[Handwritten top: Assignment 1 Posted Due Oct 4]

MIT ICAT
MIT International Center for Air Transportation

Fundamentals of Airline Markets, Demand and Competition

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16.71J/1.232J/15.054J/ESD217
The Airline Industry
September 20, 2010

MIT ICAT — *Lecture Outline*

1. **Basic Airline Profit Model**

2. **Air Travel Markets**
   - Spatial Definitions of Air Travel Markets

3. **Origin-Destination Market Demand**
   - Dichotomy of Airline Demand and Supply

4. **Air Travel Demand Models**
   - Price and time elasticity of demand

5. **Airline Competition**
   - Market Share/Frequency Share Model

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[Handwritten top: Yield=rev per RPM "fares" — worse measure of doing well]

MIT ICAT — *1. Basic Airline Profit Model*

Operating Profit = Revenues - Operating Expense

Operating Profit = RPM x Yield - ASM x Unit Cost

[Handwritten: revenue pass mile]

- **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) *[Handwritten: avg load factor — full planes]*

- **Profit maximizing strategy is to increase revenues, decrease costs, but the above terms are interrelated.**

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MIT ICAT — *Strategies to Increase Revenues*

- **Increase Traffic Carried (RPMs):** *[Handwritten: ALF↑]*
  - Reduce fares (average yields) to stimulate traffic, but revenue impact depends on demand elasticity
  - For revenues to increase, price cut must generate disproportionate increase in total demand (i.e., "elastic demand")
  - Alternatively, frequency or service quality can be increased to attract passengers, but both actions also increase operating costs *[Handwritten: fly more freq. tested not really on board service, reliability]*

- **Increase Fares (Yields):**
  - Economic theory tells us any price increase will lead to an inevitable traffic decrease, but a price increase can still be revenue positive if demand is "inelastic" (i.e., percent decrease in passengers is lower than percent increase in price).

[Handwritten: — lose traffic, but ok if market is inelastic ↑ biz market]

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Strategies to Reduce Costs

- **Reduce Unit Costs (Cost per ASM):**
  - Reduce service quality, but too many cuts can affect consumers' view of the airline's product, leading to a reduced RPMs and market share *[handwritten: no pillows, etc]*
  - Increase ASMs by flying more flights and larger airplanes, which can lower unit costs but lead to higher total operating costs and lower load factors *[handwritten: use more intensivly]* *[handwritten: — many airlines did it at same time]*

- **Reduce Airline Output (Decrease ASMs):**
  - Cutting back on number of flights will reduce total operating costs, but lower frequencies lead to market share losses (lower RPMs)
  - Reduced frequencies and/or use of smaller aircraft can result in higher unit costs, as fixed costs are spread over fewer ASMs.

[handwritten left margin: Can't just look at unit cost →]

Yield vs. Distance Relationship

[handwritten: → inverse related to distance]

Yield vs. Distance – Top 50 O+D Markets

[handwritten below chart: landing + takeoff]
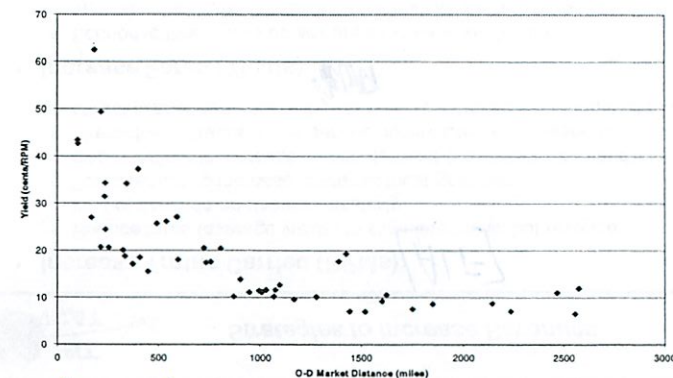
Additional Airline Measures

- **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)

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2. Air Travel Markets

- **Passenger trip characteristics and air travel markets:**
  - Purpose of trips is to move from "true" origin to "true" destination, not from airport to airport
  - Most involve round-trip travel
  - Characteristics of complete trip affect air travel demand, not simply in-flight times or on-board experience

- **Spatial definition of origin-destination (O-D) market:**
  - Potential travelers per period wishing to travel from all originating points served by airport A to destination points around airport B
  - Round-trip market A-B-A has an "opposite" market B-A-B, which can have different characteristics (e.g., BOS-LAS-BOS vs. LAS-BOS-LAS)
  - Because opposite markets share airline supply, O-D market traffic typically reported as combined totals

[handwritten bottom: make ↑ longer avg stage lenghts, big airplanes]

Slide 9

Air Travel: Typical Passenger Trip

[handwritten: demand affected by total trip time]

Ground Access — Outbound Air Trip — Ground Egress

Enplanement Processing — Deplanement Processing

Duration of Stay

Deplanement Processing — Enplanement Processing

Ground Egress — Inbound Air Trip — Ground Access

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Slide 10

Distinct and Separate O-D Markets

[handwritten right margin: 2 different demands elasticities passenger mix need for service]

[handwritten: Cachment market]

Air Services A to B

BOS — LAS

Air Services B to A

Airport A

Airport B

Trip Origin

Air Services

Destination Region B

Origination Region A

Airport C

IAH

Destination Region C

[handwritten below slide: Supply serves 2 different markets — harder to analize]

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Slide 11

Distinct and Separate O-D Markets

Air Services A to B

BOS — LAS

Air Services B to A

Airport A

CO123 Air Services

Airport B

Trip Origin

Destination Region B

CO456

Origination Region A

Airport C

IAH

Destination Region C

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Slide 12

Spatial Definitions of Air Travel Markets

- **Distinct and separate O-D markets**
  - Markets A-B and A-C are effectively independent in terms of demand volume and characteristics, and potentially airline price and supply
  - BOS-IAH and BOS-LAS are distinct and separate O-D markets

- **Competitive airport regions -- Parallel markets**
  - Market regions served by multiple airports can lead to interrelated "parallel" markets (A-B and A-D on following slide)
  - Example: BOS-Washington National and BOS-Washington Dulles are strong "parallel" markets
  - Fares and services in one market affect demand in parallel market
  - Southwest's entry into PHX-BUR stimulated demand, but also diverted traffic from PHX-LAX services, and led to overall fare drop

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Competitive Regions -- Parallel Markets

(handwritten: Cross elasticity)

Spatial Definitions of 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
- **Broader market definitions**
  - Demand for air travel between Northeast US and Florida, or even between Northeast US and "warm winter destinations"

(handwritten: no right way to do the analysis — just pay attention)

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3. Origin-Destination Market Demand

- **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 serves many other O-D markets, as part of connecting or multi-stop paths

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Example: BOS-LAS O-D MARKET
430 Day Each Way (PDEW)

(handwritten: per day each way (avg over year))

DIRECTION	ITINERARY	Avg. PAX/DAY
BOS to LAS	BOS-LAS-BOS	250
	LAS-BOS-LAS	150
	BOS-LAS one-way	30
	TOTAL	430
LAS to BOS	LAS-BOS-LAS	150
	BOS-LAS-BOS	250
	LAS-BOS one-way	30
	TOTAL	430

(handwritten: take it)

(handwritten at bottom: ---s a hard/impossible to know supply)

Example data

Example: Choice of Paths in BOS-LAS O-D Market (430 passengers PDEW)

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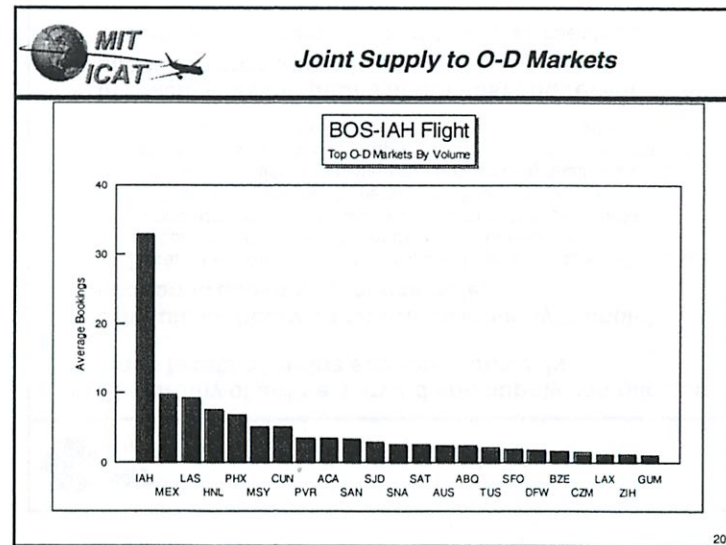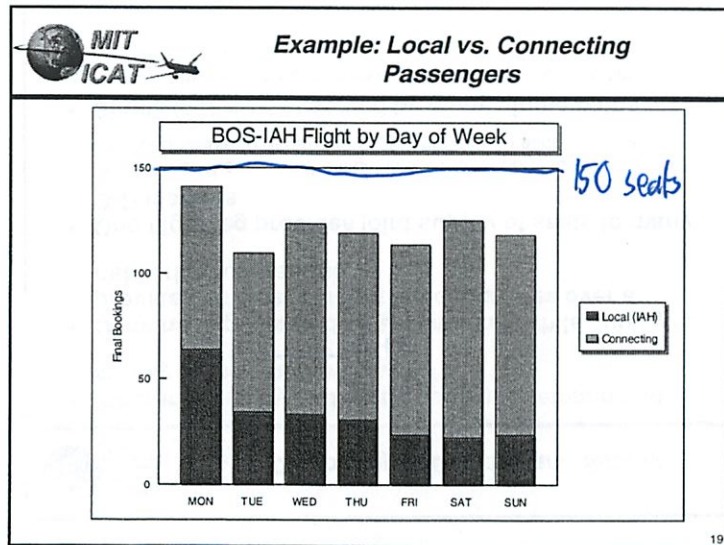| PATH QUALITY	AIRLINE	Avg. PAX/DAY	
NONSTOP	US (2 flights)	160	
	B6 (1 flight)	110	
ONE-STOP	WN (2 flights)	40	
CONNECTIONS	DL via ATL	20	
	CO via IAH	15	
	NW via DTW	15	
	AA via DFW	10	
	UA via ORD	5	
	US via CLT	5	etc...

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A plane

Example: Passenger Loads on Nonstop US Airways Flight BOS-LAS (150 seats)

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O-D Market	Passenger Path	Avg. PAX/Flight
BOS-LAS	BOS-LAS	80
BOS-LAX	BOS-LAS-LAX	10
BOS-SEA	BOS-LAS-SEA	6
BOS-SAN	BOS-LAS-SAN	4
PWM-LAS	PWM-BOS-LAS	4
JFK-LAS	JFK-BOS-LAS	2
YQB-LAS	YQB-BOS-LAS	2
FRA-ONT	FRA-BOS-LAS-ONT	3
ATH-SAN	ATH-FRA-BOS-LAS-SAN	1
		etc...
	TOTAL LOAD	120
	AVG LOAD FACTOR	80%

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Can't have a supply curve — can redirect stuff anywhere

network effects

Example: Local vs. Connecting Passengers

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BOS-IAH Flight by Day of Week

150 seats

Final Bookings — Local (IAH) / Connecting — MON TUE WED THU FRI SAT SUN

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Joint Supply to O-D Markets

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BOS-IAH Flight
Top O-D Markets By Volume

Average Bookings — IAH MEX LAS HNL PHX MSY CUN PVR ACA SAN SJD SNA SAT AUS ABQ TUS SFO DFW BZE CZM LAX ZIH GUM

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Markets served by that 150 seat air plane

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Dichotomy of Demand and Supply

- **Inherent inability to directly compare demand and supply at the "market" level** *O-D*

- **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 to determine <u>supply</u> of seats to each O-D market

- **Single O-D market served by many airline paths**
  - Tabulation of total O-D market traffic requires detailed ticket coupon analysis

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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

no one can sue an airline for predatory pricing

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Airline Terminology

- **Flight Leg (or "flight sector" or "flight segment")**
  - Non-stop operation of an aircraft between A and B, with associated departure and arrival time

- **Flight**
  - One or more flight legs operated consecutively by a single aircraft (usually) and labeled with a single flight number (usually)
  - NW945 is a two-leg flight BOS-MSP-SEA operated with a B757

- **Route**
  - Consecutive links in a network served by single flight numbers
  - NW operates 2 flights per day on one-stop route BOS-MSP-SEA

- **Passenger Paths or Itineraries**
  - Combination of flight legs chosen by passengers in an O-D market to complete a journey (e.g., BOS-SEA via connection at DTW)

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4. Air Travel 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)

whole course

- **A properly estimated demand model allows airlines to better 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

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Factors Affecting Volume of O-D Demand

- **Socioeconomic and demographic variables:**
  - Populations, disposable income levels, and amount of economic interaction between cities A and B

  dot.com bubble → Bos ↔ San Jose

- **Trip purpose characteristics:**
  - Business, vacation, personal "VFR" (visiting friends and relatives)

  ↳ how much do flights/day matter

- **Prices of travel options:**
  - Airline fare products, as well as prices of competing modes

- **Quality of travel services**
  - Frequency of departures determines "total travel time" including schedule displacement or "wait times"
  - Also comfort, safety, and ease of travel by air and on other modes

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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

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↓ Southwest rule

– cut fares 50%

– double market demand

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

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Total Trip Time from Point A to B

- **Next to price of air travel, most important factor affecting demand for airline services:**   *time*
  - 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   *"headway" – even though you know ahead of time*

- **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

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Total Trip Time and Frequency

$$T = t(fixed) + t(flight) + t(schedule\ displacement)$$

- 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

(handwritten: ω headway — much more important to short haul)

- **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)

(handwritten: may still be preferable)

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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

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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

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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)

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5. 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

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freq -> most important for biz travelers

Market Share / Frequency Share

- **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:**
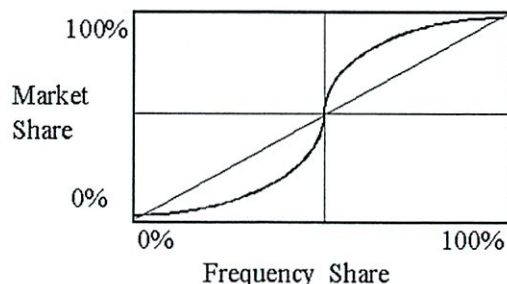 - Higher frequency shares are associated with disproportionately higher market shares
  - An airline with more frequency captures all passengers wishing to fly during periods when only it offers a flight, and shares the demand wishing to depart at times when both airlines offer flights
  - Thus, there is a tendency for competing airlines to *match* flight frequencies in many non-stop markets, to retain market share

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- short haul   - highly biz
↳ if not legacy carriers out of biz

MS vs. FS "S-Curve" Model

Market Share vs Frequency Share "S-Curve" Model

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we know 0, 50, 100% for sure

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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↑ in the assignment
$\alpha = 1 = $ linear
$2 < \alpha < 1 \rightarrow$ how important freq is

CHAP

Slide 1

MIT International Center for Air Transportation

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Introduction to Airline Pricing and Revenue Management

16.71J/1.232J/15.054J/ESD217

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The Airline Industry
September 22, 2010

Slide 2 — Lecture Outline

1. Pricing: Setting Fare Structures
- Differential Pricing Theory
- Traditional Demand Segmentation: Restrictions
- Fare Simplification
- Competitive Pricing in Practice

2. Revenue Management: How Many Seats to Sell
- Overview of RM Systems and Objectives
- Revenue Management Techniques
- Seat Protection Logic
- EMSRb Flight Leg Revenue Maximization

Slide 3 — 1. Pricing: Setting Fare Structures

- **Price is defined for an O-D market, not for an airline flight leg:**
  - Prices for travel A-B depend on O-D market demand and supply characteristics in that market
  - Different markets with different demand functions, which must share joint supply on a flight leg
- **With competitive airline pricing:**
  - Different O-D markets can have prices not related to distance traveled, or even the airline's operating costs
  - Airlines offer a wide range of "fare products" at different price levels with different amenities and restrictions

Slide 4 — Distinct and Separate O-D Markets

Handwritten notes:

almost everywhere in the world

Chap 4 does in more detail

goes in w/ supply   lots of trips

Southwest
LCCs get killed
Why most

4: 4:4 combos
3: 2:1 combos
trip
also round

(remember)   based on observations   tenders to   were outliers   drift to middle

Freq var –
build # too
Navy flights

Could pay less by walking away in middle (hidden city)
- but 1 way only (cancel flight)
- no bags
- if something goes wrong

- currency differences
- leisure markets; price lower
- or Athens via Frankfurt

Distinct and Separate O-D Markets

BOS-LAS $199 *elastic leisure competitor*

Air Service A to B

BOS
Airport A

Air Services B to A

Trip Origin

CO123 Air Services

Airport B LAS

Destination Region B
CO456

Origination Region

BOS-IAH $450 *inelastic controls market*

Airport C IAH

Destination Region C

5
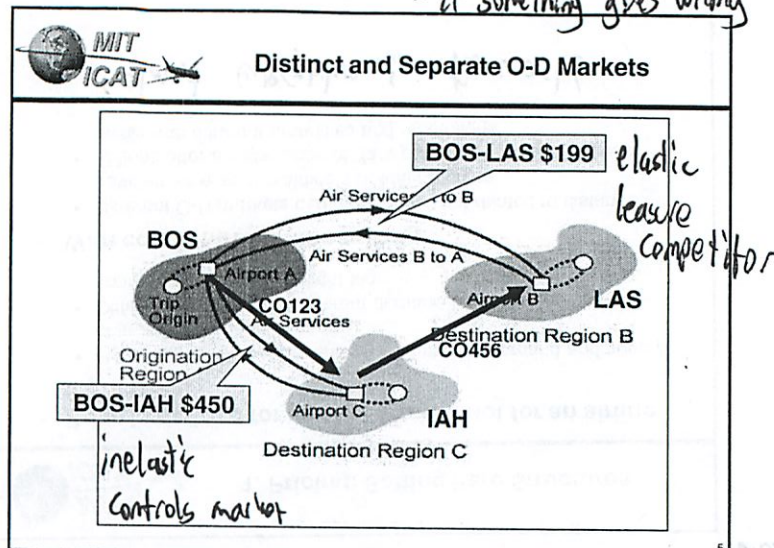
- don't know cost since joint supply

Differential Pricing Theory (pre-2000)

P

Q

- 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
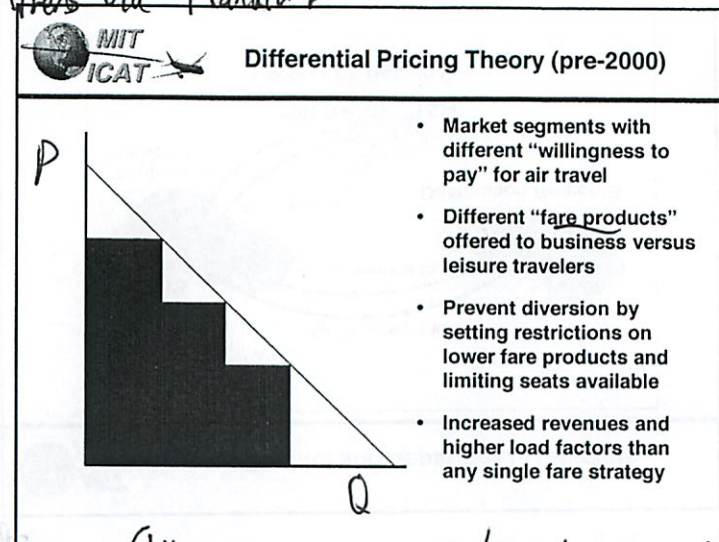
WTP varies widely

fill up more area   how do you do it??

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 <u>otherwise</u> 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

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Flying same plane
no marginal cost

Mostly the incremental revenue from ~~last~~ cheap fares
is new since dereg

Price Discrimination vs. Product Differentiation

- **Price discrimination:**
  - Charging different prices for same product with same costs, based only on "willingness to pay"

- **Product <u>differentiation</u>:**
  - Charging different prices for products with different characteristics and costs of production   - Sat stay, 14 day advance

- **Current airline fare structures reflect both:**
  - "<u>Differential Pricing</u>" based on very different fare products, but also based on willingness to pay

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Why premium class airlines fail
- no flexibility
- less freq
- can't fill up seats on weekend

2

Market Segmentation

- **Successful differential pricing depends on effective ways to identify different demand segments:**
  - In theory, total revenue is maximized when <u>each</u> customer pays a different price equal to his WTP
  - In practice, this is clearly impossible to achieve as airlines cannot determine each individual's WTP for a given trip
- **Instead, airlines identify segments with similar traits:**
  - Business vs. leisure travelers are two traditional segments, still them most important distinction for pricing purposes
  - Possible to increase revenues with more segments, prices and products, but it is difficult to keep additional segments separate

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The Market Segmentation Challenge

- **Demand segmentation through the use of both service amenities and restrictions:**
  - More severe restrictions will reduce percentage of high fare passengers that divert to lower fares
  - But, these same restrictions will reduce number of passengers stimulated to buy lower fares
  - Excessive restrictions will reduce both diversion and stimulation, reducing revenue potential
- **Objectives:**
  - <u>Stimulate</u> new demand for low fare travel
  - Prevent <u>diversion</u> of consumers with higher WTP to lower fare products
  - Given imperfect "fences", balance diversion vs. stimulation to maximize revenues

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Make low fares unattractive to biz
no miles, no upgrades

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

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disutility
things have changed a lot
w/ forward thinking policies

where by
- many biz must use travel agents
- have rules preventing "misuse" even if it saves $ iei If you stay weekend then we will pay for your hotel + a bonus b/c it is still cheaper

Restrictions Help to Segment Demand

Fare Code	Dollar Price	Advance Purchase	Round Trip?	Sat. Night Min. Stay	Percent Non-Refundable
Y	$500	--	--	--	--
B	$375	7 day	Yes	--	50 %
M	$250	14 day	Yes	Yes	100 %
Q	$190	21 day	Yes	Yes	100 %

- Business passengers unwilling to stay over Saturday night will not buy M or Q.

