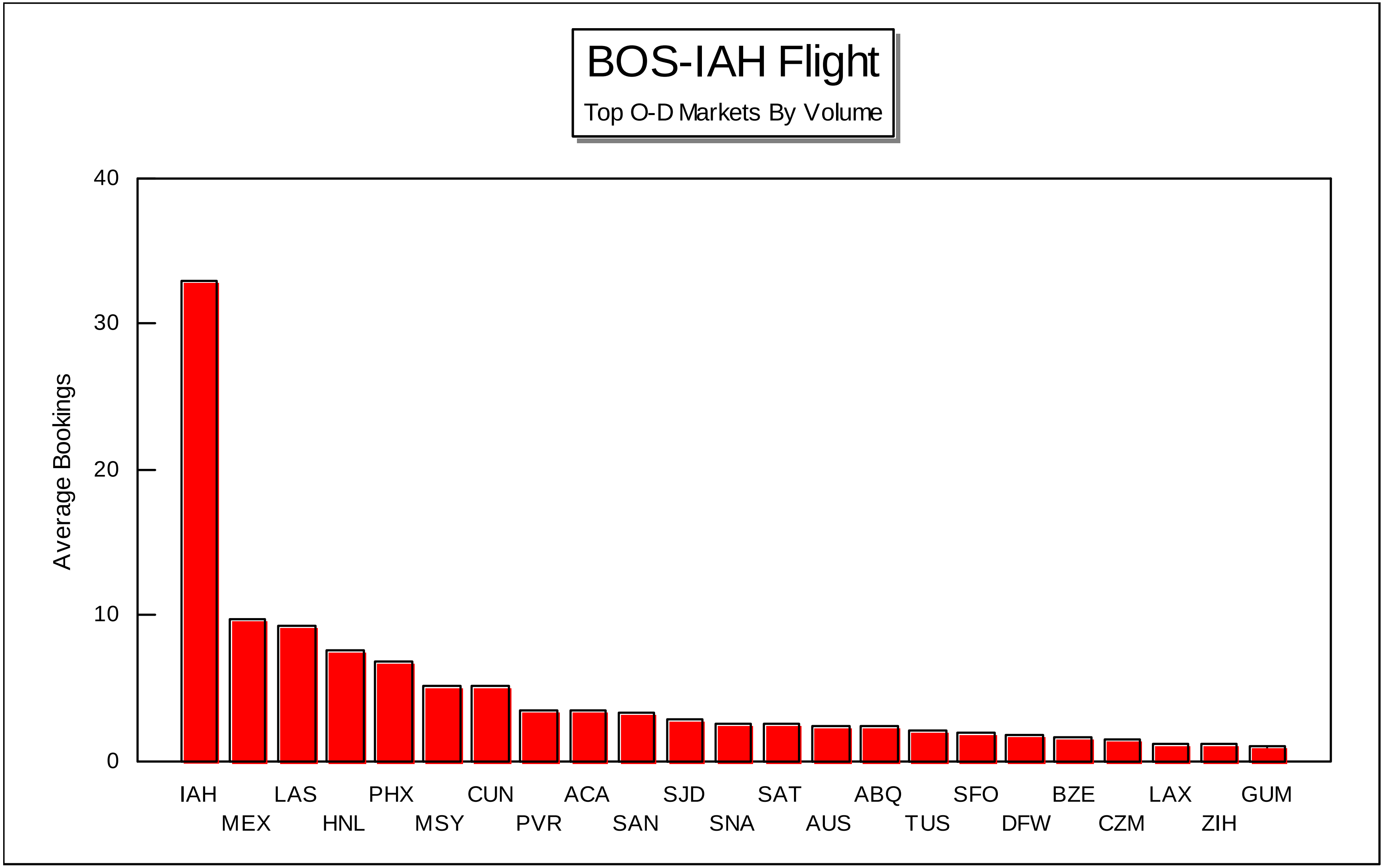
Distinct and Separate O-D Markets



Origin-Destination Market Demand

- **Air travel demand is defined for an origin-destination <u>market</u>, 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 <u>paths</u>
  - Any single non-stop flight leg A-B can also serves many other O-D markets, as part of connecting or multi-stop paths

Joint Supply to O-D Markets



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 <u>assumptions</u> 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.)