- RM system protects for Y, B demand but keeps M,Q classes open without losing revenue.

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can change 2 to 12 times at $5/change on GDS

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Slide 13

BOS-SEA Fare Structure
American Airlines, October 1, 2001

"good old days" (handwritten)

Roundtrip Fare ($)	Cls	Advance Purchase	Minimum Stay	Change Fee?	Comment
458	N	21 days	Sat. Night	Yes	Tue/Wed/Sat
707	M	21 days	Sat. Night	Yes	Tue/Wed
760	M	21 days	Sat. Night	Yes	Thu-Mon
927	H	14 days	Sat. Night	Yes	Tue/Wed
1001	H	14 days	Sat. Night	Yes	Thu-Mon
2083	B	3 days	none	No	2 X OW Fare
2262	Y	none	none	No	2 X OW Fare
2783	F	none	none	No	First Class

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Slide 14

Diversion and Revenue Loss

Price, P1, P2, Quantity (axis labels)

bad restriction (handwritten)
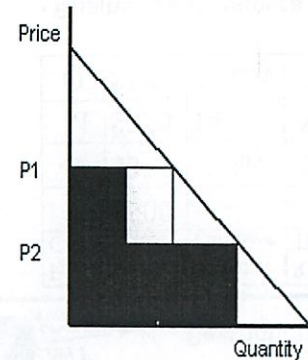
- Given imperfect restrictions, some percentage of the higher demand segment will buy lower fare at P2, which is lower than their WTP.

- If 40% of those with high WTP divert to P2, revenue is lost (yellow area).

- Inadequate restrictions, or "fare fences", can lead to so much diversion that any revenue benefits of differential pricing disappear.

14

Slide 15

Changing Fare Structures Worldwide

- **Major shifts in airline pricing strategies since 2000**
  - Growth of low-fare airlines with relatively unrestricted fares
  - Matching by legacy carriers to protect market share and stimulate demand   9/11 (handwritten)
  - Increased consumer use of internet search engines to find lowest available fare options
  - Greater consumer resistance to complex fare structures and huge differentials between highest and lowest fares offered

- **Recent moves to "simplified" fares overlook the fact that pricing segmentation contributes to revenues:**
  - Fare simplification removes restrictions, resulting in reduced segmentation of demand

15

Slide 16

Jet Blue (handwritten)

Fare Simplification Reduces Segmentation

Fare Code	Dollar Price	Advance Purchase	Round Trip?	Sat. Night Min. Stay	Percent Non-Refundable
Y	$500	--	--	--	--
B	$375	7 day	--	--	50 %
M	$250	14 day	--	--	100 %
Q	$190	21 day	--	--	100 %

horrible for revenue (handwritten)

- With fewer restrictions on lower fares, some Y (business) passengers are able to buy B, M and Q.

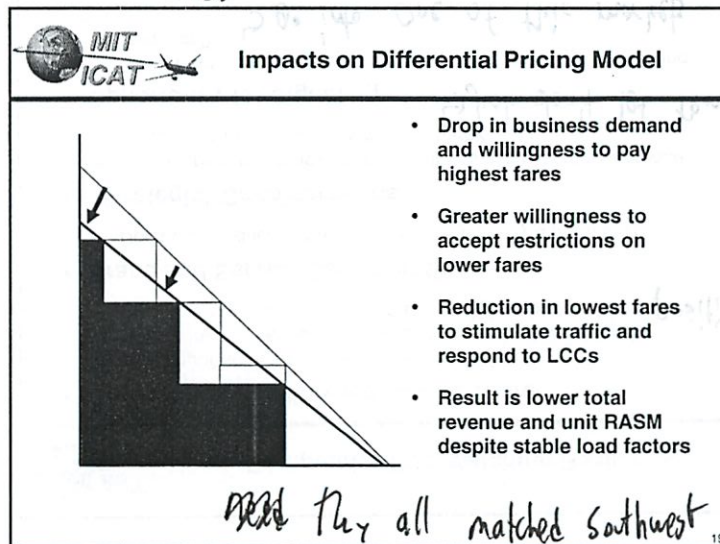- Keeping B, M, Q classes open results in "spiral down" of high fare passengers and total revenues.

16

4

Slide 17: BOS-SEA Simplified Fare Structure
Alaska Airlines, May 1, 2004

everyone matches (handwritten)

Roundtrip Fare ($)	Cls	Advance Purchase	Minimum Stay	Change Fee?	Comment
374	V	21 days	1 day	Yes	Non-refundable
456	L	14 days	1 day	Yes	Non-refundable
559	Q	14 days	1 day	Yes	Non-refundable
683	H	7 days	1 day	Yes	Non-refundable
827	B	3 days	none	No	2 X OW Fare
929	Y	none	none	No	2 X OW Fare
1135	F	none	none	No	First Class

17

easy jet may be the best at this (handwritten)
+ LCCs (handwritten)

Slide 18: Revenue Impact of Each "Simplification"

Simulations (handwritten)

Bar chart — y-axis from 30,000 to 65,000. Categories: Fully Restricted, Remove AP, Remove Sat Night Min Stay (-16.8%), Remove All Restr, Keep AP (-29.6%), Remove All Restr and AP (-45%)

18

Slide 19: 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

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they all matched Southwest (handwritten)
in 2000s to try and (handwritten)
hammer them down (handwritten)
before they can build capacity (handwritten)
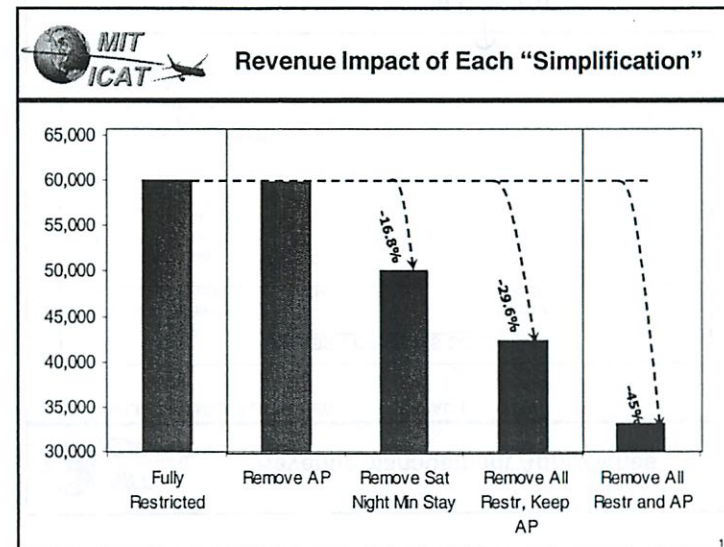
Slide 20: Factors Affecting Fare Structure in an O-D Market

- **Economics 101: Demand Segmentation**
  - Multiple fare levels and restrictions to capture passenger WTP
  - Stimulate leisure demand with low fares, but prevent diversion from higher fares
- **Brand and Service Considerations**
  - Differences in airline products, frequency, non-stop vs. connects
- **Expected Demand and Future Seat Availability**
  - Advance bookings compared to previous year; excess capacity
- **Operating Costs**
  - Have very little influence on fares in individual O-D markets
- **Competitors' Fares**
  - Shown to have the GREATEST influence of fare structures

compete off the radar (handwritten)

20

Competitive Fare Matching Decisions

- **Competitive Position and Market Share**
  - How important is this market to the airline?
  - Will we lose market share if we don't have the lowest fare?
  - What are impacts on CRS and (especially) website listings? *positioning on Orbit's price list*
- **Brand and Service Considerations**
  - Does our product and/or service pattern justify a premium?
- **"Strategic" Considerations**
  - Will failure to match low fare competitors allow them to increase presence and steal (more) market share? *↳ Just don't let them grow*
- **Opportunity for Signaling**
  - Can we reflect displeasure with this new fare through our pricing response? *↳ go into one of their markets*

21

---

2. Revenue Management

- **Two components of airline revenue maximization:**

  Differential Pricing:
  - Various "fare products" offered at different prices for travel in the same O-D market

  Revenue Management (RM):
  - Determines the number of seats to be made available to each "fare class" on a flight, by setting booking limits on low fare seats

- **RM takes a set of differentiated prices/products and flight capacity as given:**
  - With high proportion of fixed operating costs for a committed flight schedule, revenue maximization to maximize profits

22

Objectives of Revenue Management

- **Optimal control of seat inventory** *← only a few high cost*
  - Requires balance of load factor and yield *↳ fill up low cost*
- **Fill each available seat with highest possible revenue:**
  - RM booking limits support the objective of differential pricing, i.e., to make consumers with higher WTP purchase higher fares
- **On high demand flights, RM systems limit discount fare and group bookings:**
  - Leads to slightly lower load factors, but higher yield
- **On low demand flights, sell empty seats at any low fare:**
  - Results in higher load factors and lower yields, but higher total flight revenue *↳ committed to schedule*

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Revenue Management Approaches

EXAMPLE: 2100 MILE FLIGHT LEG   CAPACITY = 200

FARE CLASS	AVERAGE REVENUE	YIELD EMPHASIS	LOAD FACTOR EMPHASIS	REVENUE EMPHASIS
NUMBER OF SEATS SOLD:				
Y	$420	20	10	17
B	$360	23	13	23
H	$230	22	14	19
V	$180	30	55	37
Q	$120	15	68	40
TOTAL PASSENGERS		110	160	136
LOAD FACTOR		55%	80%	68%
TOTAL REVENUE		$28,940	$30,160	$31,250
AVERAGE FARE		$263	$189	$230
YIELD (CENTS/RPM)		12.53	8.98	10.94

↑ Asian airlines

24

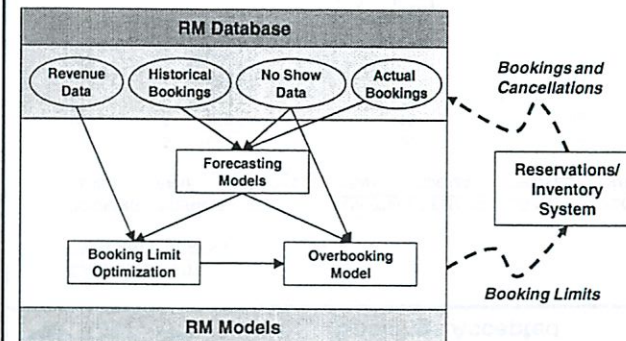*Good RM is saying no, even if seats available*

6

Typical 3rd Generation RM System

- Collects and maintains historical booking data by flight and fare class, for each past departure date.

- Forecasts future booking demand and no-show rates by flight departure date and fare class.

- Calculates limits to maximize total flight revenues:
  - Overbooking levels to minimize costs of spoilage/denied boardings
  - Booking class limits on low-value classes to protect high-fare seats

- Interactive decision support for RM analysts:
  - Can review, accept or reject recommendations

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Third Generation RM System

RM Database

Revenue Data | Historical Bookings | No Show Data | Actual Bookings

Forecasting Models

Booking Limit Optimization → Overbooking Model

RM Models

Bookings and Cancellations

Reservations/ Inventory System

Booking Limits

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Revenue Management Techniques

- **Fare Class Mix (Flight Leg Optimization)**
  - Determine revenue-maximizing mix of seats available to each booking (fare) class on each flight departure

- **Overbooking**
  - Accept reservations in excess of aircraft capacity to overcome loss of revenues due to passenger "no-show" effects

- **Traffic Flow (O-D) Control (Network RM)**
  - Further distinguish between seats available to short-haul (one-leg) vs. long-haul (connecting) passengers, to maximize total network revenues
  - Currently implemented by most advanced and largest network airlines

[handwritten: Sell low costs tickets far in advance need to guess]

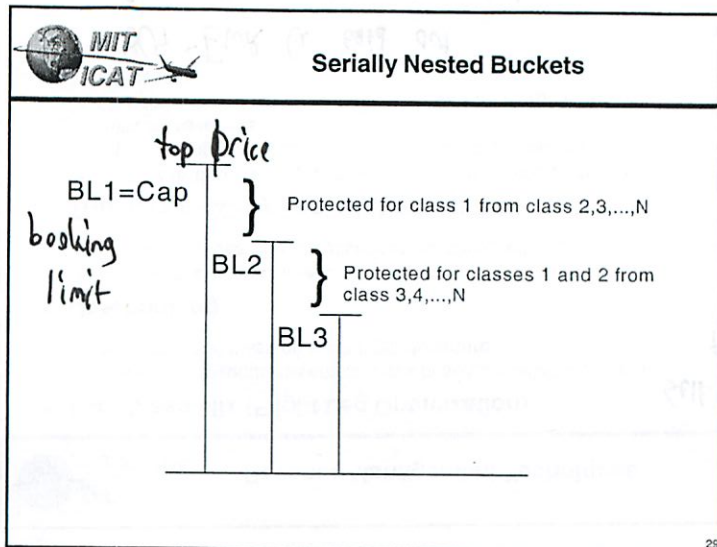*[handwritten: BOS -EWR Q sold out
BOS -EWR -SFA Q ok!]*

27

Single-Leg Seat Protection Problem

- **Given for a future flight leg departure:**
  - Total remaining booking capacity of (typically) the coach compartment
  - Several fare (booking) classes that share the same inventory of seats in the compartment
  - Forecasts of future booking demand by fare class between current DCP and departure
  - Revenue estimates for each fare (booking) class

- **Objective is to maximize total expected revenue:**
  - Protect seats for each fare class based on revenue value, taking into account forecast uncertainty and probability of realizing the forecasted demand

28

7

Serially Nested Buckets

top price

BL1=Cap

} Protected for class 1 from class 2,3,...,N

booking limit

BL2

} Protected for classes 1 and 2 from class 3,4,...,N

BL3

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EMSRb Seat Protection Model

CABIN CAPACITY =	135					
AVAILABLE SEATS =	135					
BOOKING CLASS	AVERAGE FARE	SEATS BOOKED	FORECAST DEMAND MEAN	SIGMA	JOINT PROTECT	BOOKING LIMIT
Y	$ 670	0	12	7	6	135
M	$ 550	0	17	8	23	129
B	$ 420	0	10	6	37	112
V	$ 310	0	22	9	62	98
Q	$ 220	0	27	10	95	73
L	$ 140	0	47	14		40
SUM		0	135			

std error (handwritten above SIGMA)

initial guess: reject 7 people for lowest fare (handwritten)

look at ratio of next level - need to be that certain someone will buy that seat (handwritten)

30

Dynamic Revision and Intervention

- **RM systems revise forecasts and re-optimize booking limits at numerous "checkpoints":**
  - Monitor actual bookings vs. previously forecasted demand
  - Re-forecast demand and re-optimize at fixed checkpoints or when unexpected booking activity occurs
  - Can mean substantial changes in fare class availability from one day to the next, even for the same flight departure

- **Substantial proportion of fare mix revenue gain comes from dynamic revision of booking limits:**
  - Human intervention is important in unusual circumstances, such as "unexplained" surges in demand due to special events

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Revision of Forecasts and Limits as Bookings Accepted

CABIN CAPACITY =	135					
AVAILABLE SEATS =	63					
BOOKING CLASS	AVERAGE FARE	SEATS BOOKED	FORECAST DEMAND MEAN	SIGMA	JOINT PROTECT	BOOKING LIMIT
Y	$ 670	2	10	5	5	63
M	$ 550	4	13	7	19	58
B	$ 420	5	5	2	27	44
V	$ 310	12	10	5	40	36
Q	$ 220	17	20	6	63	23
L	$ 140	32	15	4		0
SUM		72	73			

Higher than expected Q bookings close L class

exceeds availability so close down lowest class (handwritten)

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Frequent Flyer Award "W-Class"

BOOKING CLASS	AVERAGE FARE	SEATS BOOKED	FORECAST DEMAND		JOINT PROTECT	BOOKING LIMIT
			MEAN	SIGMA		
CABIN CAPACITY =	135					
AVAILABLE SEATS =	135					
Y	$ 670	0	12	7	6	135
M	$ 550	0	17	8	23	129
B	$ 420	0	10	6	37	112
V	$ 310	0	22	9	62	98
Q	$ 220	0	27	10	95	73
L	$ 140	0	47	14	158	40
W	$50					-23
	SUM	0	135			

(handwritten) ← freq Flyer awards

(handwritten, arrow pointing to SUM) Value it at some point

33

Current State of RM Practice

- **Most of the top 50 world airlines (in terms of revenue) have implemented 3rd generation RM systems.**

- **About a dozen leading airlines have implemented next generation Network "O+D control" RM systems**
  - Further distinguish between seats available to local versus connecting passengers, based on total revenue contribution

- **Need to modify RM systems for new fare structures**
  - Existing systems, left unadjusted, generate high load factors but do not maximize revenues
  - Many airlines are currently using manual overrides
  - Current research into forecasting of passenger choice and willingness to pay, to prevent "spiral down" and increase revenue

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(handwritten) Freq. Flyers dept to argue w/ RM people about valuation

(handwritten) So actually freq. Flyer seats are most available 3-4 weeks in advance

Slide 1

Airline Pricing and Competition

Prof. Nancy L. Rose
16.71J/1.232J/15.054J
The Airline Industry
September 27, 2010

econ prof

1

Slide 2

Airline Pricing and Competition

I. Basics of airline price determination
  - Profit maximization and price determination
  - Demand: Factors affecting passenger choice of air carriers

II. What do airline price structures look like, and why?

III. The role of competition
  1. On average fares *Mean*
  - Airport market structure: hub premia
  - Route market structure: actual & potential competition
  2. On fare structure *distribution*
  - Stochastic demand/revenue management
  - Price discrimination/price dispersion
  3. And fees: "Add-on Pricing"

2

Slide 3

Airline prices are determined by profit-maximizing carriers

Who optimize with respect to

- Demand
  - Which is stochastic and varies across potential customers *heterogeneous*

- Costs
  - Passenger and Flight-level costs
  - Capacity (opportunity costs)
  - Route level costs
  - Network characteristics

- Competitors' expected responses

Oligopoly
potential competitors
- preditory pricing?

3

Slide 4

Price Determination Analytics

Profit Maximization implies:

Choosing price, P, or price distribution, g(p), to maximize profits:

$$\pi = P^*D(P) - C(D(P)) \quad \text{for a single uniform price}$$

At the optimum, marginal revenue = marginal cost

$$\frac{\partial \Pi(P)}{\partial P} = 0 \implies \frac{P - MC}{P} = -\frac{1}{\varepsilon_d} \quad \text{for single price, P}$$

single, non stratigic single price

$$\implies \frac{p - c}{p} - \frac{\lambda}{p \cdot \Pr(\text{seat offered at } p \text{ is sold})} = -\frac{1}{\varepsilon_d} \quad \text{for distribution of prices } g(p); \text{ see Dana (1999b)}$$

where MC = marginal cost of additional passenger (capacity + operating)
  ε_d = demand elasticity for this airline w.r.t. own price(s)
  c = marginal operating cost of additional passenger
 λ = shadow capacity cost of additional seat

4

Price Determination Analytics

- **Profit-maximizing prices increase with**
  - Level of marginal costs, including "effective marginal cost of capacity"
  - Consumer willingness to pay/inelasticity of demand
  - Competitors' prices (through elasticity term, assuming prices are strategic complements)

- **Profit-maximizing price may not be uniform IF**
  - Firms have market power (not perfectly competitive) ✓
  - Customers vary considerably in willingness to pay ✓
  - There is an effective (& not too costly) customer segmentation mechanism ✓

[handwritten: basic]

[handwritten: price to q sell at demand]

[handwritten: — Can't resell ticket]

5
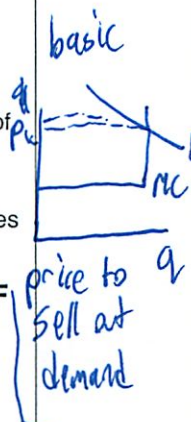
Demand Determinants

Passenger share on route j for airline i is a function of <u>own and competitors'</u>:

- **Price(s)**

- **Frequency of service and schedule**
  - departure time, elapsed travel time, flight frequency, flight share

- **Quality of service and products offered**
  - reliability (on-time)
  - airport and in-flight service amenities
  - restrictions on discount fare products

- **Airline brand quality**
  - loyalty programs (FFPs), reputation
  - route structure from passenger home airport

6

II. What do airline price structures look like?

Most-expensive domestic routes
One-way fare, based on price per mile

	Distance (miles)	Passengers per day	Average fare	Price per mile
Boston–Philadelphia	280	484	$342	$1.22
Hartford, Conn.–Washington, D.C.	326	189	$324	$0.99
Boston–New York	200	2,968	$196	$0.98
Portland, Ore.–Seattle	129	461	$125	$0.97
Chicago–Cincinnati	264	399	$240	$0.91

Least-expensive domestic routes

Boston–Long Beach	2,602	330	$169	$0.06
Ft. Lauderdale, Fla.–Long Beach	2,327	232	$158	$0.07
Ft. Lauderdale, Fla.–Seattle	2,717	334	$196	$0.07
New York–Oakland	2,576	326	$190	$0.07
New York–San Jose	2,569	320	$200	$0.08

* Jan.–March 2010

Source: Department of Transportation

[handwritten: Short]

[handwritten: long]

[handwritten: ← most expensive route in county! but now southwest (should look again)]

7

And it isn't all distance.....

Prices across similar distance OD markets. 2010 Q1

Market	Distance	Pax/day	2010 Q1 Mean Fare	Price Per Mile
Boston-New York	200	2,968	$196	$0.98
Miami-Tampa	204	232	$151	$0.74
NY-Syracuse	209	253	$131	$0.63
LAS-Long Beach	231	425	$89	$0.39
Boston – Philadelphia	280	484	$342	$1.22

Source: Wall Street Journal calculations from DOT DB1B, 2010: Q1

8

4 flights may be less costly than 2— for the passenger, not the airline

- Boston – Detroit: Northwest

$686 in 2007; $457 in $2008; $330 in 2009 (3 weeks AP)
  - Depart: Mon, Oct 18, 6 am, Northwest flight 1831
  - Return: Wed, Oct 20, 4:58 pm, Northwest flight 332

****

- Boston – Chicago (via Detroit): Northwest
  $357 in $2007, $411 in 2008; $200 in 2009
  - Depart Mon, Oct 18, 6 am,
    - Northwest flight 1831 BOS-DTW
    - Connect: Northwest flight 1237 DTW-ORD
  - Return Wed, Oct 20, 1:46 p.m
    - Northwest flight 1421 ORD-DTW
    - Connect: Northwest flight 332 DTW-BOS

9

Prices Vary Across Passengers on a Given Carrier-Route

- Within OD markets, airlines offer a wide range of "fare products" at different price levels with different amenities and restrictions

- Prices may be lower for products with higher production costs; for example, round-trip v. one way purchases

10

Round trips may cost less than a one way trip with the same flight

Boston – DTW Northwest One-way (3 wk AP)

$811 in 2008; $524 in 2009; $579 in 2010

Oct 26: BOS – DTW Northwest 371

RT fare with return on Oct 28: $330 in 2008

                                   $591 in 2010 (DL)

RT fare with return November 1 (Saturday night stay)

                                   $299 in 2010 (DL)

Nonstop carrier on route: Northwest (DL in 2010)

11

But not always....

Boston – ORD United

Oct 26: BOS-ORD UA 527 (6:55 a.m.)
One-way $89 ($104 on USAIR 6439 code-shared)
  $109 in 2010 ($127 on USAir or CO code-share)

someone else's codeshare cost more or other way around

Roundtrip with return on Oct 28, UA #540 (4:05 pm):
$179 RT ($219 in 2010)

Nonstop carriers on route: AA, UA, Jet Blue

12

- people don't know, don't want to spend search time

Slide 13

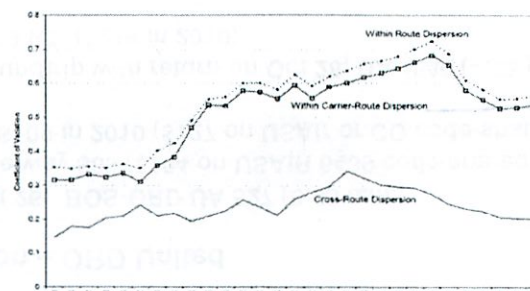**Airline price variation is substantial, but has declined in recent years**

- **Across passengers within a carrier-route**
  - Price dispersion across passengers on a carrier-route increased considerably over post-deregulation period
    - By mid-1990s, expected difference in fares paid by 2 randomly selected passengers on a route approached 50% of the mean fare on the route
  - Price dispersion has been falling since 2001
    - About 20% lower than peak dispersion levels
- **Across airports and routes**
  - Average fares across most expensive and least expensive top 50 airports have converged since mid-1990s peak difference

[handwritten: For a ANAHAN — 1 OD market]

13

Slide 14

[handwritten top: Varies a lot over time]

Within (Carrier-) Route Fare Dispersion Increased with Deregulation, But Has Declined Post- 2001

Figure 5: Within-Route and Cross-Route Price Dispersion, 1979-2007

Source: Borenstein and Rose, 2008.

[handwritten: σ / Mean]
[handwritten: 1979 ... year ... 2001]

14

Slide 15

Disparity in Average Airline Prices (distance-adjusted) across 50 Largest Airports 1984-2007

[handwritten: + general fare levels]

Source: Borenstein and Rose, 2008
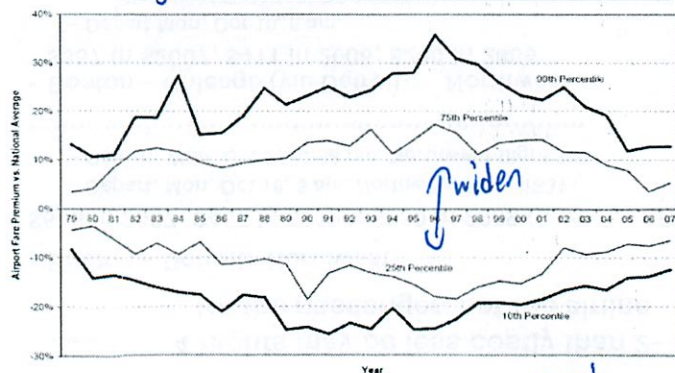
[handwritten: ↑widen   ↓ narrowed]
[handwritten: erosion of hub airport effect]

15

Slide 16

The observed price structure is complex

- **Airline prices vary substantially**
  - Across airports, routes, and passengers
- **Often in ways that seem inexplicable (to travelers)**
  - Differences in yields across routes
  - Hidden City Fares
  - One-way v. Round-trip Fares
- **How much is explained by competitive factors?**
  - Economists have developed extensive empirical analyses of pricing patterns
  - Particularly around competition and demand elasticities

16

Slide 17

A variety of possible contributors

PRICE-O-METER

AIRLINE TYPE	COMPETITION	PASSENGERS	OPERATING COSTS
Low-cost carriers influence the market.	Fewer airlines or having two airlines with partnership deals drives up prices.	Business fliers are less sensitive to higher prices.	High terminal rents, landing fees and other airport expenses boost ticket prices.

LONG ROUTES

FROM NEW YORK TO LONDON — $0.17

FROM NEW YORK TO LOS ANGELES — $0.12

SHORT ROUTES

FROM HARTFORD TO WASHINGTON DC — $0.99

FROM MILWAUKEE TO ST. LOUIS — $0.30

WSJ 8/26/2010

(handwritten below slide:) Budget / Fierce / Lease / Operating cost — slots, takeoff fees / Premium / Biz

17

Slide 18

Q1: How does competition affect average fare levels?

Can we make sense of these (seemingly anomalous) patterns?

- Few airline markets are perfectly competitive, even with multiple carriers
  - Most markets served by a small number of firms, who recognize that their actions affect market outcomes
  - Airline service is a differentiated product: consumers may not view different flights as identical products, even on the same carrier-OD market pair.
  - Firms interact repeatedly, over time and across markets
- Economic theory of oligopoly behavior suggests many possible outcomes ("Folk Theorem")
- Econometric analyses help to assess the most important competitive determinants
  - Nature of competition is essential
  - But is it actual or potential competition?
  - How does identity of competition matter?

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Slide 19

Competition at the Airport Level Matters

- *Airport* market structure—not just *route* competition—has an important effect on average fares

- This is particularly true at hub airports:
  - Economically and statistically significant hub premium, even after controlling for route characteristics and competition (e.g., Morrison and Winston, 2000)

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Slide 20

Hub Premia Estimates

Large hub-large hub	.34 (.09)
Large hub - medium hub	.33 (.09)
Large hub - nonhub	.03 (.11)
Medium hub-medium hub	.33 (.09)
Small hub- small hub	-.01 (.16)

Estimated premium for ln(fare) relative to nonhub-nonhub markets. Standard errors in parentheses.

Source: Morrison & Winston, 2000

(handwritten:) old / Think may have changed

20

Airline Pricing and Competition - 27 September 2010

5

FFP = loyalty programs

Interpretation of airport hub premia

Ongoing debate over interpretation

• Some evidence that hub premia have declined somewhat in recent years

Do they result from:
- Market power (enhanced by FFPs) *— dominate airline, lots of freq. and loyalty programs*
- Product quality differences:
  • Hub markets have more frequent service than non-hub (can control for this; premium persists)
  • Hub carrier produces more desirable product (FFP awards)
- Business/fare mix *do they locate hubs in big market?*

• Lederman (2007 & 2008): First two matter, and interact considerably: extensions to FFPs through alliances increase demand and prices on the most affected routes (dominated/hub airports)

21

Competition on the *route* also is important

Rich economics literature on this question, with qualitatively similar results across studies

• Adding service by a second airline on a monopoly route reduces fares on the route by about 8%, all else constant

• Adding a third competitor reduces fares another 8%

• Not much effect beyond the third

Source: Borenstein, Journal of Economic Perspectives, 1992

dozens of studies

22

just mean effects
— could it vary widely on each route

Identity of competitors matters at least as much as the degree of competition

• **Carriers exhibit substantial heterogeneity in costs**
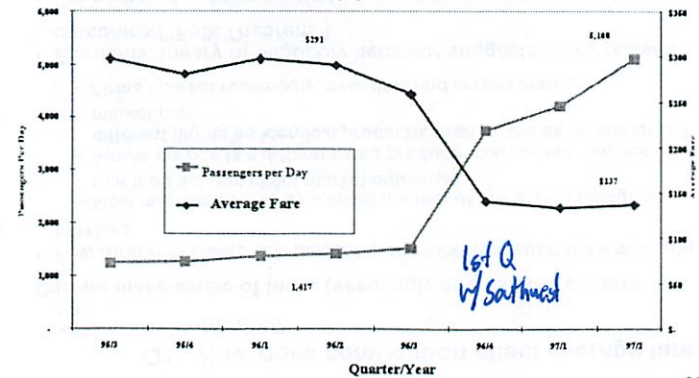
• **Low-cost competitors tend to produce the largest fare reductions on routes**
  – ANECDOTALLY

• **Regression evidence suggests this can be huge**
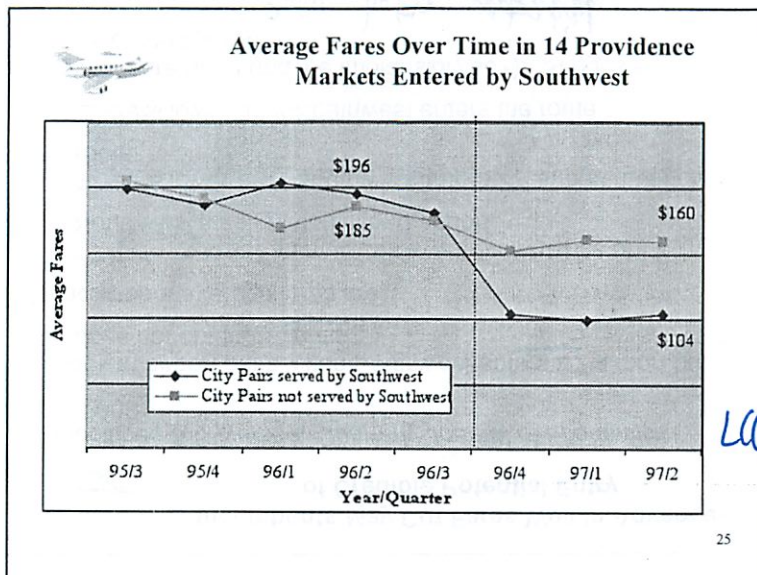 – Morrison & Winston, 2000

23

Southwest Entry into Providence Markets

Fare and Passenger Trends in 14 Providence Markets Before and After Entry by Southwest in October 1996

1st Q w/ Southwest

24

Slide 25

Average Fares Over Time in 14 Providence Markets Entered by Southwest

Chart showing Average Fares (y-axis) vs Year/Quarter (x-axis: 95/3, 95/4, 96/1, 96/2, 96/3, 96/4, 97/1, 97/2). Values noted: $196, $185, $160, $104.

Legend:
- City Pairs served by Southwest
- City Pairs not served by Southwest

25

Handwritten notes:
In 90s → LCCs came into nearby regional airports — lessen legacy response

---

Slide 26

Competitor Effect Estimates
Morrison & Winston, 2000

Number of legacy carriers on route	-.03 (.01)
Number of low-fare carriers on route	-.06 (.06)
Southwest on route	-.40 (.03)
Southwest on adjacent route, not this route	-.10 (.02)
Low-fare carrier on adjacent route, not this route	-.10 (.02)
Southwest at endpoint airport(s) number endpoints, not on this route	-.08 (.02)

Estimated premia in ln(fare). Standard errors in parentheses.

26

Handwritten notes:
% decline for each add. legacy customer
already there, just needs to shuffle their schedule to add → credible threat reduction
Southwest

Slide 27

Should Potential Competition Matter?

<u>These are firms that *could* enter, but haven't yet</u>

Classical Economics Models say "No":

- If market participants are symmetrically informed and positioned, pre-entry pricing behavior won't affect post-entry game.

- Incumbents would sacrifice short-term profits by reducing price in anticipation of entry, even if they know prices will be lower after entry

- Incumbents therefore should price to maximize profits given actual competition, deal with entry if/when it occurs

27

Slide 28

Should Potential Competition Matter?

Game theoretic and behavioral models say "Maybe"

- Game theory: Incumbents may be able to deter entry or reduce scale of entry by pre-entry price reductions
  - Asymmetric information/signaling:
    lower prices credibly signal less profitable entry
  - OR Altered payoffs:
    lower prices today increase customers attached to the incumbent, reducing entrants

- Behavioral models: Consumer perceptions of "fair" pricing may constrain pre-entry price behavior
  - If consumers interpret significant price reductions post-entry as evidence of "unfair" high prices, and shift to entrant, incumbents may reduce prices in anticipation of entry

28

Handwritten notes:
Why does southwest not publish fares on other sites?
- differentiate branding
- loyalty

Behavioral economics: "Fairness" in pricing may constrain firms

- Prices that seem arbitrary may be interpreted by consumers as "unfair"
  - Prices across OD markets that appear unrelated to distance or operating costs
  - Prices that are lower for products with higher production costs: Hidden city" fares, round-trip v. one-way fares
  - Lower prices on the same route post-entry: either by entrant, or incumbent price matching of entrant low price: do these signal "exploitation" by incumbent before entry?
- Consumer response to "unfair" prices may constrain optimal price paths (e.g., Rotemberg, 2005)
  - =>Firms may reduce prices in anticipation of possible entry

Consumers madi you ripped me off for years → I'm glad I can leave you

29

Given the ambiguity, what's the evidence on potential competition?

Econometric analysis:

- Adding a potential, but not actual, competitor reduced average fares by no more than 1% - 2% through 1980s, early 1990s (Borenstein, 1992)

- Morrison and Winston, 2000: Low-fare carrier potential competition (presence at endpoints or alternate airports) reduces prices by 8-10% even when not present on route

30

Incumbents May Cut Fares Well in Advance of Credible Potential Entry

Goolsbee & Syverson, *Quarterly Journal of Economics* (2008)

Look at airport pairs when Southwest enters 2nd airport but does not enter the route.

Incumbent average fares are:

- 10 to 14 % lower as much as a year in advance of Southwest's entry into second airport

- 17-22% lower after Southwest enters 2nd airport, but not route

- 22-29% lower after Southwest enters the route

Effects are huge (maybe implausibly so?). Suggests research opportunity.

even before potential

definite entry

31

Airline Pricing and Competition

1. Competition and Average Fare Levels

2. Competition and Fare structure

3. The Rise of Fees

32

Competition affects Fare *Structure* as well as Fare Levels

- Airline markets exhibit considerable dispersion in fares
  - Across routes (on yield / rpm basis)
  - Across carriers on a route
  - Across customers of a given carrier on a route
- Recall the time pattern of within-route price dispersion-- increasing over time until 2000, declining since then
  - Why? Possibly LCC penetration (different pricing model)

33

Fare dispersion is implied by stochastic demand management ...

Stochastic demand management models
  - Revenue management key given stochastic nature of demand, non-storable output, and fixed short-run capacity
    - Professor Belobaba will cover this in detail
  - Theoretical economic models: e.g., Dana, RAND, 1999a, b.
    - Carriers fix prices and inventory in advance
    - Low-price seats sell first. High-price seats sell last, and only if demand for that flight turns out to be high
  - These models predict that different passengers on a given flight may pay different amounts for their tickets—and usually have a more precise set of predictions about the relation between prices and probability of sold-out flight, order of ticket sale, etc.

34

And by price discrimination

- What is price discrimination?
  - George Stigler: Differential mark-ups of price over MC, based on consumer heterogeneity in price- or quality- sensitivity ("demand elasticities")
  - This facilitates identification of price discrimination across differentiated products
- Many pricing institutions seem intended to segment demand along willingness-to-pay or elasticity lines, hard to reconcile with stochastic demand management   *Segmentation*
  - Advanced purchase, Saturday night stays: "Single best restriction of them all"
  - Initiatives to make discount tickets less attractive to business flyers (reduced exchange option, fee for standby, etc): reduce arbitrage opportunity across fare classes.
  - Limited by competition with LCCs that don't impose similar restrictions

might not be able to do if LCC does not play along

35

Empirical evidence suggests competition may increase price dispersion

- Competition tends to reduce low-end fares by more than high-end fares
- Price dispersion appears to increase with competition on the route (e.g., Borenstein and Rose, 1994, Stavins, 2001).
  - Duopoly and competitive routes have more price dispersion than monopoly routes
  - Asymmetric duopoly has less price dispersion than symmetric duopoly (looks closer to monopoly)
- Consistent with significant price discrimination on "brand loyalty" as well as overall willingness-to-pay

36

Price Dispersion and Competition in the 21st Century

- BUT: Recent economics paper (Girardi & Hale, 2009) suggests that entry onto routes may decrease rather than increase price dispersion
  - Perhaps a result of the type of entry: More LCC entry in past decade. LCC such as Southwest and Jet Blue have different business, pricing models.
  - How much is this effect? (Explanation in the paper doesn't quite work)
  - The jury is still out....

[handwritten: Flips previous results]

37

Price Dispersion and Competition in the 21st Century: II– The Internet

- Interesting new work in this area (Bill Brunger, Steve Wiggins, and others): More on this in a couple weeks
  - Internet may reduce search costs, leading to more intense competition and perhaps compressed fare distributions?
  - The end of price dispersion???

[handwritten: responsible for fees?]

38

Airline Pricing and Competition

Q1: Competition and average fare levels

Q2: Competition and Fare structure

Q3: Airline fees & "add-on pricing"
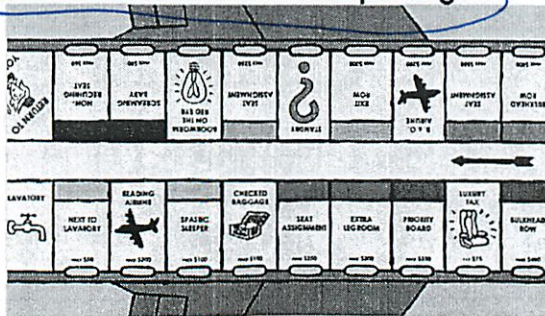
39

Q3: Does Competition Increase or Limit the Use of Fees?

Add-on pricing, fees, and obfuscation

Internet-induced pricing transparency may change market dynamics—but also firms' strategies

Recent economic models & empirical work suggest that firms need not be passive when technology, such as internet search sites, intensify competition by increasing pricing transparency

— and it probably isn't optimal for them to be

When customers with high willingness to pay for "add-ons" have high search costs, firms may use "hidden" add-on prices as additional price discrimination tool

Competition may not erode these add-ons, as making add-on prices transparent can be costly and increase sales to "cheap" customers more than sales to "high price" customers

See Ellison, 2005; Ellison & Ellison, 2009; Ellison & Wolitzky, 2009

[handwritten: don't quality of data - what fees w/ what ticket]

[handwritten: memory modules in PC market - hiding cost - advertise crappy product, then upsell (want to read)]

40

10

Slide 41

The Rise of Airline Fees & "Add-on Pricing" The Competitive Response?