Total Trip Time from Point A to B

- **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
- **<u>Total trip time</u> 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 hours / 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

	Business Air Travel Demand	Personal Air Travel Demand
First Class	D_{fb}	D_{fp}
Coach Class	D_{cb}	D_{cp}
Discount Class	D_{db}	D_{dp}

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Demand Models by Segment

Demand Functions for Business Travel

$$D_{fb} = M_b \; I_f \; P_f^{a1} \; T_f^{b1} \; P_c^{c1}$$

$$D_{cb} = M_b \; I_c \; P_c^{a1} \; T_c^{b1} \; P_f^{c1}$$

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 Models by Segment

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

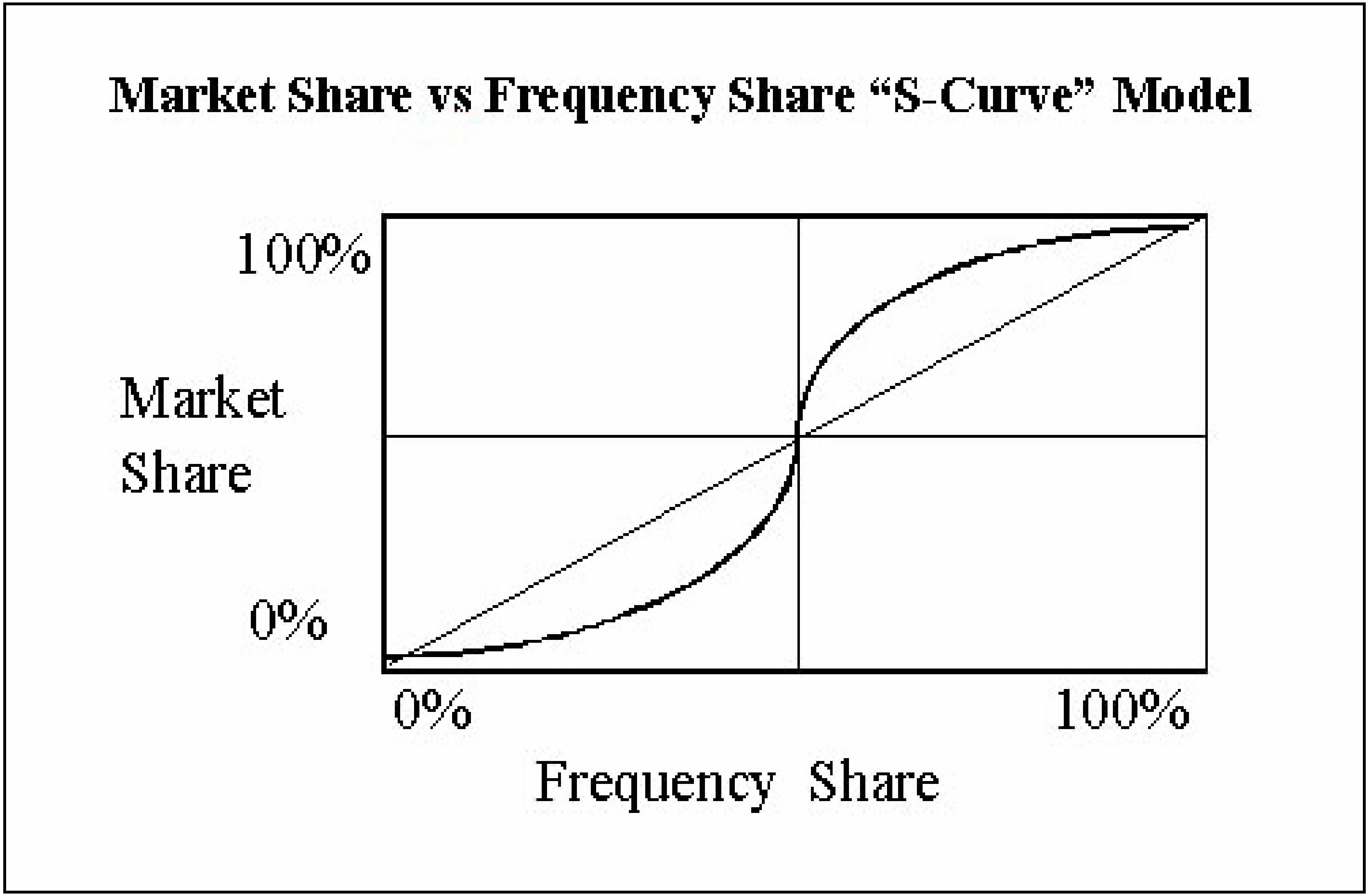
4. Airline Competition

- **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