"Big business, nasty business

In 2009 alone, airlines generated $7.8 billion from ancillary fees, largely from checked bags. That's a 42% increase over the previous year. And while that growth rate is unsustainable over the long term, no one expects the industry to throttle back on its newfound reliance on fee revenues."
USA Today 7/8/2010

In the second quarter of 2010, airlines collected $2.1 billion in ancillary fees, which include charges for checked bags, ticket changes, pet transportation and other fees, according to the Bureau of Transportation Statistics. *CNN 9/22/2010*

"For airlines, one huge advantage of fees is that they don't show up in most reservation systems when consumers are shopping for airfares. That's because airlines aren't required to advertise fees that only certain customers will pay, like those checking baggage. As a result, head-to-head price comparisons at booking sites like Expedia.com, Travelocity.com and Orbitz.com become more difficult, and prices listed in travel-agency computers won't tell the whole story. What's more, low teaser rates can lure fliers, even if the ultimate cost of the travel is higher." -S. McCartney, WSJ, 3/3/2009

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Slide 42

A sampling of the variety of fees in 2009

http://www.billshrink.com/blog/4143/hidden-airline-fees/

Fee Comparison:	CHECKED BAGS	INFLIGHT WIFI	UNACCOMPANIED MINOR	TELEPHONE BOOKING	PETS	FLIGHT CHARGE
AirTran	$15 FIRST $25 SECOND	$9.95 LAPTOP / $7.95 MOBILE	$39	$15	N/A CARGO $25 CABIN	$15 PET / $0 STANDBY LEG
AA	$15 FIRST $25 SECOND	$9.95 LAPTOP / $7.95 MOBILE	$100	$20	$150 CARGO $100 CABIN	$50
Continental Airlines	$15 FIRST $25 SECOND	$0 FIRST CLASS / $6 ECONOMY DIRECTED FLIGHTS / $100 CONNECTING	$75 NON-STOP / $100 CONNECTING	$15	$149 CARGO $125 CABIN	$150
Delta	$15 FIRST $25 SECOND	$9.95 LAPTOP / $7.95 MOBILE	$100	$20	$275 CARGO $150 CABIN	$150
Frontier	$25 ECONOMY $0 ELITE CLASS	NONE	$50	$25	$100 CARGO N/A	DEPENDS ON TICKET TYPE
jetBlue	$0 FIRST $30 SECOND	LIMITED TRIAL ACCESS	$75	$15	N/A CARGO $100 CABIN	$100
Midwest	$15 FIRST $25 SECOND	NONE	$50 NON-STOP / $75 CONNECTING	$25	$150 CARGO $125 CABIN	$50
Southwest Airlines	$0	LIMITED TRIAL ACCESS	$25	$0	N/A CARGO $75 CABIN	$0
spirit	$19/$25 1ST BAG/LAPTOP $25 SECOND	NONE	$100	$4.90 ALSO ONLINE	N/A CARGO $100 CABIN	$100
United	$15/$20 1ST BAG/LAPTOP $25 SECOND	NONE	$99	$25	$250 CARGO $125 CABIN	$150
US Airways	$15/$20 1ST BAG/LAPTOP $25/$30 SECOND	NONE	$100	$25	N/A CARGO $100 CABIN	$150

Slide 43

A bit of the variation in fees for booking seats- & when they are disclosed

	AirTran	Continental	Frontier	JetBlue	Spirit	United	US Airways
FOR SALE	Advance seat assignments	"Choice" seats	"Stretch" seats	"Even More Legroom" seats	Advance seat assignments	Economy Plus seats	"Choice" seats
PRICE RANGE	$6 to $20	Undisclosed	$15 to $25	$10 to $40	$8 to $20	$9 to $49	$5 and up
WHAT YOU GET	The ability to pick your seat; some higher-priced seats come with extra legroom	7 extra inches of legroom	5 extra inches of legroom	4 extra inches of legroom	The ability to pick your seat	Up to five extra inches of legroom	A non-middle seat at the front of the plane
WHERE	Any seat on the plane	Exit and bulkhead rows	First four rows	Rows 2 to 5 and the exit rows	Back rows, $8 Middle rows, $12 Front rows, $16 Exit rows, $20	First few economy rows	Aisle or window seat in first, several rows of coach
PRIORITY BOARDING?	For premium seats and exit rows only	No	No	No	No	No	No
WHEN TO BUY	During ticketing	During check-in	During check-in	During ticketing and check-in	After ticketing	During ticketing and check-in	During check-in

All prices are per flight segment and are generally based on the length of the flight.

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Slide 44

Policy Response: DOT Notice of Proposed Rulemaking, June 2010

- 8. Baggage and Other Fees and Related Code-Share Issues
  A. Require U.S. and foreign air carriers that maintain a website accessible to the general public to prominently disclose on the homepage of such website any increase in the fee for checked or carry-on baggage or any change in the free baggage allowance for checked or carry-on bags.

- B. Require U.S. and foreign air carriers that issue e-ticket confirmations to passengers to include information regarding their free baggage allowance and/or the applicable fee for a carry-on bag and the first and second checked bag on the e-ticket confirmation.

- C. Require U.S. and foreign air carriers that have a website accessible to the general public to disclose all optional services that have fees to consumers through a prominent link on their homepage that leads directly to a listing of those fees.

- D. Request comment on requiring carriers to provide up-to-date information on all ancillary fees to global distribution systems to make sure the information is available to both Internet and "brick and mortar" travel agencies.

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no studies yet
politically hot

Current Policy Debate

ATA opposes DOT rulemaking to require "full fare advertising," purchase site disclosure of ancillary fees, and required provision of fee data to GDS (distribution systems) as unnecessary, overreaching, or both

Airline passenger groups filed their response to NOPR:

MAD AS HELL DAY!
SEPTEMBER 23, 2010 ▲ Hidden fees ❶ Have you paid?

Stay Tuned!

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(handwritten) Chap 5

MIT ICAT
MIT International Center for Air Transportation

AIRLINE OPERATING COSTS AND PRODUCTIVITY MEASURES

Dr. Peter P. Belobaba

16.71J/1.232J/15.054J/ESD217J
The Airline Industry
September 29, 2010

(handwritten) Assignment 1 ~~soon~~ due Mon

MIT ICAT — *Lecture Outline*

- **US DOT Form 41 Operating Cost Database**
  - Alternative cost allocation schemes
  - Functional cost categories and typical breakdown
  - Legacy vs. LCC cost trends by category

- **Flight Operating Costs**
  - Comparisons across aircraft types

- **Total costs vs. unit costs**
  - Comparisons across airlines

- **Airline Productivity Measures**
  - Aircraft productivity and impacts on block-hour costs
  - Employee productivity trends

2

MIT ICAT — *DOT Form 41 Database*
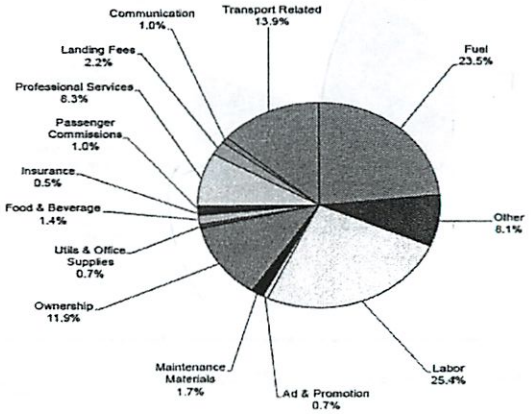
- **Form 41 contains traffic, financial, and operating cost data reported to the DOT by US Major airlines** *(handwritten) reported*
  - Data is reported and published quarterly for most tables
  - Detail of reporting differs for different expense categories *(handwritten) – not consistant +*
    - → Aircraft operating expenses by aircraft type and region of operation
    - → Other expenses more difficult to allocate by aircraft type *(handwritten) – diff ways to interperate*

- **Cost categorization schemes differ, but all are affected by accounting and allocation assumptions**
  - Administrative cost categories – financial reports
  - Functional cost categories – airline cost and productivity comparisons

3

MIT ICAT — *Administrative Cost Breakdown 2010 Q1*

(handwritten) raw materials

- Communication 1.0%
- Transport Related 13.9%
- Landing Fees 2.2%
- Professional Services 8.3%
- Fuel 23.5%
- Passenger Commissions 1.0%
- Insurance 0.5%
- Food & Beverage 1.4%
- Other 8.1%
- Utils & Office Supplies 0.7%
- Ownership 11.9%
- Maintenance Materials 1.7%
- Ad & Promotion 0.7%
- Labor 25.4%

4

Handwritten left margin:
→ Cost categories he is interested in
- not clean ways possible

Slide 5 — Functional Cost Categories

MIT ICAT

- **Aircraft operating costs**
  - Expenses associated with flying aircraft, also referred to as "Direct Operating Costs" (DOC)
- **Aircraft servicing costs**
  - Handling aircraft on the ground, includes landing fees
- **Traffic service costs**
  - Processing passengers, baggage and cargo at airports
- **Passenger service costs**
  - Meals, flight attendants, in-flight services
- **Promotion and Sales costs**
  - Airline reservations and ticket offices, travel agency commissions
- **Other costs, including:**
  - General and administrative expense
  - Depreciation and amortization

5

Slide 6 — Functional Cost Breakdown 2010 Q1

MIT ICAT

Pie chart:
- Transport Related 13.9%
- Flying Operations 36.6%
- Depreciation & Amortization 4.9%
- General & Administrative 6.0%
- Promotion & Sales 6.1%
- Aircraft & Traffic Servicing 15.5%
- Maintenance 10.4%
- Passenger Service 7.0%

Handwritten: a little over 50% is airplane operating cost

6

Slide 7 — Activity Drivers by Functional Category

MIT ICAT

- **Aircraft Operating Costs**
  - Per Block Hour (for example, $3300 for 150-seat A320 in 2010)   *(handwritten: door close ↔ door open)*
- **Aircraft Servicing Costs**
  - Per Aircraft Departure (average $1200)
- **Traffic Servicing Costs**
  - Per Enplaned Passenger (average $16)
- **Passenger Servicing Costs**
  - Per RPM (average $0.012)
- **Reservations and Sales Costs**   *(handwritten: changed over the years)*
  - % of Total Revenue (average 9%)
- **Other Indirect and System Overhead Costs**
  - % of Total Operating Expense (average 12%)

7

Slide 8 — Airline Operating Cost Breakdown

MIT ICAT

- **Adapted from Form 41, used by Boeing, MIT (and Aviation Daily) for more detailed comparisons**
  - FLIGHT (DIRECT) OPERATING COSTS (DOC) = 50%
    - → All costs related to aircraft flying operations
    - → Include pilots, fuel, maintenance, and aircraft ownership
  - GROUND OPERATING COSTS = 30%
    - → Servicing of passengers and aircraft at airport stations
    - → Includes aircraft landing fees and reservations/sales charges
  - SYSTEM OPERATING COSTS = 20%
    - → Marketing, administrative and general overhead items
    - → Includes in-flight services and ground equipment ownership
- **Percentages shown reflect historical "rules of thumb".**

8

Handwritten bottom notes:
transport related - misleading
  payment to subsidiaries + regional providers
  - don't include in unit cost → stupid

2

Slide 9: World Airline Operating Cost Breakdown

ICAO OPERATING COST CATEGORIES	1992	2002	2005
Direct Aircraft Operating Costs	44.0	49.1	54.0
Flight Operations (Total)	26.1	30.7	37.7
Flight Crew	7.2	9.0	7.8
Fuel and Oil	12.2	13.0	21.9
Other	6.7	8.7	8.0
Maintenance and Overhaul	10.9	11.3	10.2
Depreciation and Amortization	7.0	7.1	6.1
Indirect Operating Costs	56.0	50.9	46.0
User charges and station expenses (Total)	17.2	17.0	16.2
Landing and associated airport charges	3.9	4.0	3.8
Other	13.3	13.0	12.4
Passenger services	10.8	10.3	9.3
Ticketing, sales and promotion	16.4	10.7	9.1
General, administrative and other	11.6	12.9	11.4

9

Slide 10: US Legacy and Low Cost Airlines

Network Legacy Carriers	Low Cost Carriers
AA – American Airlines	WN – Southwest Airlines
UA – United Air Lines	B6 – JetBlue Airways
DL – Delta Air Lines (incl. NW)	FL – AirTran Airways
CO – Continental Airlines	F9 – Frontier Airlines
US – US Airways (incl. HP)	VX – Virgin America

- Legacy group carried 67% of total US airline traffic in 2009.
- These airlines carried another 17% of total US traffic (RPMs).

10

Slide 11: Flight Operations Expense per Block-hour

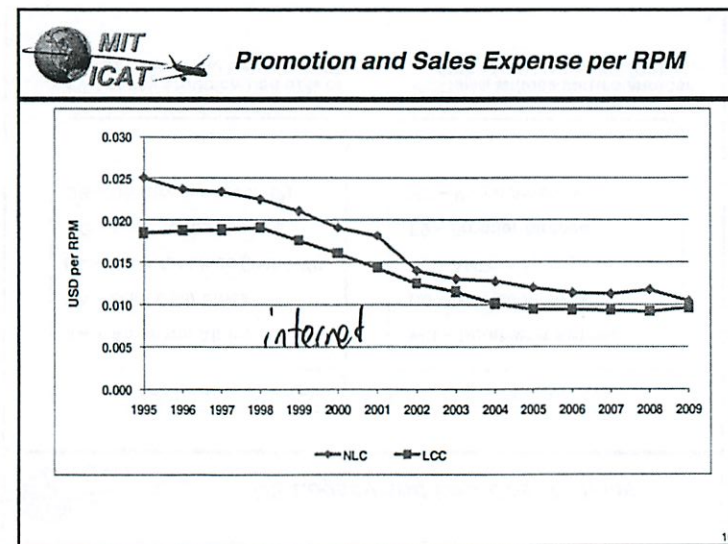*(handwritten annotations: "trends", "← larger aircrafts", "exclusive of passengers")*

11

Slide 12: Maintenance Expense per Block-hour

(handwritten annotations: "← bigger, international higher wages", "← newer aircraft")

12

Passenger Service Expense per RPM

food, blanket + pillows

← international 1st class lounges etc

Aircraft Servicing Expense per Departure

larger aircraft international – extra security

Traffic Servicing Expense per Enplanement

Complexity Connections hub + spoke

Promotion and Sales Expense per RPM

internet

Slide 17

- **Flight operating costs (FOC) by aircraft type:**
  - Reflect an average allocation of system-wide costs per block hour, as reported by airlines for each aircraft type
  - Can be affected by specific airline network or operational patterns
  - Collected by US DOT as Form 41 operating data from airlines

- **Typical breakdown of FOC for US carrier:**
  CREW: Pilot wages and benefits
  FUEL: Easiest to allocate and most clearly variable cost
  MAINTENANCE: Direct airframe and engine maintenance cost, plus "burden" or overhead (hangars and spare parts inventory)
  OWNERSHIP: Depreciation, leasing costs and insurance

Want to compare one airplane to another (handwritten)

17

Slide 18

- **Costs per block-hour**

	2005	2007	2010
CREW	$ 470	$ 454	$ 573
FUEL	$1327	$1713	$1433
MAINTENANCE	$ 524	$ 576	$ 692
OWNERSHIP	$ 570	$ 570	$ 604
TOTAL FOC	$2891	$3313	$3300

- **Based on reported average stage length and block-hr daily utilization (weighted averages):**
  - Different stage lengths and utilization by different airlines result in substantial variations in block-hour costs for same aircraft type
  - Also, differences in crew (union contracts, seniority), maintenance (wage rates), and ownership costs (age of a/c)

as people get more senior (handwritten)

18

Slide 19

- **All else being equal, larger aircraft should have highest flight operating cost per hour, lowest unit cost per ASM:**
  - There exist some clear economies of aircraft size (e.g., two pilots for 100 and 400 seat aircraft, although paid at different rates)
  - Also economies of stage length, as fixed costs of taxi, take-off and landing are spread over longer flight distance

- **But, many other factors distort cost comparisons:**
  - Pilots paid more for larger aircraft that fly international routes
  - Newer technology engines are more efficient, even on small planes
  - Reported depreciation costs are subject to accounting procedures
  - Aircraft utilization rates affect allocation of costs per block-hour

19

Slide 20

Aircraft Type	SEATS	FOC/ Block-hr	FOC/ Seat-hr	Average Stage (mi.)	Utilization (block-hrs/day)
DC9-30	100	$3,272	$32.72	486	7.9
A319	127	$3,049	$24.01	876	11.2
737-300	135	$3,595	$26.62	573	8.9
757-200	180	$4,486	$24.92	1429	10.2
A330-200	277	$7,093	$25.61	3724	11.6
747-400	381	$9,451	$24.80	4755	11.7

20

pilots make more $$ (handwritten)

biz + 1st class ↓ seats to "spread" operating costs over 5 (handwritten)

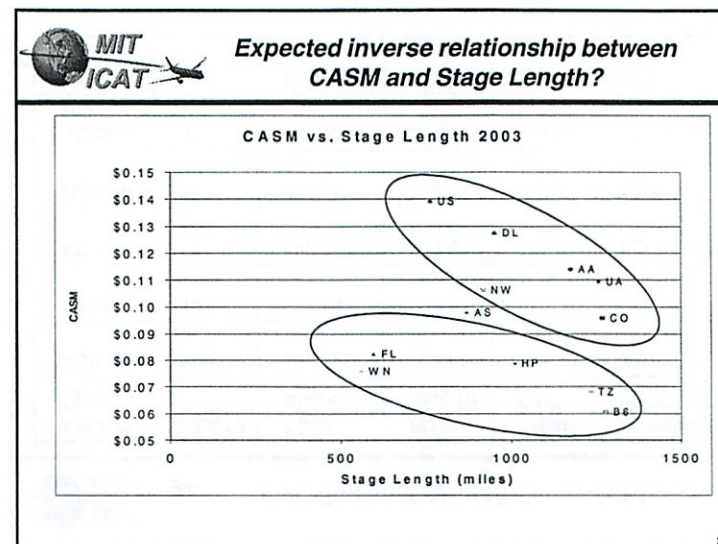*talk cost w/ adj*

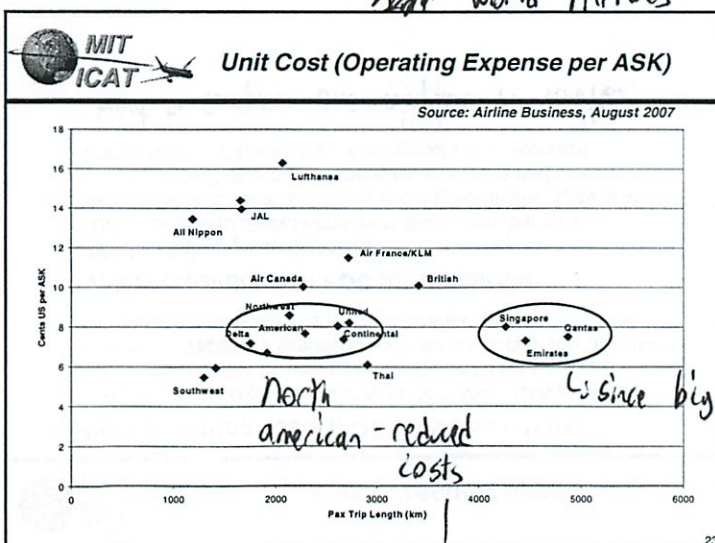## Slide 21 — Total Operating Costs vs. Unit Costs

MIT ICAT — **Total Operating Costs vs. Unit Costs**

- **Total operating costs increase with size of airline, aircraft size and stage length**
  - Increased output (ASMs) leads to higher total operating costs
  - Bigger aircraft cost more to operate (per block hour, per flight)
  - Longer stage length means more fuel burned, more pilot and flight attendant hours
- **But, due to high fixed costs, airlines should have economies of scale in unit costs (in theory):**
  - Larger aircraft should have lower operating costs per seat and per seat-mile (ASM)
  - Longer stage lengths should lead to lower unit costs
- **Larger airlines with bigger aircraft flying longer stage lengths should have lowest unit costs.**

21

Slide 22 — Expected inverse relationship between CASM and Stage Length?

MIT ICAT — **Expected inverse relationship between CASM and Stage Length?**

CASM vs. Stage Length 2003

22

World Airlines

Slide 23 — Unit Cost (Operating Expense per ASK)

MIT ICAT — **Unit Cost (Operating Expense per ASK)**

Source: Airline Business, August 2007

North american - reduced costs

since big airlines fling long distances

are cost competitive

23

Slide 24 — Aircraft Productivity

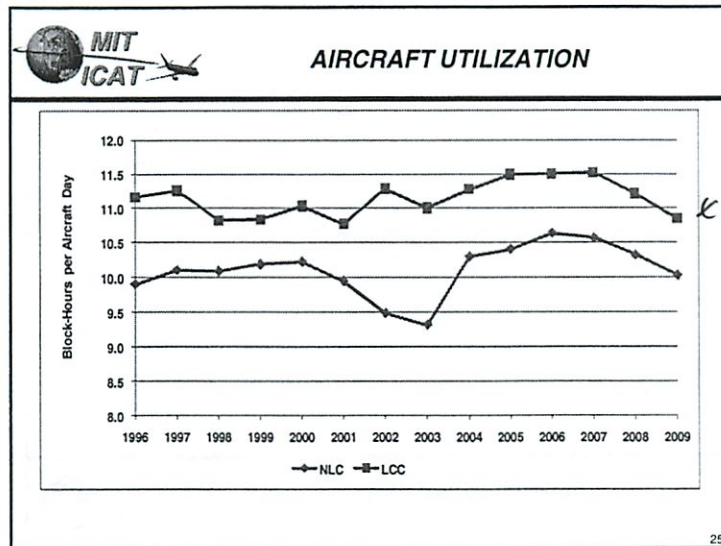**MIT ICAT** — **Aircraft Productivity**

- **Aircraft "utilization" measured in block-hours/day:**
  - Block hours begin at door close (blocks away from wheels) to door open (blocks under wheels)
  - Gate-to-gate time, including ground taxi times
- **Productivity measured in ASMs per aircraft per day:**

  = (# departures) X (average stage length) X (# seats)

- **Increased aircraft productivity achieved with:**
  - More flight departures per day, either through shorter turnaround (ground) times or off-peak departure times
  - Longer stage lengths (average stage length is positively correlated with increased aircraft utilization = block hours per day)
  - More seats in same aircraft type (no first class seating and/or tighter "seat pitch")

24

↑ LCCs unit cost lower - cram more seats in no 1st class

6

AIRCRAFT UTILIZATION

(handwritten) ← LCCs turn around their airplane often

Change in Utilization and Stage Length by Carrier 2000 to 2006

(handwritten) increase stage length to ↑ utilization

AIRCRAFT PRODUCTIVITY (ASMs per aircraft-day)

NLCs use bigger aircraft (and longer stage lengths) to achieve higher ASM/day, despite lower aircraft utilization rates.

Example: Airbus 320 Productivity 2005

(handwritten) Same aircraft

Airline	Flights per Day	Block Hours	Stage Length	Seats	ASMs
Northwest	3.6	9.3	957	148	513,513 (Base)
United	3.9	11.2	1116	146	639,801 (+25%)
JetBlue	4.0	13.7	1358	157	861,627 (+68%)

(handwritten) ↑ 1st class?

A320 FOC per Block Hour 2005 and 2007

(handwritten: 05)

Airline	Crew	Fuel	Maintenance	Ownership	Total
Northwest	$750	$1256	$597	$613	$3214
United	$478	$1241	$539	$436	$2694
JetBlue	$362	$1159	$358	$486	$2365

(handwritten: 07)

Airline	Crew	Fuel	Maintenance	Ownership	Total
Northwest	$540 (-28%)*	$1659 (+32%)	$564 (-6%)	$554 (-10%)	$3317 (+3%)
United	$435 (-9%)	$1740 (+40%)	$569 (+6%)	$576 (+32%)	$3555 (+32%)
JetBlue	$428 (+18%)	$1676 (+45%)	$338 (-6%)	$431 (-11%)	$2872 (+21%)

(handwritten: "if in bankrupcy not paying lease costs")

(handwritten: "once you have become a sucessful LCC — you piolets want raise, planes get old, pension/retirement liabilites seniority")

29

Employee Productivity

- **Measured in ASMs per employee per period**

- **As with aircraft, employee productivity should be higher with:**
  - Longer stage lengths (amount of aircraft and traffic servicing for each flight departure not proportional to stage length)
  - Larger aircraft sizes (economies of scale in labor required per seat for each flight departure)
  - Increased aircraft productivity due to shorter turnaround times (more ASMs generated by aircraft contribute to positive employee productivity measures)

- **Yet, network airlines with long stage lengths and large aircraft have lower employee productivity rates**

30

ASM per Employee

(handwritten: "LCCs higher productivity – culture")

(handwritten: "but NLCs ↑ productivity")

31

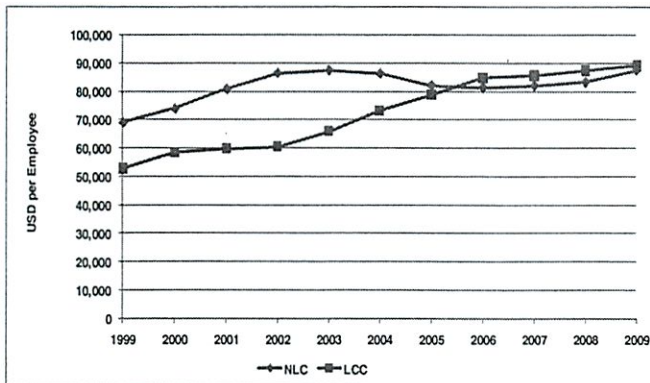## NLC employment down by 35% since 2000, a loss of 140,000 jobs

(handwritten: "↑ Fired a bunch of people technology – can fly w/o talking to employees")

32

8

Gap in Salaries/Benefits per Employee Disappeared in 2006

Chart: USD per Employee, 1999–2009, lines for NLC and LCC

Handwritten notes (right of chart):
LCCs pretty much pay people the same!

– but LCCs have higher productivity

Concluding Thoughts

- **US carriers made dramatic progress in cost cutting and productivity improvement 2001-2007**
  - Labor and distribution costs saw biggest reductions
  - Productivity improvements through network shifts, work rules and use of IT for passenger processing

- **With surging fuel prices and dropping demand, industry "recovery" stalled in 2008**
  - Not much room for further cost reductions – labor will push to recover recent concessions, distribution costs can't go lower
  - Aging fleets will push up maintenance costs
  - A return to profitability will depend more heavily on demand and revenue generation

Handwritten notes (right):
loose work rules
– looser def. of who does what

labor wants it back

33   34

9

Michael Plasmeier 10/2

ASSIGNMENT #1 (INDIVIDUAL)   DUE: MONDAY 04 OCTOBER

QUESTION 1 *(25 points)*

Consider the following small example of an airline network, in which MidUSA Airlines operates daily non-stop flights between its hub at St. Louis (STL) and Seattle (SEA), Los Angeles (LAX), Philadelphia (PHL) and Boston (BOS). Once each day, a 150-seat aircraft flies the route BOS-STL-LAX and back, while a second 120-seat aircraft flies the route PHL-STL-SEA and back again. The airline operates a connecting bank at STL in both directions, meaning that eastbound and westbound passengers can connect between the two flights at STL. For example, passengers originating at PHL can switch airplanes and continue to LAX.

You are provided with the following statistics on the operations of MidUSA Airlines for a <u>month of operations</u>. The "Average Prorated Fare" refers to the fact that total fares paid between, for example, BOS-LAX have been divided between the two legs that the passengers traversed.

Flights Aircraft Between	Capacity	Flights Distance	Average Operated	Average Load	*avg fare* Prorated Fare
BOS-STL	150	1037	60	102	$180
PHL-STL	120	803	60	90	$150
STL-SEA	120	1717	60	108	$230
STL-LAX	150	1597	60	132	$210

30 each way
Casino Airlines estimates its unit cost of operations to be ~~1~~1.5 <u>cents</u> per available seat-mile.

(a)   <u>Define</u> and <u>calculate</u> the following measures for this small network, using the information above for the <u>complete month of operations</u> (please show all calculations). If the measure <u>cannot</u> be calculated with the given information, explain why *(2 points each):*

all   for network - don't break down

(1) Total available seat miles
(2) Total revenue passenger miles
(3) Average network load factor
(4) Average leg load factor (ALLF)
(5) Average passenger yield
(6) Average stage length
(7) Average passenger trip length

(b)   Compare your answers to (3) and (4) in Part (a). Explain the reason for any discrepancy in the calculated values <u>in this specific example</u>. Which one is a better measure of "load factor"? Why? *(3 points)*

(c)   Use the information provided to calculate the monthly network operating profit for MidUSA Airlines. How much would its unit cost have to change for the airline to have a zero operating profit (break-even)? *(3 points)*

(d)   Using specific examples from this small network, define and explain the relevance to air transportation economic analysis of the following: *(5 points)*

   (1) Origin-destination markets that are "distinct and separate"
   (2) "Dichotomy of supply and demand" in air transportation

QUESTION 2 *(20 points)*

In an isolated O-D market, there are currently 2 competitors each operating 4 non-stop flights per day in each direction with 150-seat aircraft. Given that their prices and service quality are identical, they each capture 50% of the total market demand, as follows

	AIRLINE A	AIRLINE B
Aircraft Size	150	150
Flights per Day	4	4
Frequency Share	50%	50%
Market Share	50%	50%
Total Passengers/Day	420	420
Average Load Factor	70%	70%

Now, consider the entry by Airline C, a new carrier that introduces lower fares to the market. Assume that both Airlines A and B match (and always will match) the new lower fares of the new entrant, and that total daily demand in passenger trips in each direction can now be expressed as:

$$D = 11000 * T^{-1.5}$$

where $T = 4 + 4/N$, and N is the total non-stop frequency in the market in each direction. Price and quality variables are assumed to be fixed for all airlines, and are therefore incorporated into the constant term in the above demand model.

The market shares of the three competitors follow the relationship where for a given competitor i:

$$MS_i = \frac{(FS_i)^{1.5}}{\sum_i (FS_i)^{1.5}}$$

where MS_i = market share of total passenger demand for airline i
        FS_i = one-way frequency share (% of total daily departures) for airline i.

With the lower fares in the market, the break-even load factor for Airlines A and B has increased to 80% [average load factors must be above 80% for the airline to make an operating profit]. Because Airline C is a lower cost new entrant, its break-even load factor is 75%. Perform the following analysis for operations in one direction, per day.

(a)   New entrant Airline C enters the market with 4 flights per day with 120-seat aircraft. What are the impacts of this additional frequency on the total market demand, and the market shares and load factors for each airline? Which airlines are making an operating profit? Is this choice of frequency by the new entrant the "best" choice? Discuss. *(6 points)*

(b)   In response to the new entry of Airline C, Airline B shifts to smaller 120-seat aircraft but increases its daily frequency to 5 flights. Find the total market demand, market shares and average load factors for carriers A, B, C after these changes. Which of the airlines are profitable now? *(3 points)*

all must be the same

(c)   Airline A has a choice of 120-seat and 150-seat aircraft available in its fleet. How should Airline A respond in terms of its aircraft size and frequency if it wishes to stay in the market? Use the model to evaluate aircraft and frequency alternatives for Airline A assuming that Airline B will continue to operate 5 flights and Airline C will maintain 4 flights per day, both with 120-seat aircraft. Discuss the strategic options available to Airline A based on your analysis of the model results for alternative scenarios. *(7 points)*

Can it even compete?
- financing?

(d)   Discuss briefly the strengths and weaknesses of the Market Share vs. Frequency Share model that you used for this analysis. Specifically, what factors affecting airline market share does this model not incorporate? *(4 points)*

oligopoly → mutual dependence

QUESTION 3 (20 points)

Casino Airlines operates a 150-seat Boeing 737-800 aircraft once daily at 9 a.m. from Boston to Las Vegas. Provided below is a summary table of fare products, prices, under the airline's CURRENT fare structure.

FARE CLASS	ADVANCE PURCHASE	MIN. STAY	PRICE
	RESTRICTIONS		CURRENT FARES (EACH WAY)
Y	0	0	$600
M	7	3 DAYS	$400
Q	14	SAT NIGHT	$199

Use pt value as guide to std.

5 pts ~ paragraph → .5/pg

(a) Discuss this fare structure in the context of the various differential pricing techniques that have been presented in class and in the readings. That is, explain the economic rationale (or lack thereof) for the relative price levels and restrictions of the different fare products offered. To what extent does this fare structure provide for effective segmentation of business versus leisure demand, and the ability for Casino to extract higher fares from passengers with higher willingness-to-pay, independent of any RM system booking limits? *(5 points)*

normal dist.
# of seats, not fare   *↑ comes after, for certain flight*

(b) CASINO EMSRB.XLS shows the initial booking limits on each fare class in the coach cabin for a future departure of this flight on the BOS/LAS leg. The three fare classes are serially nested in the descending order Y, M, Q. This flight will depart 90 days from today and there are no actual bookings in the reservations system for this flight at this point in time. The worksheet shows that the optimal protection level for Y-class is 26 seats for a mean forecast Y-class demand of 30 bookings. Explain in intuitive terms (i.e., using English not math) the logic behind this outcome. *(3 points)*

(c) Use the spreadsheet to determine the impacts on the booking limits of the following changes to the inputs. Describe the output changes you observe and explain whether they make economic and intuitive

just use spreadsheet
- # seats protected depends on ratio of prices
  - every seat I protect for 600, but I get 400 3
  - tradeoff b/w 600 and 400 not 600 and 0
  - mean means P = .5 so avg A = 300 - so sell for 400!

$$E \ MSR \ [Y 2 6] \geq \frac{400}{600}$$

expected
marginal
seat
rev

① Deterministic model = abs. certainty

probalistic model = uncertain

(learn these terms, get really good at algortms)
 — need to get much better!

sense, under the assumptions of the EMSRb seat protection model. In each case, what real-world factors does the EMSRb model not capture, and how would these factors affect your acceptance of the EMSRb limits as Casino's RM analyst? (assess each change separately, with all else held constant): *(4 points each)*

real world → not all things =

(1) Due to a newly announced major conference to be held in Las Vegas in 3 months time, mean forecast demand for Y-class is increased to 60.

(2) Due to the pricing actions of a competitor, Casino reduces the Q-class fare to $149 and the fare input in the RM system is also reduced to $149.

real world; change price → also changes demand

(d) The airline's senior management believes that the "restricted" fare structure in (a) is too complicated, and is proposing that the minimum stay restrictions be removed from both the M and Q fare products. What would be the expected impacts on this flight's average load factor, yield and revenues? Explain why these impacts are expected to occur. *(4 points)*

QUESTION 4 *(15 points)*

Operating Profit = RPM • yield − ASM • unit cost

With the help of the "Basic Airline Economics" operating profit equation presented in class, discuss how each of the following recent airline industry trends can be explained by the components of the profit equation. That is, for each change below, identify the variables in the operating profit equation that are affected by the change, and describe the economic motivation for the change on the basis of these variables. Be sure to consider the interrelationships between the variables of the operating profit equation (maximum 1/2 page each).

why? how explain w/ each of 4

(a) An airline decides to reduce its frequency of service at off-peak times to reduce fuel consumption. *market share model*

(b) An airline shifts to increased use of internet distribution channels to sell tickets, instead of travel agencies.

(c) Two large network carriers decide to merge their networks and operations (explain the impacts on the combined carrier's operating profit).

QUESTION 5 Data Analysis and Performance Measures *(20 points)* *2 pgs*

Traffic + Capacity by operating region

A variety of traffic, capacity, revenue, expense and profitability measures for US airlines are presented on our "Airline Data Project" web site (airlinedataproject.mit.edu). These data are from DOT Form 41, and consist of selected measures for 15 of the largest US airlines. The data is provided at an aggregate system level (as well as for some sub-categories) for each airline, by year from 1995 through 2009.

just look operating income − not other stuff

link trends

Choose one of the 12 airlines with complete data shown for the 10-year period 2000-2009 (America West, Virgin America and Allegiant may not be chosen). Use the data available on the Airline Data Project web site to analyze the major trends experienced by your chosen airline since 2000 in terms of traffic, capacity, and profitability. Specifically, consider the evolution of the following measures and any interrelationships between them for your airline:

for that 1 airline what drives it
① describe data
② insights + analysis
③ interrelationships RPM (LCCs)/ASM

US Airways
− merge w/ American West

4

- Total System RPM, ASM, and Load Factor
- Total System Operating Revenue, Passenger Revenue, Cargo Revenue
- Operating Expenses, Operating and Net Income
- Total System Passenger Yields, Unit Revenues and Unit Costs

Please limit your analysis to "total system" data, even though there may be much more detailed data available on the website.
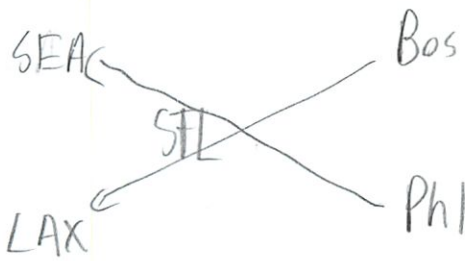
Discuss your findings and relate your analysis of your airline's recent performance and current situation to the primary "trends and forces" affecting the US airline industry, as described in class and in your readings (e.g., GAO Reports, ATA Annual Report). Your answer should not exceed 3-4 pages, including tables and graphs as appropriate.

ACADEMIC HONESTY

All assignments in this subject are to be completed individually, unless otherwise specified in the assignment. Discussion of the questions, concepts and data analysis approaches is allowed (and even encouraged), especially among airline team members. However, your submission for any individual assignment should be entirely your own work product, in your own words and format.

Use of any data, graphs or words from other sources should be specifically and properly attributed to the source, including web sites. Any evidence of direct copying (plagiarism) either from other sources or among students will result in a zero grade for the entire assignment. Further action may also be taken, including a permanent notation in the student's file and referral to the appropriate MIT academic disciplinary committee.

85

Median = 85   decimal places
90s = 6   min of 3 sig
80s = 11   digits
70s = 8   - like for yield
               (I think I did
               not look close enough
               at small changes)

1.

SEA — Bos   moth of operations
    STL
LAX — Phl

a 1) **Total ASMs** = $\sum$ Seats flying in revenue service • miles flown in rev service

$60 \cdot 150 \cdot 1037 + 60 \cdot 120 \cdot 803 + 60 \cdot 120 \cdot 1717 + 60 \cdot 150 \cdot 1597$

in general))

= 41,850,000 ✓

2) **Total RPMs** = seats filled (per mile)

$60 \cdot 102 \cdot 1037 + 60 \cdot 96 \cdot 803 + 60 \cdot 108 \cdot 1717 + 60 \cdot 132 \cdot 1597$

= 34,457,040

3) **Avg network load factor**

ratio RPM/ASM

$$\frac{34,457,040}{41,850,000} = \frac{47857}{58175} = .8233$$

4) **Avg leg load factor**

ratio RPM/ASM for each leg

Bos - STL $60 \cdot 102 \cdot 1037 / 60 \cdot 150 \cdot 1037 = .68$ avg
                                                                          .8025
PHL - STL   .75
STL - SEA   .9
STL - LAX   .88

5) <u>Avg passenger yield</u>

Revenue / RPM

total revenue: $(102 \cdot 180 + 90 \cdot 150 + 108 \cdot 230 + 132 \cdot 210) \cdot 60$

5,065,200

yield $= \dfrac{5,065,200}{34,457,040} = .147 = 14.7$ cents

6) <u>Avg stage length</u>

Avg non-stop flight distance
Aircraft miles flown / aircraft departures

↳ $\dfrac{1037 \cdot 60 + 803 \cdot 60 + 1717 \cdot 60 + 1597 \cdot 60}{60 + 60 + 60 + 60} = 1288.5$ miles

7) <u>Avg passenger trip length</u>

avg distance flown from O to d
RPM / Passengers

- but we don't know total passengers
- who got out in STL
- will assume no one got out in STL, everyone flew 2 legs

Pax $= \dfrac{60 \cdot 102 + 60 \cdot 90 + 60 \cdot 108 + 60 \cdot 132}{2} = 12,960$ people

③

$$\frac{34,457,040}{12,960} = 2658.72 \text{ miles}$$

b) Compare 3 + 4

Each has its own benefits

Network lead factor - good to analyze overall profitability of an airline, since it is impossible to split up costs to particular segment

leg load factor - Good to analyze a particular leg or flight of an airline → for instance to decide if to continue it or to switch to another route.

c) $\text{Costs} = .115 \cdot 41,850,000 = 4,812,750$

So current profit is $5,065,200 - 4,812,750 = 252,450$

To break even costs must be $\frac{5,065,200}{41,850,000}$ 12.1 cents

d) Using specific examples, define + explain:

1. OD markets being distinct + seperate.
Airlines don't sell tickets for certain flights, they sell you a ticket from point A to point B, Travelers don't care in which city they stop in. Each city pair has a distinct market with a set of competitors and market charastics.

For instance BOS-SEA may have a lot of business travelers and not much competition (such as a direct BOS-SEA flight) So this example does not show this information for O-D markets. This could be important. For example, as I said, BOS-SEA could have a very high price, while BOS-LAX has a very low price. The 2 prices have be averaged and prorated, so the given table may not be communicating the fares paid by each person most effectivly.

2) Dichotomy of supply and demand

Airlines run ~~//~~ a network ~~\~~ model. They can not allocate costs to each flight eaisly. For example if a plane is set up to fly A→B→C, if the airline decides to abandon A→B because it is unprofitable and add A→D, then what will happen to the B→C flight now that that airplane is in D, not B? Even if B→C has high demand, the airline still needs to fly A→B. In addition, a gate agent at airport B may be checking in people to A, C, D at the same time. How do you divide their labor cost? If you cancel the flight B→D, you still need the agent. Furthermore as explained above, some people on B→C will be connecting C→E

So what portion of their ticket price do they pay for B→C and C→E? In addition the B→E market may be very competitive and the price B→C C→E is less than B→C! Thus it is impossible to determine the cost of just an individual flight, and the cost is not related to what people pay. The airline will charge as much as possible reguardless of cost, (competition (demand WTP) and will fill every seat, even if the fare is below CASM because some revenue is better than no revenue.

Answer not complete.
See solution
− 1.5

23.5

2. 2 competitors ^{each} 4 flights/day (1-way)

Now C enters market. A+B match fares

$$D = 11\,000 \cdot T^{-1.5}$$

$$\circ\ 4 + \frac{4}{N} \leftarrow \text{total freq.}$$

$$MS_i = \frac{(FS_i)^{1.5}}{\sum_i (FS_i)^{1.5}}$$

Freq share (% of flights) for airline

↑ market share airline i

a) C enters w/ 4 flights/day   120 seats/flight

[Do on Excel

There seems to be a descripency where the model given for 3 airlines does not match model for 2.

In particular $D = 11\,000 \cdot \left(4 + 4/8\right)^{-1.5} = 1152$ not the 840 stated in the problem.

Anyway, total market demand 840 or 1152 → 1219 ↑ 379 depending which initial demand you use ↑ 67

Market share each airline $= \frac{1}{3}$

$$ALF = \begin{cases} A & .67 \\ B & .67 \\ C & .84 \leftarrow \text{due to smaller plane size} \end{cases}$$

unprofitable
unprofitable
profitable

(1)

Well best choice is based on best profit. We don't know fares, so can't calculate profit. We can look at which has highest ALF.

	ALF	Market Share
1 flight	.114	.105
2	.137	.15
3	.61	.24
4	.84	.33
5	1.05	.41 ← above capacity w/ 120
6	1.2	.47
7	1.39	.53

Yes 4 flights/day would give it the highest ALF without overfilling its 120 seat plane. (w/o looking at fares, cost, etc). An additional flight would increase its market share only 6% while 3→4 flights added 8%

~~—I~~

b) B → 120 seats, 5 flights/day

Total demand ≈ 1230 people

Market share =
{ A .29
  B .41
  C .29

ALF =
{ A .68
  B .84   ← back to profitable
  C 75   ← bairly profitable

Not necessarily best for profits

What is best?
- profitability
- hammering other guys
Could be more profitable in terms of higher total profits

⑧

c) A → 120 or 150 seats at 4 flights/day

150 seats → MS = .24   ALF = .60
120 seats → MS = .29   ALF = .75

A should cut the size of its planes because that will _not_ affect market share. Instead it will cut ALF to something a bit less $-losing. ✓
Also the cost is weird in this model in that it is linear w/ plane size which not entirly reflected of reality.

If A increases to 5 flights, at 120 seats

	ALF	MS
2	.64	.12
3	.72	.24
4	.75	.29
5	.76	.36
6	.75	.43

See solution: discussion on the competitive strategy to adopt.