Market Share / Frequency Share

- <u>Rule of Thumb</u>: 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



S-Curve Model Formulation

$$MS(A) = \frac{FS(A)^{\alpha}}{FS(A)^{\alpha} + FS(B)^{\alpha} + FS(C)^{\alpha} + \ldots}$$

where

$MS(i)$	=	market share of airline i
$FS(i)$	=	non-stop frequency share of airline i
α	=	exponent greater than 1.0, and generally between 1.3 and 1.7

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5. Airline Prices and O-D Markets

- Like air travel demand, airline fares are defined for an O-D market, not for an 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 ($E_t < -1.0$), as demand can be stimulated by improving travel convenience**
  - **Leisure demand is time inelastic ($E_t > -1.0$), 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

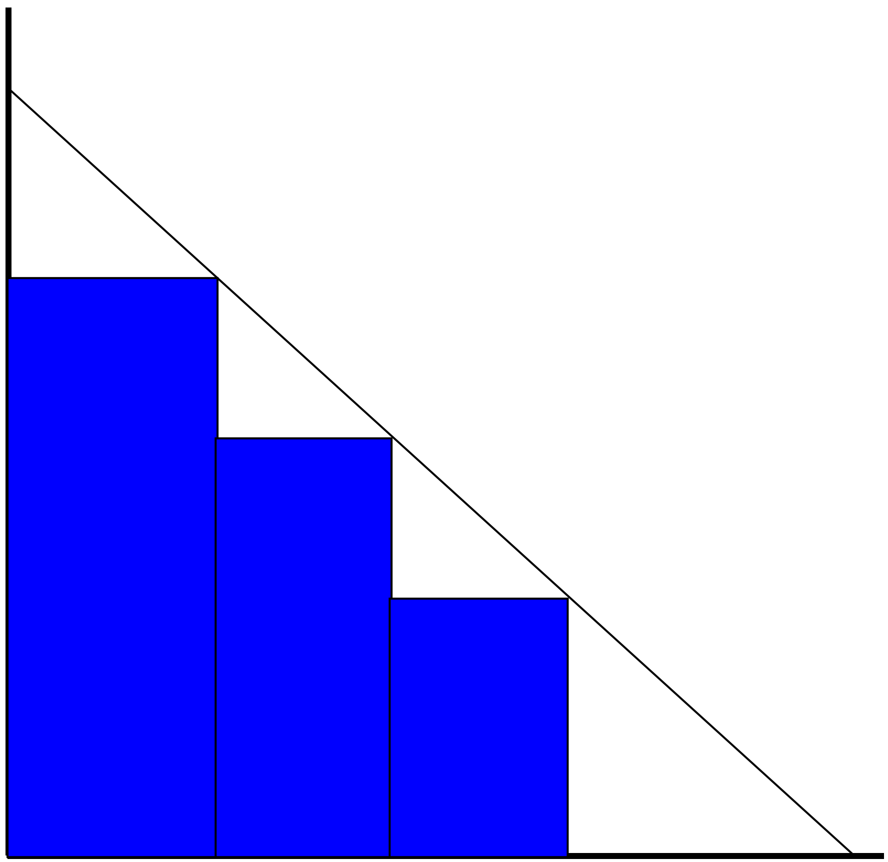
Price Discrimination vs. Product Differentiation

- **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:**
  - <u>Differential Pricing</u> based on differentiated <u>fare products</u>
  - 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

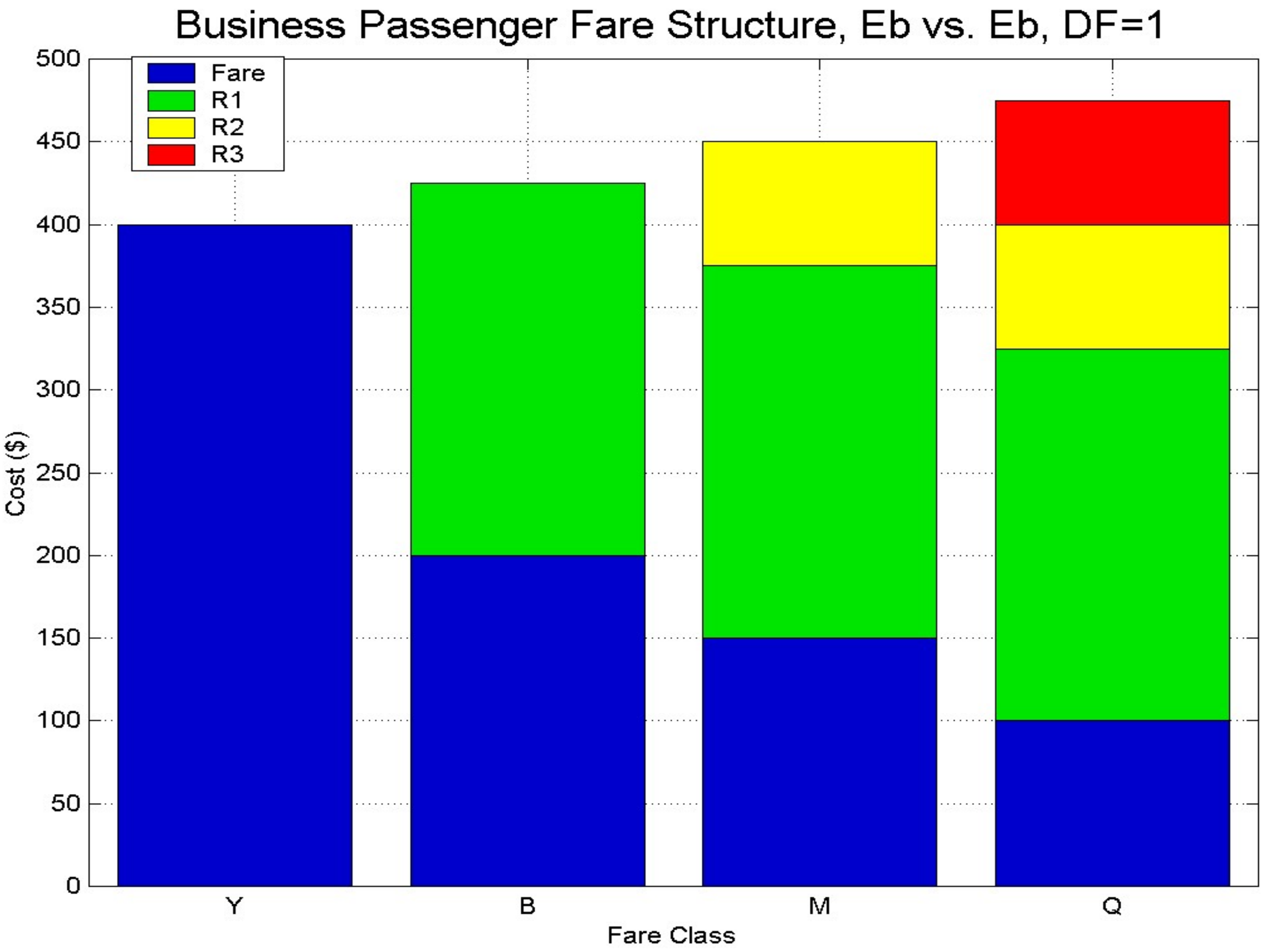
Why Differential Pricing?