It should cut to 120 planes anyway, but it can't make money in this market. Perhaps it should drop out, but it will depend on the entire network, if it can. Or it can wait, as no one is making $ for others to blink.

d) What about this model?

As I mentioned, the cost is all based on plane size, which may not be accurate. (linearly)

In addition revenue is hidden and not fully considered by this model. Airlines may play pricing games.
It ignores fare segmentation, assuming that they all do the same thing.

(9)

But predomantly it ignores the financing or opportunity costs of adding additional flights.

But overall this is a good model of a oligopoly,

- Schedule
- connechy services   - 2

see solution

~~financing restrictions~~

(16)

	A	B	Sum
# of flights	4	4	8
Freq Share	0.5	0.5	1
FS^1.5	0.353553	0.353553	**0.707107**
Market Share	0.5	0.5	1

T	4.5
Demand	1152.322

	A	B	Sum
Plane Size	150	150	**300**
Pax/Day	576.1611	576.1611	**1152.322**
ALF	0.960268	0.960268	

a).

	A	B	C	Sum
# of flights	4	4	4	12
Freq Share	0.333333333	0.333333	0.333333	1
FS^1.5	0.19245009	0.19245	0.19245	0.57735
Market Share	0.333333333	0.333333	0.333333	1

T	4.333333333
Demand	1219.437479

	A	B	C	Sum
Plane Size	150	150	120	420
Pax/Day	406.4791597	406.4792	406.4792	1219.437
ALF	0.677465266	0.677465	0.846832	

b).

	A	B	C	Sum
# of flights	4	5	4	13
Freq Share	0.307692308	0.384615	0.307692	1
FS^1.5	0.170676983	0.238528	0.170677	**0.579882**
Market Share	0.294330389	0.411339	0.29433	1

T	4.307692308
Demand	1230.3415

	A	B	C	Sum
Plane Size	150	120	120	**390**
Pax/Day	362.1268917	506.0877	362.1269	**1230.341**
ALF	0.603544819	0.84348	0.754431	

c).

	A	B	C	Sum
# of flights	5	5	4	14
Freq Share	0.357142857	0.357143	0.285714	1
FS^1.5	0.21343368	0.213434	0.152721	**0.579588**
Market Share	0.368250644	0.368251	0.263499	1

T	4.285714286
Demand	1239.817788

	A	B	C	Sum
Plane Size	120	120	120	360
Pax/Day	456.5636993	456.5637	326.6904	1239.818
ALF	0.760939499	0.760939	0.680605	

d).

	A	B	C	Sum
# of flights	6	6	5	17
Freq Share	0.352941176	0.352941	0.294118	1
FS^1.5	0.209678303	0.209678	0.159508	**0.578864**
Market Share	0.36222359	0.362224	0.275553	1

T	4.235294118
Demand	1262.023153

	A	B	C	Sum
Plane Size	120	120	120	360
Pax/Day	457.1345568	457.1346	347.754	**1262.023**
ALF	0.634909107	0.634909	0.57959	

3. Casino airlines Fare pricing.

a) This fare structure matches what we talked about in class. The most expensive seats can be purchased at the last minute and do not have any minimum stays. Meanwhile the lowest fares must be purchased 2 weeks in advanced and require a Sat. night stay. The airlines want to make this low fare unattractive to biz. travlers. They could also force no cancelations, no free bags, no freq. flyer miles to their lowest fares to keep biz travlers away. However Sat night stay is the most popular restriction.

Diff. customers have different willingness to pays, and different demand elasticities. Biz travlers in general are willing to pay more and don't care about the price. Leasure travelers are actually paying so they care what the price is, are willing to put up with restrictions, and may not fly if the price is too high.

One price

Consumer surplus →

Revenue

dead weight loss

3 prices

Revenue   Q

← higher revenue
lower consumer surplus
lower dead weight loss

b. Because the highest price tickets are often the last to sell, the airline needs to reserve seats for them. Now they are forcasting 30 people will buy them with an uncertanity of ± 10 seats. However to determine how many seats to protect, they need to look at the price of the next seat class. At the extream example what if

$$Y = \$600$$
$$M = \$599$$
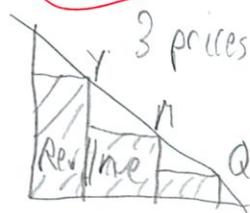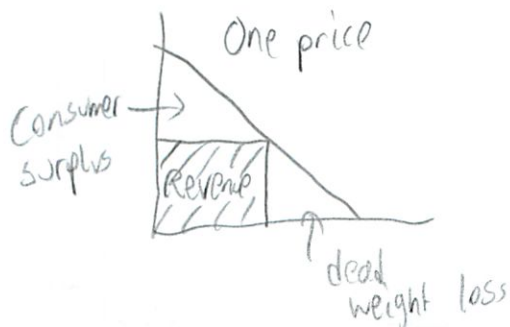
How many seats should you protect for Y over M. Not many, if any. But if $M = \$400$, then you would want to protect some seats for just Y. So Calculate the ratio of the fares, here $\frac{400}{600}$ and then take the inverse of the normal cumulitive distribution of 1 - ratio. (Z-score) Take the mean number of seats and multiply the Z-score by the Sigma, Add the 2 values, If the ratio is reasonable $(.5 < X < .8)$ you will get a value above mean - sigma and below the mean, This is how many seats to protect in Y class,
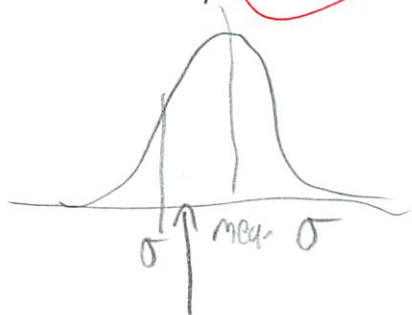
C. What happens + does it make sense?

1. Mean Y class goes to 60

The protected seats for Y goes to 56, which because sigma did not change, just added the additional seats to Y class. If we accept this new, unchanged sigma it makes sense to drop the number of bargin fares from 66 to 35

But also affects other classes. — 1

2. 5 seats in Q class are now protected. For Y + M classes, Because of the lower fare, the airline is more willing to chance the seat not being filled, in order to possibly sell it to a higher paying Y + M class passenger.

Impacts on demand? — 2

d.) The company would lose money by lessening the distinction between the classes and thus lowering the demand for higher fare classes. Instead they should just publish their restrictions to make it easy to comprehend.

Spiral down RM system will respond w/ more cheap seats

So remaining restrictions ↳ ↓ Y and M demand
↓ avg. fare paid
↓ revenue → *depends but likely*

It would ↑ load as less seats should be protected (assuming the model was updated)

Yield would fall greatly with both a higher load and a lower average fare.

Inital

BOOKING CAPACITY =			150								
AVAILABLE SEATS =			150					CALCULATIONS IN THESE COLUMNS -- DO NOT CHANGE			

BOOKING CLASS	AVERAGE FARE	SEATS BOOKED	REMAINING DEMAND		JOINT PROTECT	BOOKING LIMIT	JOINT DEMAND -- TOP DOWN			FARE RATIO	Z-SCORE
			MEAN	SIGMA			MEAN	SIGMA	AVE FARE		
Y	$ 600	0	30	10	26	150	30	10	$600.00	0.6667	-0.4307
M	$ 400	0	50	15	84	124	80	18.0	$475.00	0.4189	0.2046
Q	$ 199	0	70	20		66	150	26.9			
TOTAL		0	150								

BOOKING CAPACITY = 150
AVAILABLE SEATS = 150

CALCULATIONS IN THESE COLUMNS -- DO NOT CHANGE

BOOKING CLASS	AVERAGE FARE	SEATS BOOKED	REMAINING DEMAND MEAN	REMAINING DEMAND SIGMA	JOINT PROTECT	BOOKING LIMIT	JOINT DEMAND -- TOP DOWN MEAN	JOINT DEMAND -- TOP DOWN SIGMA	AVE FARE	FARE RATIO	Z-SCORE
Y	$ 600	0	60	10	56	150	60	10	$600.00	0.6667	-0.4307
M	$ 400	0	50	15	115	94	110	18.0	$509.09	0.3909	0.2770
Q	$ 199	0	70	20		35	180	26.9			
TOTAL		0	180								

| BOOKING CAPACITY = | | 150 | | | | | CALCULATIONS IN THESE COLUMNS -- DO NOT CHANGE | | | | |
| AVAILABLE SEATS = | | 150 | | | | | | | | | |

BOOKING CLASS	AVERAGE FARE	SEATS BOOKED	REMAINING DEMAND MEAN	REMAINING DEMAND SIGMA	JOINT PROTECT	BOOKING LIMIT	JOINT DEMAND -- TOP DOWN MEAN	JOINT DEMAND -- TOP DOWN SIGMA	AVE FARE	FARE RATIO	Z-SCORE
Y	$ 600	0	30	10	26	150	30	10	$600.00	0.6667	-0.4307
M	$ 400	0	50	15	89	124	80	18.0	$475.00	0.3137	0.4854
Q	$ 149	0	70	20		61	150	26.9			
TOTAL		0	150								

4. Operating profit = RPM · Yield − ASM · Unit cost

a) Reduce off peak times to ↓ fuel cost

Unit cost — ~~flat~~ ✗ if all planes in the fleet are the same reduce variable + total costs fixed cost less spread at

could ↓ if they ground inefficient planes

remaining units (reduce utilization · aircraft) will ↑

ASM ↓ as flights cancled ✓

Rpm ↓ a little — flights mostly empty but some
pax. will no longer fly ✓

Yield ↑ a little — off peak flights likly discounted
so Yield may go up ✓

Operating Profit, ↑ = good move for the airlines, just
watch losing marketshare and not being
able to respond to a disaster

4

b) Internet not travel agencies

Unit cost ↓ less commissions ✓

ASM — Unchanged ✓

RPM ? ↑ ↓) Online... is more competitive as people can
search more, while agent's commission was
based on price, here page is sorted by price

Yield ↓

Yield is likely to be forced down by competition.
If they are the lowest price, RPMs will
fill up. If they are trying to protect
yields, RPMs will fall

OC.

Operating profit = ↓ likely to be forced down w/ competition

5

(19) "On the other hand, perhaps more people will fly. ✓ yes.

c) Airlines merge ASM ops
(APMs)? and RPMs will be summed. Hopefully (RPMs) will increase
as they have more routes to more places on the globe.
Unit cost will hopefully be ✓ as economies of scale kick
in at the airport, pending labor's agreement.
Yield will hopefully increase as the combined airline
has more pricing power. ✓
Hopefully both airlines' operating profits will be greater
4 than the sum of their parts.

(13) costs ↓ ← big part
pricing power – habye
more network coverage ↑ revenues/yields

US Airways

Prep (not submitted)

- look at fin reports for company for context
- 5th largest US air carrier
- realigned in 2009
- to just hub network
- ↓ RPMs

- "should I do it this way or just the data"
- do jet fuel
  - they lost money on hedging !
- On time performance bonus
- Ticker is LCC to get Low cost carrier
- look at US air bankruptcy too
- Certificate merger 2007
- call sign merge 2008
- bankrupcy Aug 12 2002
  - reorg
- hardest hit after 9/11
- considered weakest of top 5

So tell bankruptcy, merger story
and then general industry
Or format: short intro then section by section
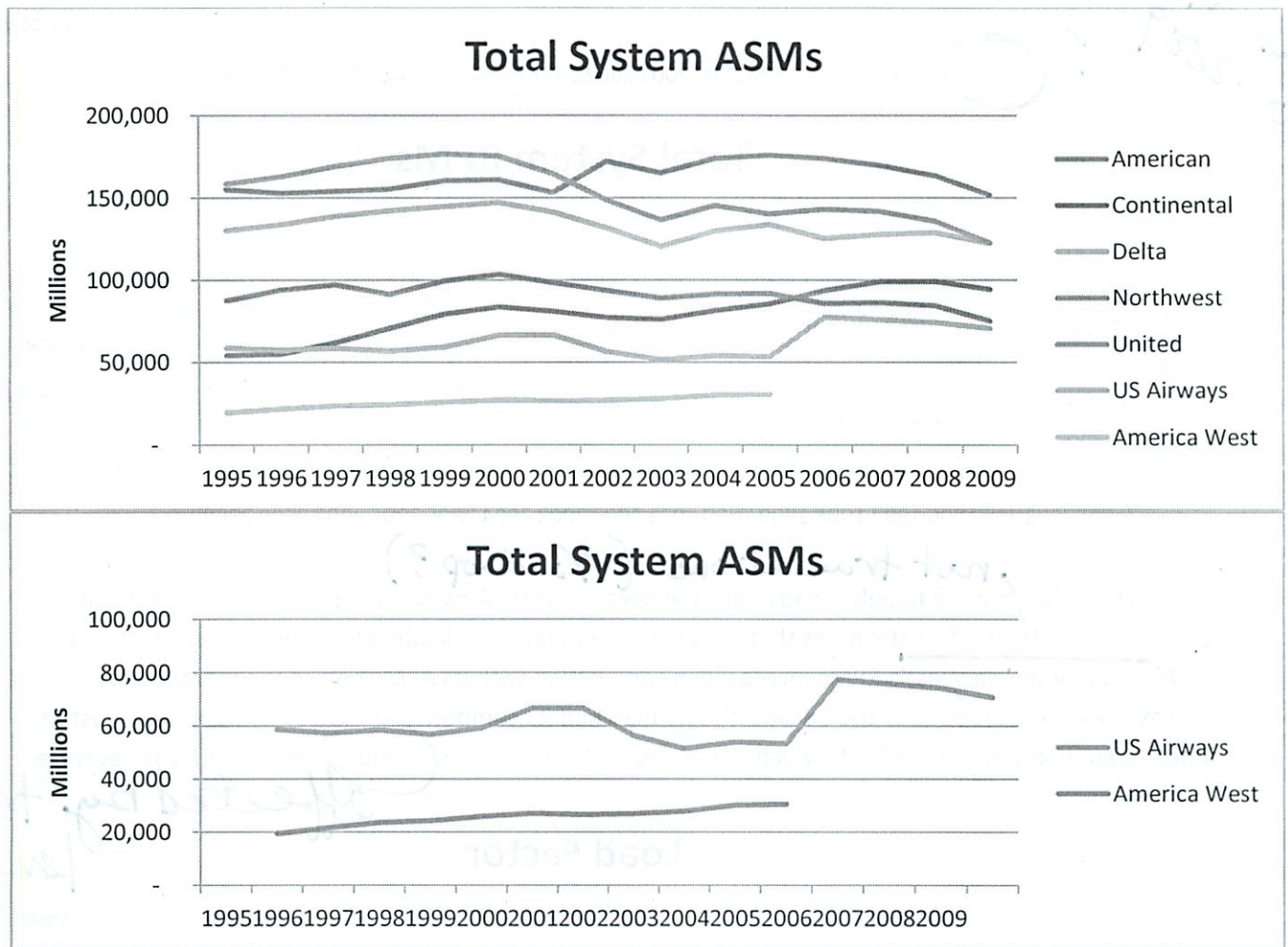rather than research paper style narrative

Much better in color

US Airways

Michael Plasmeier

airlines

The last 10 years have been full of turmoil for US Airways. At the start of the decause, US Airways was focused on the business-heavy east cost. 9/11 hurt all airways, but the effect was particular bad on the east coast where the attacks occurred, and where business travelers had other options. US Airways had one of the highest costs in the industry until it filed for bankrupcy in 2002. In 2005, US Airways merged with American West airways and relanched under the "LCC" stock symbol to try to brand itself as a low-cost carrier. However, in 2008 fuel prices spiked and the recession hit business travel, further delaying US Airways' return to profitability.

Total System ASMs

Legend: American, Continental, Delta, Northwest, United, US Airways, America West

Total System ASMs

Legend: US Airways, America West

Total System ASMs were largely steady leading into the decade. In the years before 2001, US Airways built capacity, which it quickly shed after 9/11. America West was slowing expanding its operations before the merger with US Airways. In 2007, the merger was finalized and America West's operations were absorbed into US Airway's operations. However, the fuel spikes of 2008 caused US Airways to cut capacity to near 2001 levels.

Back out percentage from # – not trends

Q: Correlation not causation ?
Q: How can draw conclusions ? – describe + terms – relate to airline biz

Total System RPMs

Chart: Total System RPMs (Millions), 1995–2009, for American, Continental, Delta, Northwest, United, US Airways, America West. Y-axis from 20,000 to 160,000.

Handwritten note (left margin): "Focus on 2000-2009 ?"

Total System RPMs

Chart: Total System RPMs (Millions), 1995–2009, for US Airways and America West. Y-axis from 10,000 to 70,000.
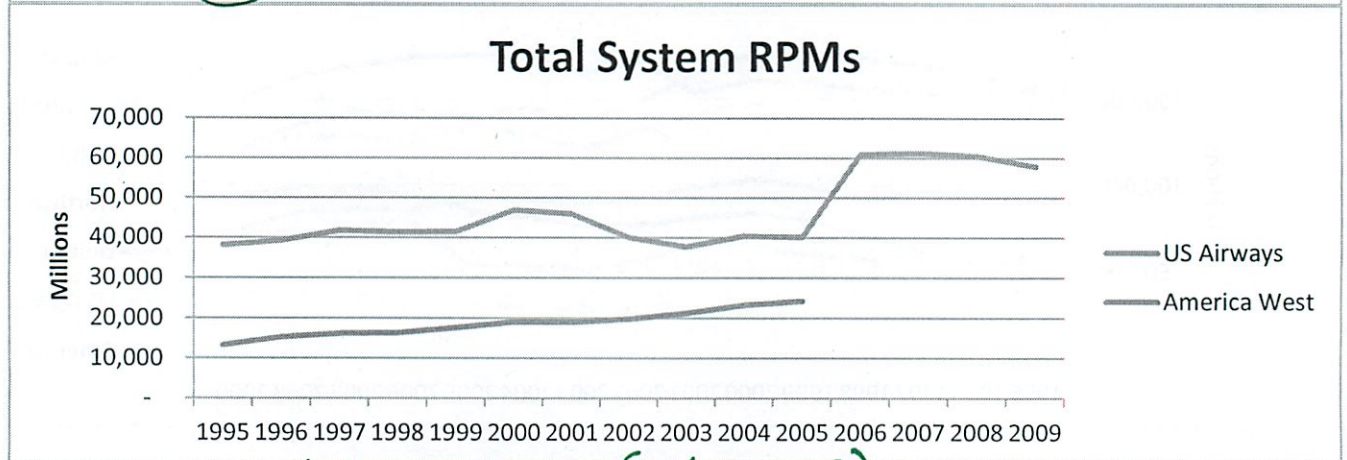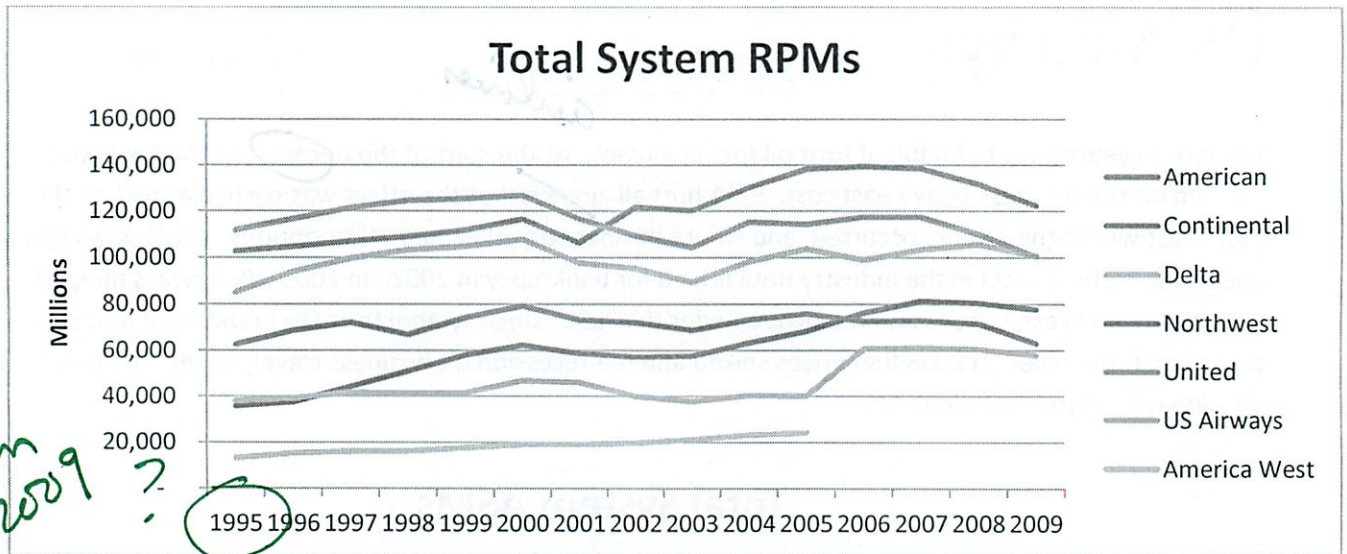
Handwritten note: "not true above (% drop?)"

Total System RPMs were largely steady over the decade for US Airways. Drops in ASMs in 2002 and 2008 largely did not affect the miles that passengers actually flew, leading to increased load factors on US Airways. America West's RPMs increased in conjunction with its ASMs before the merger. US Airway's aggregate load over the decade closely matched its competitors. However, US Airways lost its industry leading yields after 9/11, which it was never able to recover. Yields eroded to industry average.

Handwritten note: "affected by trip length."