- **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



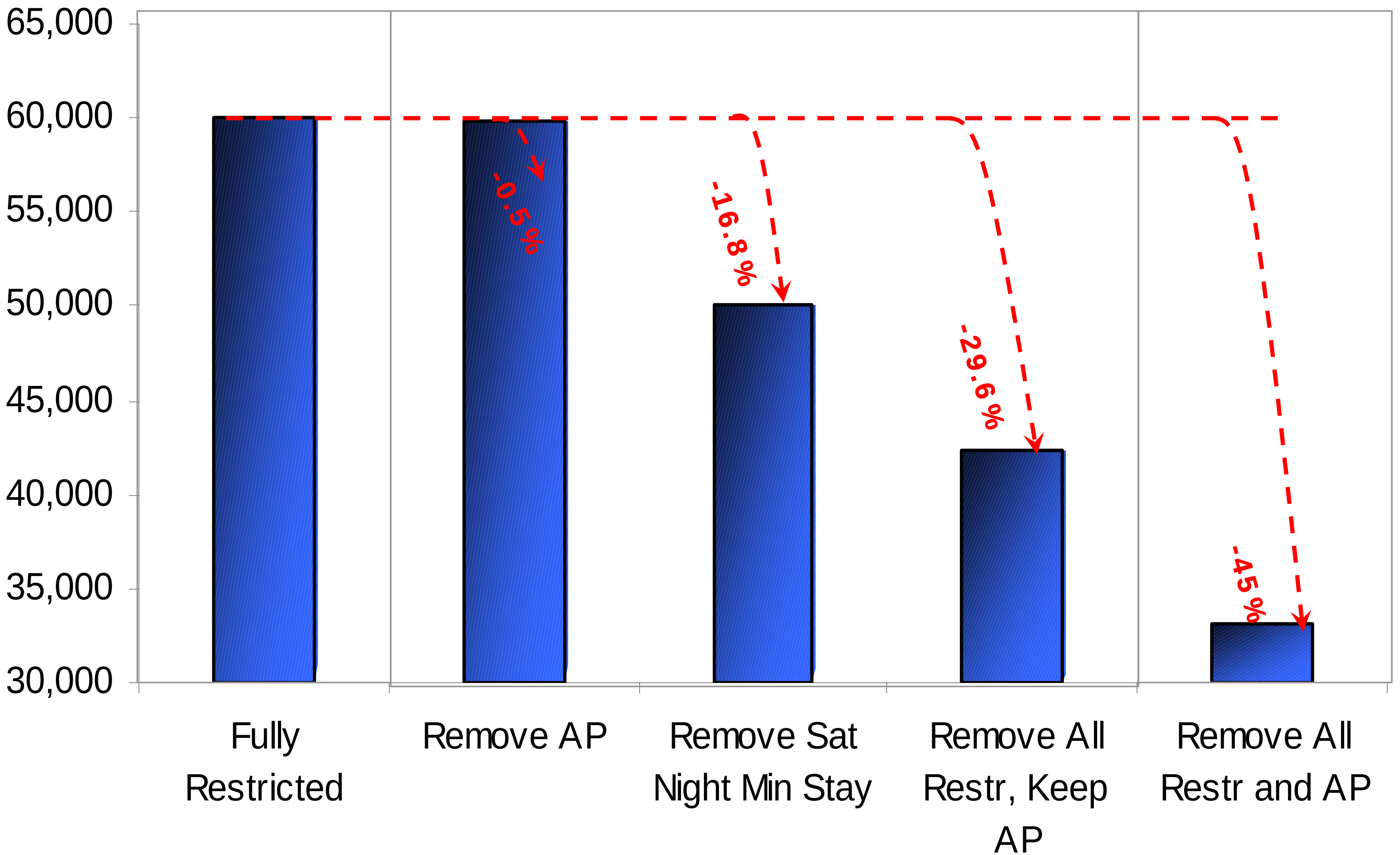
Fare Simplification: Less Restricted and Lower Fares