Load Factor

Chart: Load Factor (%), 1995–2009, for American, Continental, Delta, Northwest, United, US Airways. Y-axis from 50.0% to 90.0%.

Yield

[handwritten note:] US was shorter haul back here.

Legend: American, Continental, Delta, Northwest, United, US Airways, America West

Y-axis: Cents/RPM — 20.00, 15.00, 10.00, 5.00, -

X-axis: 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

System Total Operating Revenue

Legend: US Airways, America West

Y-axis: $ Billions — $14.00, $12.00, $10.00, $8.00, $6.00, $4.00, $2.00, $-

X-axis: 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

[handwritten notes:] why? (LCCs) — use %Δ, compare to RPMs

Despite RPMs remaining somewhat static, System Total Operating Revenue was volatile for US Airways over the decade. The airline saw a large drop in revenue after 9/11 which never recovered. The merger with America West complicates matters, causing a large increase in US Airway's revenue on paper. After the merger, revenue remained more or less static until 2009, when it took a dive as the recession hurt business travel. System Passenger Revenue largely followed the same trends, as US Airways large increase in its cargo business was not enough to offset the drop in passenger revenue in 2009.

Cargo Revenue

Legend: American, Continental, Delta, Northwest, United, US Airways, America West

Y-axis: $ Billions — $1.200, $1.000, $0.800, $0.600, $0.400, $0.200, $-

X-axis: 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
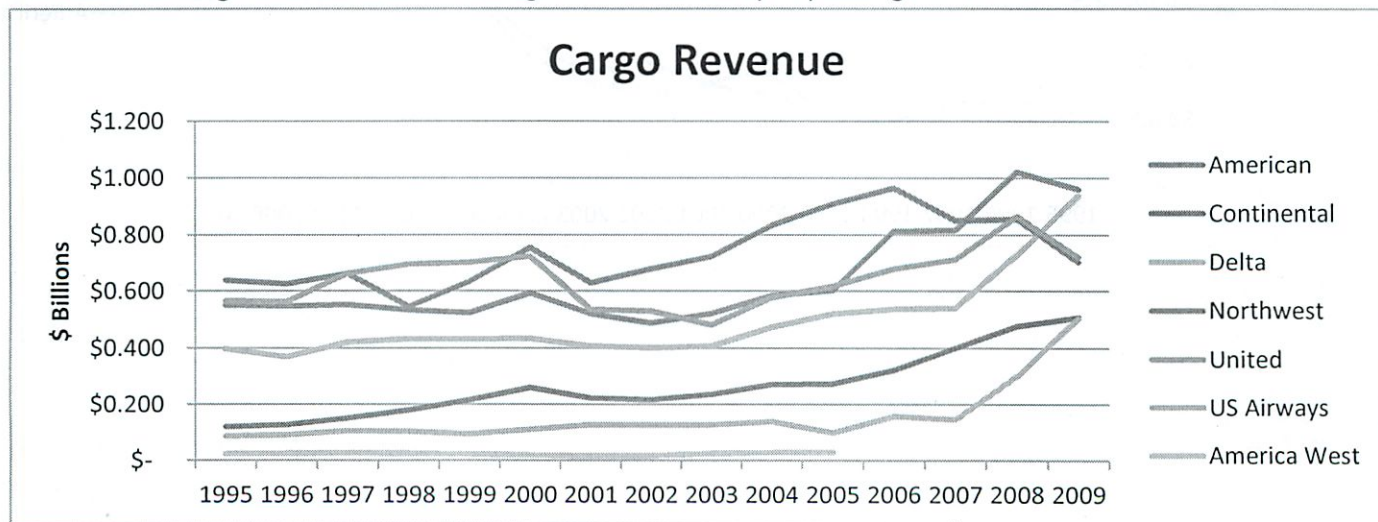
System Operating Expenses were volatile for US Airways over the decade as fuel costs swung wildly and US Airways was able to achieve substantial givebacks with its employees during bankruptcy proceedings in 2002 US Airways was also able to offload its pension liabilities during the same period. US Airways' efforts in the first half of the decade brought its costs in line with the rest of the industry. During the decade US Airways was able to half its Labor Cost per Available Seat Mile from 6 cents to 3 cents, largely through its merger with America West.

System Operating Expenses

$ Billions

US Airways
America West

1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

Fuel Cost Per Gallon

$ Dollars

US Airways
America West

1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

Industry CASM

Chart showing Cents/ASM from 1995 to 2009 for American, Continental, Delta, Northwest, United, US Airways, and America West.

Pension and Post Retirement Benefits

Chart showing $ Millions from 2000 to 2009 for US Airways Group Inc I, US Airways Group Inc II, and America West Holdings Corp.

esp here

* Scale is important *

Use # → "ASMs ↑ 30% Yield ↑ 28% so revenue ↑ 5%"

-point count → indicators about effort

-The more you went on w/ #5 the more you step into puddles

System Labor Costs

Chart: System Labor Costs (1995–2009), showing US Airways and America West.

Labor CASM

Chart: Labor CASM (Cents/Seat Mile), 1995–2009, showing US Airways and America West.
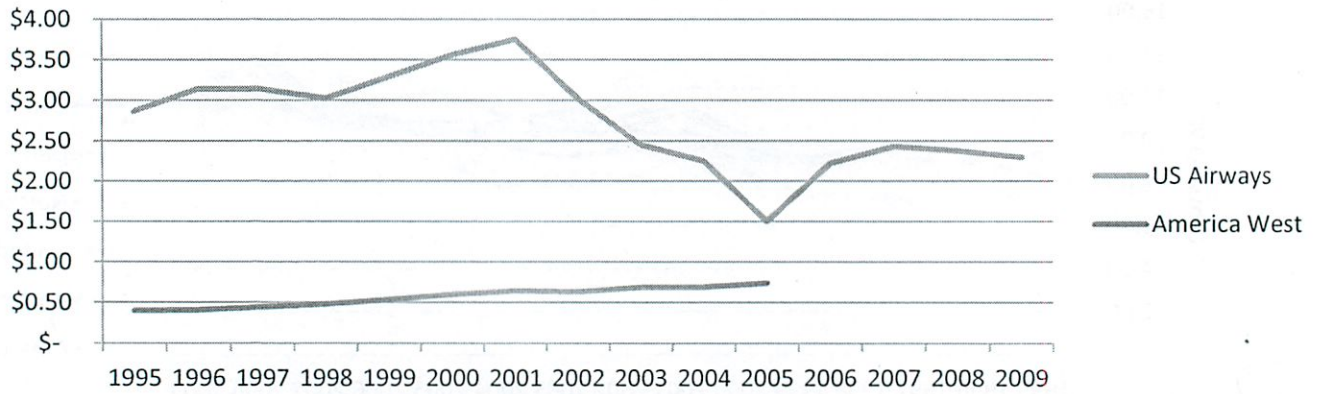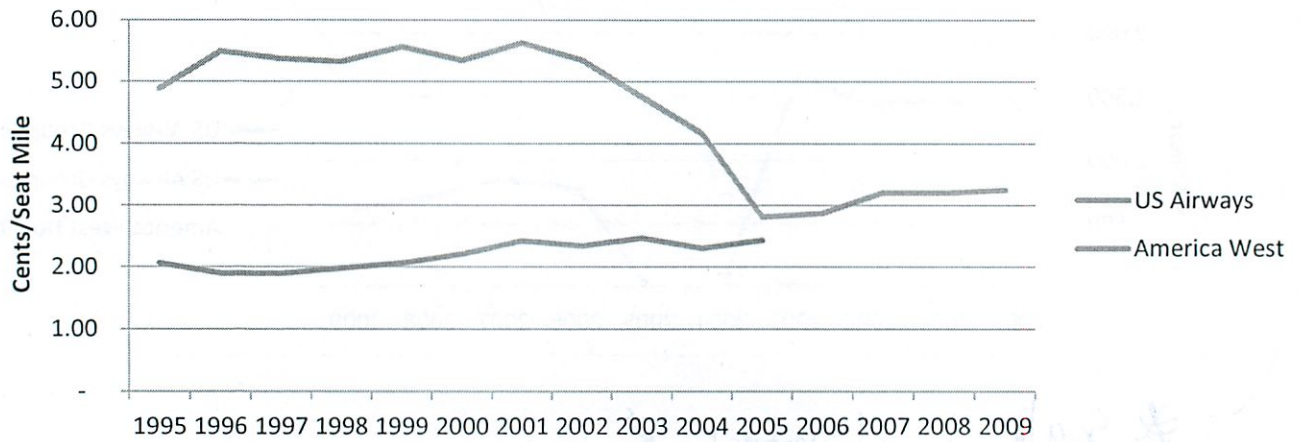
US Airways continues to have difficulty making a profit, with the combined company ending 2009 with a slight profit of $118 million.

Operating Income
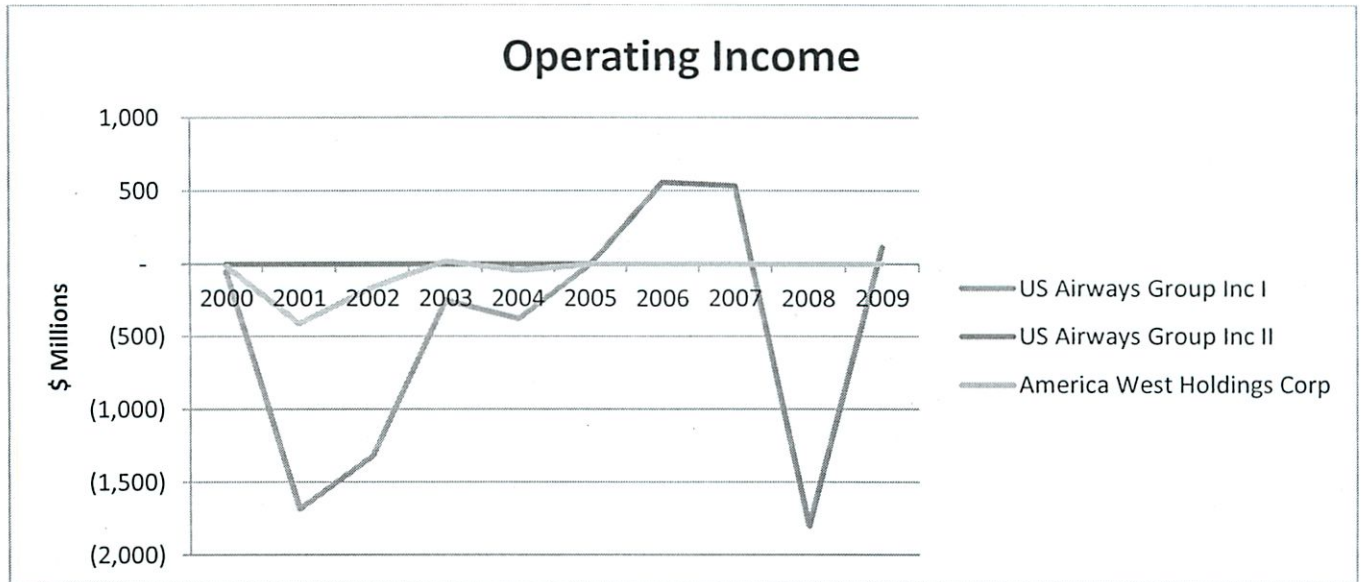
All data is from the MIT Airline Data Project. Downloaded 10/2/2010

Nice graphs, not fully explained/referenced in your answer. Avoid qualitative phrases like "steady" or "similar trends", when substantial changes (10%+) are occurring.

1.6

Assignment #1 Solution Outline

QUESTION 1 (25 points)

1 (a)   (1) Total Available Seat Miles: Number of seats multiplied by distance and number of flight departures.
= 60(150)(1037) + 60(120)(803) + 60(120)(1717) + 60(150)(1597)
= 41,850,000

(2) Total Revenue Passenger Miles: Passengers carried multiplied by distance and number of flight departures
= 60(102)(1037) + 60(90)(803) + 60(108)(1717) + 60(132)(1597)
= 34,457,040

(3) Average System (Network) Load Factor: Total RPMs divided by total ASMs
= 34,457,040/ 41,850,000 (totals per month)
= 82.33%

(4) Average Flight Leg Load Factor: Mean of leg load factors over all legs operated, where each leg load factor is simply passengers divided by capacity.
= [60(68.00%)+60(75.00%)+60(90.00%)+60(88.00%)] / 240
= 80.25%

(5) Average Passenger Yield: Total Revenue divided by RPMs
= [60(102)($180) + 60(90)($150) + 60(108)($230) + 60(132)($210)]/ 34,457,040
= $5,065,200/34,457,040
= $0.147 per RPM

(6) Average Aircraft Stage (Flight) Length: Average distance flown by a single non-stop flight.
= [60(1037) + 60(803) + 60(1717) + 60(1597)] / 240
= 1289 miles per flight stage

(7) Average Passenger Trip Length: Average distance flown by each passenger from origin to destination (including connecting flights). CANNOT BE CALCULATED because we do not know the O-D composition of passengers in this network. We only have total loads for each leg, which carries both local and connecting passengers.
(14 points)

(b) The average leg load factor is 80.25% while the average system load factor is higher, at 82.33%. In this case, the latter is higher because it gives greater weight to the longer distance flights, which happen to have higher leg load factors. The network load factor is generally more useful in comparing different airlines, and for making judgements with respect to overall network performance, such as profitability. Average leg load factors are useful in evaluating aircraft assignments to routes, as well as on-board service quality (e.g. flight attendant staffing).*(3points)*

(c) Total Operating Profit: Total Revenues minus Operating Costs

    = Total Revenues - [(ASMs)(Unit Cost)]

    = $5,065,200- (41,850,000)(0.115)

    = $252,450 per month

For operating profit to drop to zero (break-even), the unit cost would have to increase to 12.1 cents per ASM, holding all else constant. *(3 points)*

(d) (1) O-D markets that are distinct and separate

In this network, there are 8 bi-directional O-D markets (a careful reading of the question would exclude BOS-PHL and SEA-LAX). Each O-D market involves different city pairs, such that the demand in one market is independent of the demand in the other market. The demand for different markets could well have very different characteristics, even though passengers travelling BOS-SEA fly on the same aircraft as BOS-LAX, for example. The implications for economic analysis are that the prices offered to each market can be very different, based on different passenger attributes such as price sensitivity. *(2 points)*

(2) Dichotomy of supply and demand in air transportation

Supply is flight leg (seats) based, while demand is O-D market based. In our network, or in any network, flight paths do not always correspond to passenger flows. Each flight from the spoke into the hub will carry passengers belonging to several different O-D markets, making it difficult to determine the exact "supply" of seats to any one O-D market, without making arbitrary assumptions about dividing up the capacity of each aircraft.
One O-D market will choose among many different paths (flight itineraries), while a single flight leg will offer supply to many different O-D markets at the same time. This makes equilibrium analysis (i.e., demand vs. supply), as well as profitability and predatory pricing evaluations, very difficult. As a result, it is not possible to determine whether the fares in an O-D market actually cover the costs of serving that market. *(3 points)*

Question 3: Airline Market Share Analysis (20 points)

A. (6 points)	AIRLINE A		AIRLINE B		AIRLINE C
AIRCRAFT CAPACITY	150		150		120
TOTAL DEMAND	1219				
FLIGHTS per day	4		4		4
FREQUENCY SHARE	33.33%		33.33%		33.33%
MARKET SHARE	33.33%		33.33%		33.33%
AIRLINE LOAD	406.48		406.48		406.48
AVE. LOAD FACTOR	67.75%		67.75%		84.68%

DISCUSSION: New entry is profitable for C, but causes A and B to become unprofitable at current frequency and capacity. Lower fares and more frequency have increased total market demand from 840 to 1219 (by 45%). For C, the decision to operate 4 flights maximizes its LF, but it could likely generate more total profits with 5 flights per day. In either case, it makes A and B unprofitable.

B. (3 points)	AIRLINE A	AIRLINE B	AIRLINE C	
AIRCRAFT CAPACITY	150	120	120	
TOTAL DEMAND	1230			
FLIGHTS per day	4	5	4	
FREQUENCY SHARE	30.77%	38.46%	30.77%	
MARKET SHARE	29.43%	41.13%	29.43%	
AIRLINE LOAD	362.13	506.09	362.13	
AVE. LOAD FACTOR	60.35%	84.35%	75.44%	

DISCUSSION: With the shift to match both the frequency and aircraft size of C, Airline B is able to return to profitability, while Airline C falls to just above its break-even level. Airline A, however, loses more load factor and loses even more money (bigger operating loss).

C. (7 points)	AIRLINE A	AIRLINE B	AIRLINE C	
SHORT RUN RESPONSE				
AIRCRAFT CAPACITY	120	120	120	
TOTAL DEMAND	1219			
FLIGHTS per day	4	4	4	
FREQUENCY SHARE	33.33%	33.33%	33.33%	
MARKET SHARE	33.33%	33.33%	33.33%	
AIRLINE LOAD	406.48	406.48	406.48	
AVE. LOAD FACTOR	84.68%	84.68%	84.68%	

DISCUSSION:
Given 5 flights per day (120-seat aircraft) offered by both B and C, there is **no frequency** at which Airline A can continue to operate its 150-seat aircraft profitably. If Airline A chooses to switch to smaller 120-seat aircraft, the same is true -- there is no profitable frequency choice.
The suggested short-run strategy for A is to respond by increasing its frequency to 5 flights per day.
This decision by A will force both B and C into uprofitable load factors, while keeping Airline A's losses to a minimum (compared to the alternatives of offering 6, 7, etc. flights). The best that Airline A can hope for is that B and/or C will reduce their frequency in an effort to return to profitability. For example, all airlines make a profit if they each offer 4 flights a day. However, even in that situation there is an incentive for one airline to increase its frequency in an attempt to gain market share and more profit. But that will also drive the other two competitors into the red, and the cycle continues...

D. Model Strengths and Weaknesses (4 points)

The Market Share/Frequency model used in this question effectively incorporates the non-linear relationship (S-curve) observed in actual airline markets. The relationships it provides between frequency, market share and load factors are quite realistic, given the relative simplicity of the model.

However, it has several shortcomings as well:
1. It is based only on frequency, not timing (schedule) of flight departures. One could argue that better timing of schedules can result in market share advantages above what the model predicts (and vice versa). On the other hand, the model assumes that flight timing is "rational" and spread throughout the day.
2. It is useful for non-stop competitive markets, but does not account for one-stop and connecting services in its present form. The problem is that there are not many markets in which only non-stop service is available.
3. It assumes that all else is equal, meaning no differences in fare levels, brand image or aircraft preference. But, in actual markets, these assumptions are not far from reality.

QUESTION 3 (20 points)

(a) Discussion of Casino fare structure (5 points)

The fare structure in this market is representative of a more "traditional" restricted fare structure. It consists of 1 fare product designed for business travellers (Y) and 2 lower-priced products designed to be attractive to leisure travellers. It uses the following to segment business and leisure demand:

- Minimum stay requirement on the lowest 2 classes – This is the most effective segmentation tool, as it prevents most business travellers from making use of these fares. On the other hand, most leisure travellers are likely to stay over the weekend, or at least 3 days.
- Advance purchase restrictions – Ranging from 7 to 14 days, these AP rules on the lowest 2 fare products make them less attractive to business travellers who typically cannot plan their trips so far in advance. On the other hand, most leisure travellers are able to plan their trips two weeks or more in advance.

The price levels in this fare structure are such that the lowest fare product is less than half the price of the highest fare product. Business passengers might be tempted to buy two low-priced tickets rather than a single high-priced ticket, but the advance purchase limits the number of business passengers who can actually do so. The difference in prices for business vs. leisure fares is substantial, but effective use of segmentation restrictions forces business passengers to pay closer to their willingness to pay.

Casino could capture even more revenue independent of RM controls by further differentiating the lowest fare products from the highest fare. For example, a 21-day advance purchase condition on Q-class would prevent even more diversion of those willing to pay $400 to the $199 fare.

(b) EMSRb Decision Rule in Intuitive Terms (3 points)

The EMSRb decision rule for seat protection is to protect seats for the exclusive use of Class 1 demand as long as the expected marginal seat revenue of each incremental seat protected exceeds the fare of Class 2. The expected marginal seat revenue is given by the product of the Class 1 fare and the probability of realizing Y-class demand for that incremental seat.

Intuitively, the probability of realizing actual demand equal to the mean forecast or greater is only 50%, so the EMSR of the 30th seat protected for class 1 is $300. It should not be protected for exclusive use of Class 1 demand, because the worst thing that can happen to that seat is it will be purchased for $400! [It can still be purchased by $600 Class 1 passengers, even if it is not protected].

We protect seats for Class 1 as long as the probability of realizing Class 1 demand for the incremental seat is greater than the ratio of the Class 2 fare to Class 1 fare. In this case, this ratio is 2/3. Only 26 seats have a probability of realized demand greater than 67%, so we protect fewer seats than the mean demand.

4

(c) CASINO EMSRB.XLS (4 points each)

BOOKING CLASS	AVERAGE FARE	SEATS BOOKED	REMAINING DEMAND MEAN	REMAINING DEMAND SIGMA	JOINT PROTECT	BOOKING LIMIT
BOOKING CAPACITY =		150				
AVAILABLE SEATS =		150				
Y	$ 600	0	60	10	56	150
M	$ 400	0	50	15	115	94
Q	$ 199	0	70	20		35
TOTAL		0	180			

(1) Increasing the Y class mean demand forecast to 60 (from 30) results in a corresponding increase in Y protection from 26 to 56 seats, and decreases both the M and Q class booking limits to 94 and 35 (from 124 and 66). Due to the increased forecast of Y-class demand, this makes sense because we are more willing to protect incremental seats for Y-class when there is more Y-class demand. In the real world, one might also ask whether this increase in forecast demand should be applied to all classes, not just the highest class. An overall increase in demand should affect all classes, unless the demand is clearly late-booking, short-stay demand.