- **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

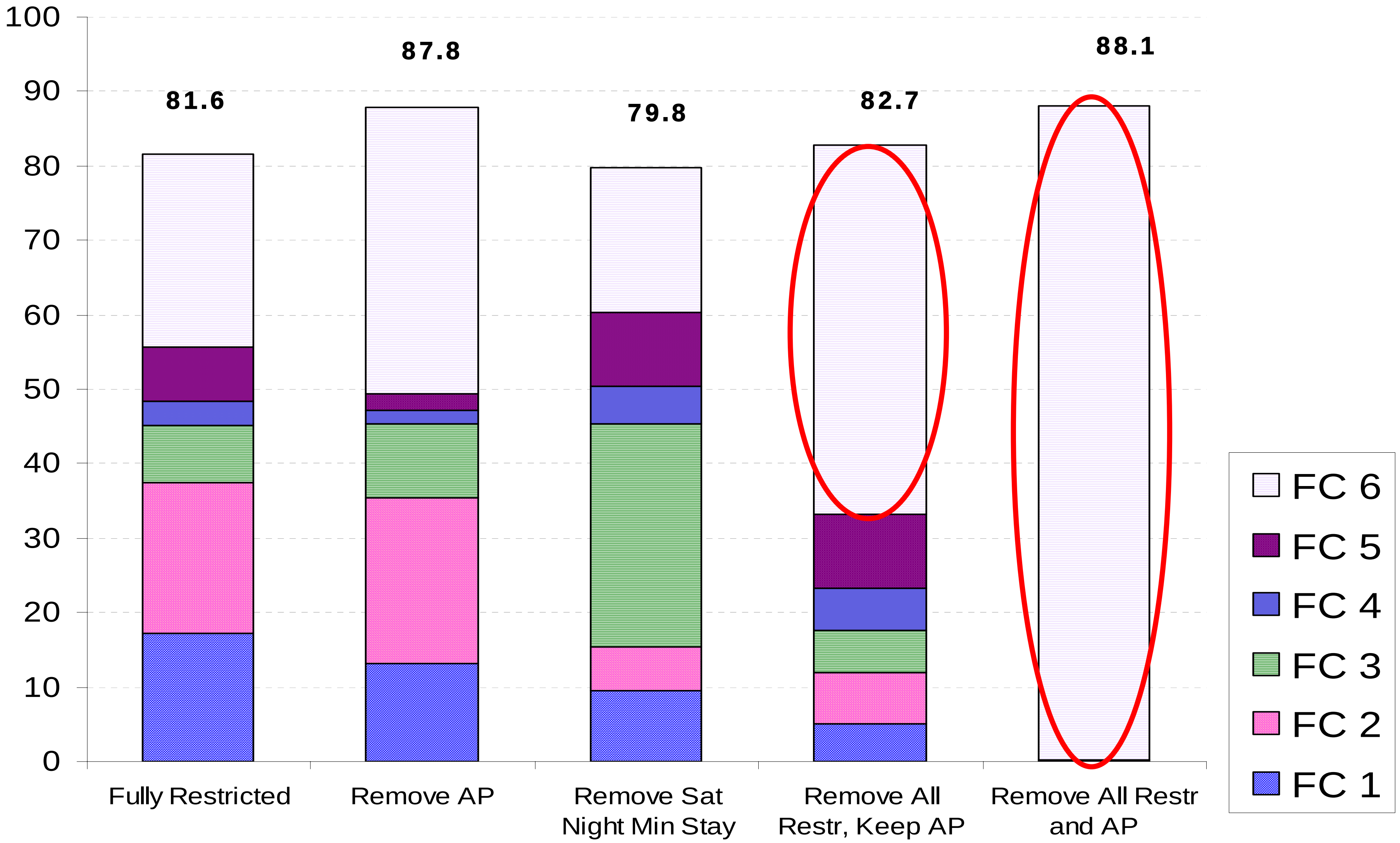
Example: BOS-ATL Simplified Fares
Delta Air Lines, April 2005

One Way Fare ($)	Bkg Cls	Advance Purchase	Minimum Stay	Change Fee?	Comment
$124	T	21 days	0	$50	Non-refundable
$139	U	14 days	0	$50	Non-refundable
$184	L	7 days	0	$50	Non-refundable
$209	K	3 days	0	$50	Non-refundable
$354	B	3 days	0	$50	Non-refundable
$404	Y	0	0	No	Full Fare
$254	A	0	0	No	First Class
$499	F	0	0	No	First Class

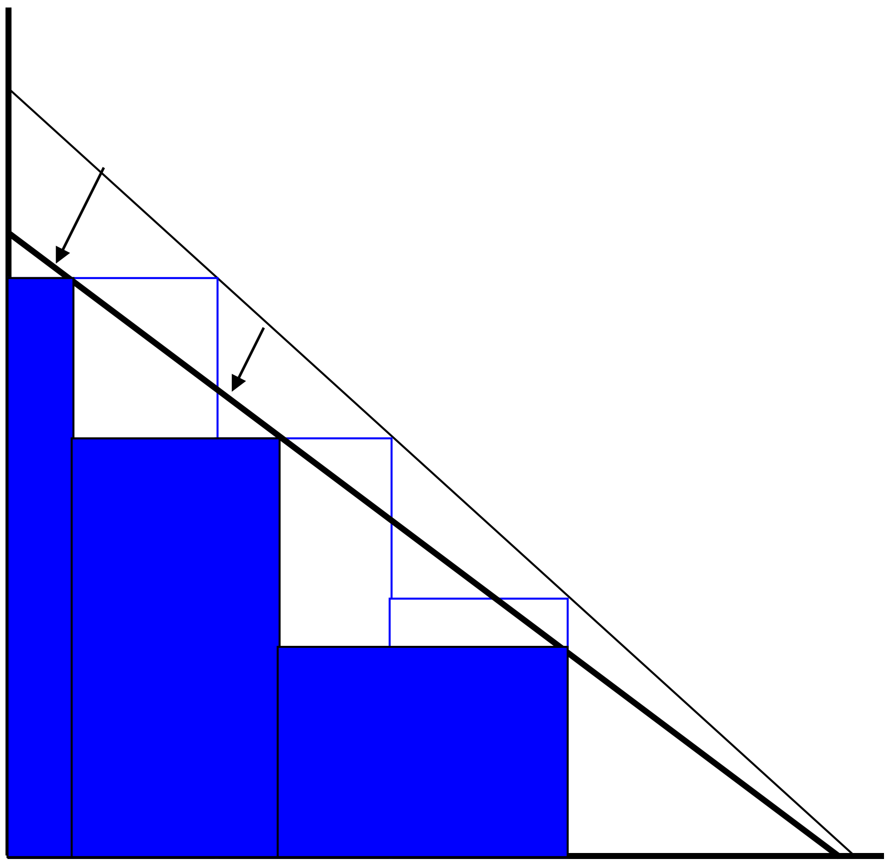
Revenue Impact of Each "Simplification"



Loads by Fare Class



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