BOOKING CLASS	AVERAGE FARE	SEATS BOOKED	REMAINING DEMAND MEAN	REMAINING DEMAND SIGMA	JOINT PROTECT	BOOKING LIMIT
BOOKING CAPACITY =		150				
AVAILABLE SEATS =		150				
Y	$ 600	0	30	10	26	150
M	$ 400	0	50	15	89	124
Q	$ 149	0	70	20		61
TOTAL		0	150			

(2) Decreasing the average Q input fare to $149 from $199 results in 5 more seats protected for Y+M classes jointly, and 5 fewer seats available to Q class. The difference between Y/M and Q class fares has increased, so we are now more willing to protect seats for the higher classes, and sell fewer seats in Q class. In the real world, a price cut in Q class will also affect the demand, perhaps of all classes (or at least M and Q). Lowering the Q fare might stimulate new Q demand, but this does not affect the EMSRb booking limits. A lower Q fare might also cause some previous M demand to buy down to Q – still, lowering the booking limit on Q might serve to prevent some of this buy-down.

(d) Removal of Minimum Stay Restrictions (4 points)

Removing the minimum stay rules on M and Q effectively removes the most powerful demand segmentation restrictions in this fare structure, with only advance purchase remaining to segment business from leisure demand.

Almost certainly, we expect to see an increase in load factors and decrease in yields with the proposed change. Load factors should increase because demand willing to pay $199 and $400 but not able to stay for Saturday night or 3 days will now be able to travel, so there will be some stimulation of demand. Yields will definitely decrease (all else equal) given that some of the previous $600 passengers are able to buy down to the lower fares.

The impact on revenues is not totally certain – it depends on the ratio of new revenues from stimulated demand to the loss of revenues from diversion of existing demand. If this ratio is greater than 1.0, revenues will increase, otherwise they will decrease. Airline experience suggests that revenues are most likely to decrease.

QUESTION 4 (15 points= 5 points each)

OUTLINE OF MAJOR POINTS

Impacts on Airline Profit Equation

$$\text{OPERATING PROFIT} = \text{RPM} \times \text{YIELD} - \text{ASM} \times \text{UNIT COST}$$

(a) An airline decides to reduce its frequency of service at off-peak times to reduce fuel consumption.

- Such a strategy is targeted at reducing total operating expenses, by reducing the scale of operations and the number of ASMs generated.
- However, with reduced flight departures (frequency), UNIT COSTS can increase as fixed costs are spread over reduced number of ASMs
- Cutting back on frequency will result in some market share loss, therefore reducing RPMs. Also, reduced capacity will itself contribute to lower RPMs. The airlines' hope is that the drop RPMs will be less than the cut in ASMs
- Objective is to maintain and even increase YIELDS, as reduced capacity is protected for higher fare passengers with proper revenue management.

(b) An airline shifts to increased use of internet distribution channels to sell tickets, instead of travel agencies.
- Overall objective is to reduce total distribution expenses, lowering total operating expenses and UNIT COSTS.
- By allowing unused seats to be sold at discount fares, airline web sites can increase RPMs and load factors without affecting ASMs
- However, higher RPMs and load factors based on more discount passengers will result in lower YIELDS

(c) Two large network carriers decide to merge their networks and operations (explain the impacts on the combined carrier's operating profit).

- The primary motivation for any merger is to achieve increased economies of scale in operations, which means lower UNIT COSTS.
- Depending on the degree of overlap of the two networks, there is likely to be some reduction in ASMs due to consolidation of routes and aircraft.
- The combined networks could well increase the frequency and network coverage of the airline, potentially increasing market share, RPMs and revenue.
- Impacts on YIELDS could be positive or negative, depending on the characteristics of the combined network and the degree to which there remains other competition.

Question 5

The first decade of the twenty-first century was difficult for legacy airlines. As we will see next, the economic downturn, 9/11 attacks, the fuel crisis, and the highly competitive environment created by LCCs made this ten year period very tough for the airline industry. In our analysis we are going to focus on American Airlines. The analysis is based on the DOT Form 41 data in the figures presented after the discussion.

The economic situation in 2001 and 9/11 attacks had a very negative effect on the airline industry and in particular on American Airlines. Demand dropped, RPMs went from 117.000 millions in 2000 to 106.000 millions in 2001, as we can see in Figure 2. At the same time AA reduced 5% the available capacity (ASMs), see Figure 1. The goal of this measure is to avoid a significant drop of the load factor, *analysis* reduce expenses, and keep the operating profit at an acceptable level. However, the load factor decreased in 2001 (see Figure 3), and the operating income reduced from $1381 millions to a loss of $2470 millions (see Figure 7). It is remarkable that even having a 5% capacity reduction from 2000 to 2001 the operating expenses (see Figure 6) increased 8%. Some factors that had a lot to do with this situation were the high fuel price, high labor cost, and the economic situation, which decreased the number of business travelers and average fares. In Figure 8, we can see how the yield went down, and the unit cost went up. If we think about the operating profit equation, when the yield decreases, the unit *dependency* cost increases, and the load factor decreases, it is obvious that the operating profit drops. Cargo revenues, which represent only ~4% of AA revenues, went 12% down from 2000 to 2001 (Figure 5).

In 2001, American Airlines acquired the bankrupt airline TWA. Airlines merging *why:* is a good way to increase operating profit and financial sustainability. Between the positive effects of airlines merging we can emphasize: cost reduction (combining redundant elements, and reducing capacity) and revenues increase (higher fares and more demand). In Figure 1, Figure 2 and Figure 3 we can see that the ASM, RPM and load factor values went up from 2001 to 2002 in big part thanks to the acquisition of TWA. However, the positive effects of merging airlines do not show immediately due to integration costs. The operating and net income reached the minimum values of the decade in 2002 (see Figure 7).

But after that, in 2003 AA as the rest of the industry started to recover. The net income progressively increased from $3511 millions loss in 2002 to a positive $501 millions net income in 2007. In Figure 2, we can see that the RPMs increased from 122 millions in 2002 to 138 millions in 2007, going back to normal levels. The increase in demand lead to an increase in capacity. In Figure 1 we can see that the ASM levels started increasing after 2003. However, due to the low capacity available the load factor went up. Figure 3 shows that the load factor have increased since 2001, being over 80% in 2009.

There are others important factor involved in the evolution of the load factor. The increase in the LCCs market share, together with the economic situation (ex. the number of business travelers decreased) led to lower average fares. American and other legacy airlines had to lower fares to compete with LCCs, and consequently increase the load factor to retain revenues at an acceptable level. Lows fares stimulate demand and make possible to reach a higher load factor. In Figure 8 we can see that the yield value was below 12 cent/RPM between 2002 and 2005. The use of smaller aircraft and higher flight frequency to gain market share and confront LCCs, and the effects of online ticketing were also important factors in the increase of the load factor in the first decade of the twenty-first century.

The recovering period for American Airlines did not last very long. The global economic crisis, and the historical maximum fuel prices reached in 2008 hit the airline industry very hard. Table 5 shows the

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evolution of fuel price per galon from 2000 to 2009.

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
$0.72	$0.78	$0.70	$0.82	$1.15	$1.68	$1.94	$2.05	$2.95	$1.94

Table 5: Fuel price per galon

The operating expenses increased almost 20% from 2006 to 2008. AA increased the yield value to counterattack the fuel price increase, but in Figure 8 we can see that the unit cost increased much more than the yield from 2007 to 2008. Consequently, the operating income dropped from $965 millions to a loss of $1889 millions in one year. The load factor did not decrease much, only 1% , thanks to the capacity reduction that closely matched the RPMs drop (due to higher yield and the economic situation). In 2009 the situation improved a little, the RPMs and passengers revenues (Figure 4) were still going down, but the sharp capacity cut (ASMs dropped 11% since 2007) and the reduction of the fuel price made possible the decrease of the yield and the increase of the operating and net profit, which were still far from being good (see Figure 7). Due to the economic downturn AA cargo revenues went 6% down in 2009. This was a bad year for air cargo traffic; US RTMs decreased 12%, the largest drop in one year in history (ATA Annual Report). *interconectness*
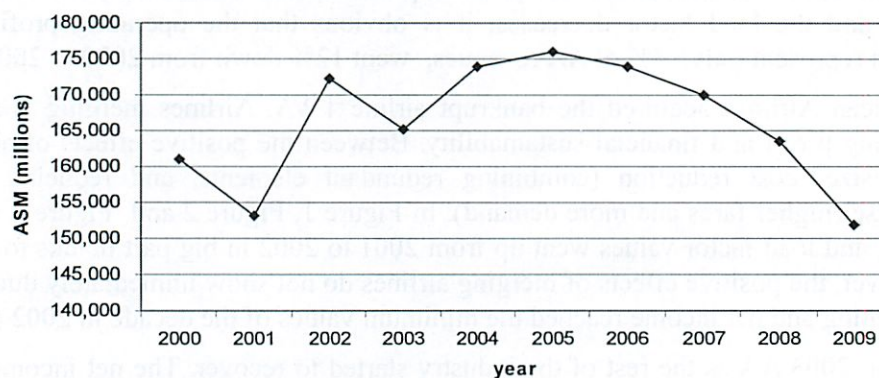

Figure 1: Available Seat Miles
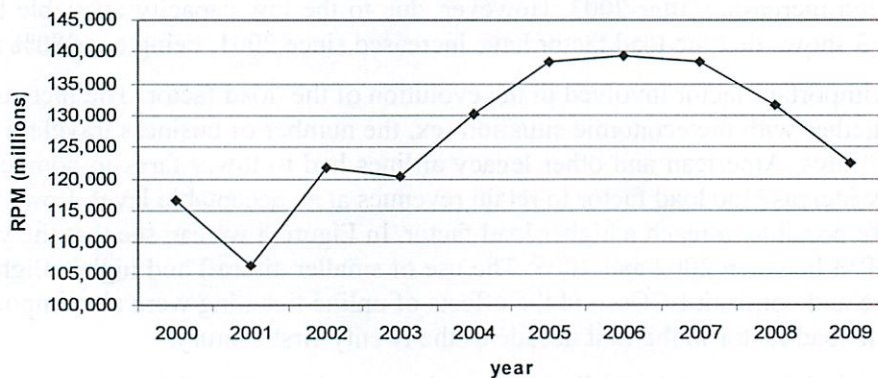
Figure 2: Revenue Passenger Miles

14
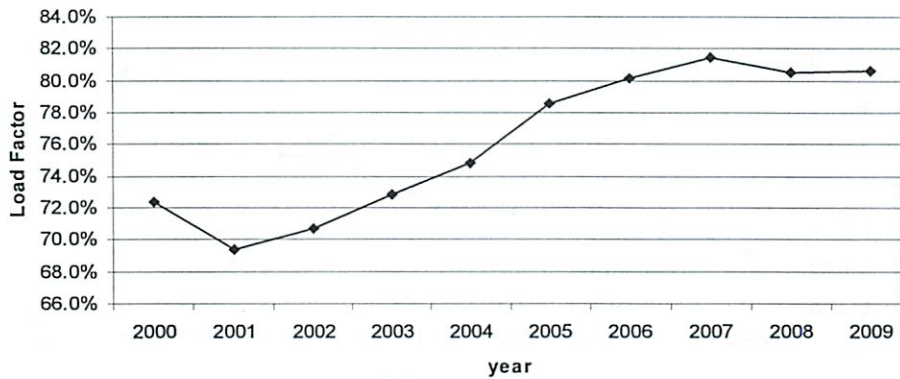
Figure 3: Load factor
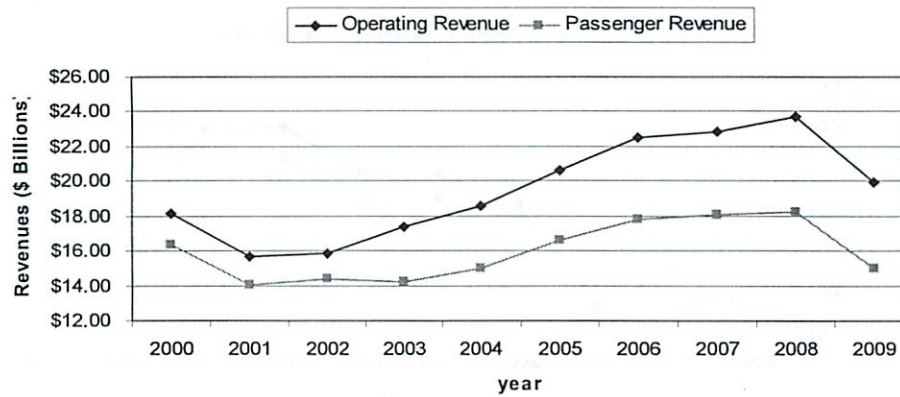
Figure 4: Operating and Passenger Revenue
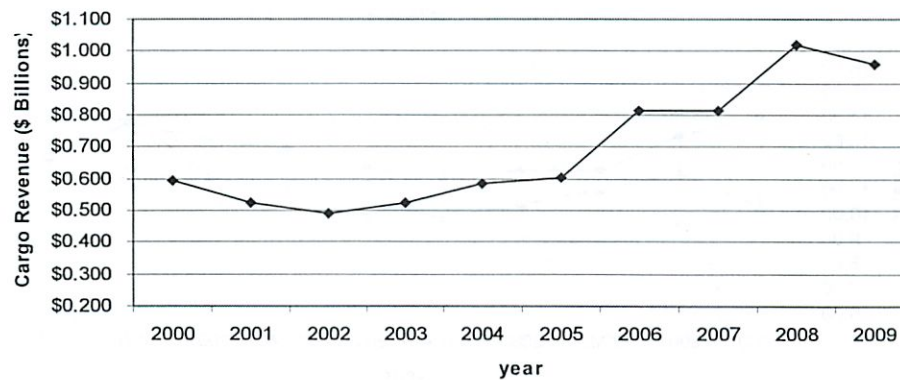
Figure 5: Cargo Revenue

15
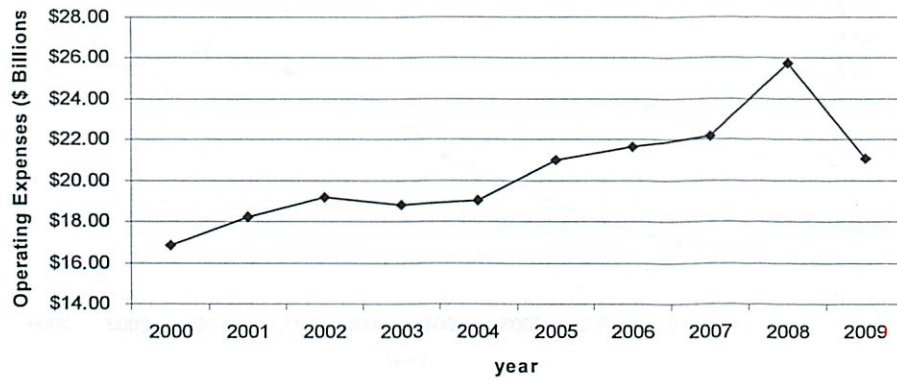
Figure 6: Operating Expenses
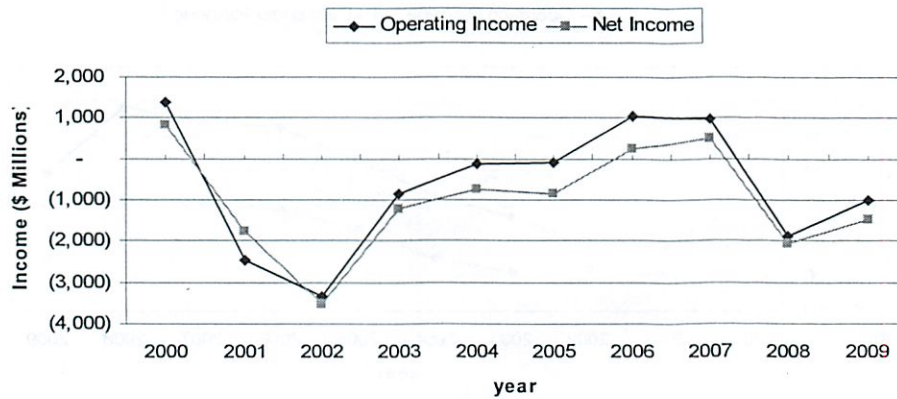
Figure 7: Operating and Net income
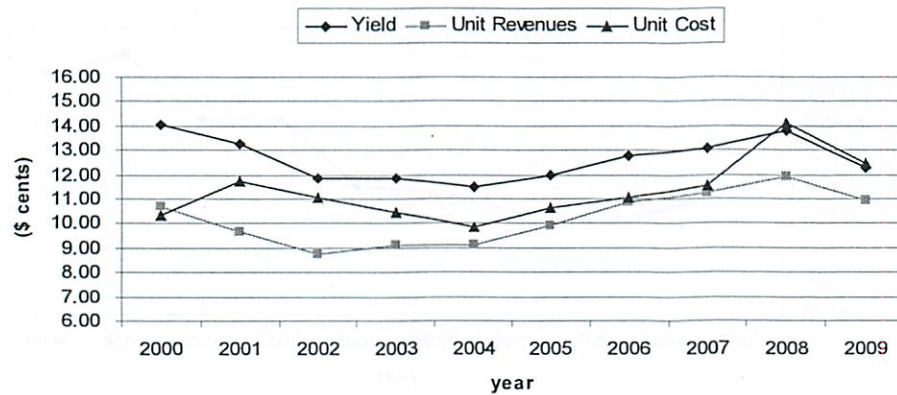
Figure 8: Yield, Unit Revenues and Unit Costs

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Slide 1

Massachusetts
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Technology

LEGACY vs. LCC AIRLINES:
COST AND PRODUCTIVITY CONVERGENCE

William S. Swelbar, Research Engineer, MIT

16.71   October 4, 2010

(handwritten) └started as flight attendant, worked in econ airlines union negotiations, consulting

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Slide 2

Massachusetts
Institute of
Technology

US AIRLINES: A Tale of Two Sectors

- **US Network Legacy Carriers**
  - Between 2001 and 2009, mainline domestic capacity cut 27%. But some was shifts to smaller aircraft and commuter affiliates. US industry capacity decreased nearly 10% in 2009. Modest increases in 2010.
  - Bankruptcies at US, UA, DL and NW were the first wave of capacity reductions, allowed for labor cost reductions and increased productivity
  → - AA and CO re-structured to remain competitive without Chapter 11
  - All network carriers have also shifted capacity to international routes

- **Low Cost Carriers**
  - By 2007, LCC share of domestic passengers has increased to over 26%, from 16% in 2000 and only 5% in 1990. Today LCC share is 33%.
  - But unit cost advantages of new entrants tend to disappear as both aircraft and employees mature
    - Fuel cost is proving to be a great equalizer in today's world
  - ASM growth has facilitated lower unit costs, but not clear there are enough market opportunities for all of the narrow body aircraft on order by LCCs.
    - Growth plans slashed by each Southwest, jetblue and AirTran in 2009

2

(handwritten) AA costs too high b/c did not file for bankruptcy
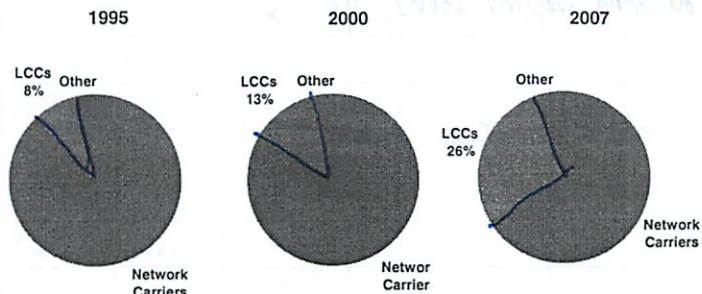
(handwritten) cutting capacity to 198_ — there before dereg — lot more international

(handwritten) how important bankrupcy was to close gap

Slide 3

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Technology

The Growth of LCC Market Share
Domestic ASMs by Industry Sector

1995   2000   2007

LCCs 8% Other   LCCs 13% Other   Other
                                         LCCs 26%

Network Carriers   Networ Carrier   Network Carriers

3

(handwritten) did airline data project

Slide 4

Massachusetts
Institute of
Technology

The LCC "Business Model" *(handwritten) Myth*

- LCC operations are assumed to have many common characteristics designed to reduce unit costs:
  - Single aircraft type or family of aircraft
  - Point-to-point vs. hub network structure *(handwritten) hybrid - do hub + spoke*
  - No connecting tickets (only point-to-point) *(handwritten) local passengers*
  - No labor unions, low wage rates
  - Single cabin service, no "premium" classes on board
  - No seat assignment (in advance and/or at the airport)
  - Reduced "frills" and seating space on board
  - No frequent flyer loyalty programs
  - No distribution through Global Distribution Systems (GDS)

- With LCC evolution, very few large LCCs actually fit this assumed LCC "business model" today...

4

(handwritten) Southwest - most unionize carrier in the US

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Evolution of LCC Business Models

	Southwest				
Single aircraft type or single family of aircraft	✓				
Point-to-point ticketing, no connecting hubs	✗				
No labor unions, lower wage rates	✗				
Single cabin service, no premium class	✓				
No seat assignments	✓				
Reduced frills for on-board service (vs. legacy)	✗				
No frequent flyer loyalty program	✗				
Avoid Global Distribution Systems (GDS)	?				

highest wages

all legacy carriers have no-frills
very important to them

5

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Evolution of LCC Business Models

	Southwest	JetBlue			
Single aircraft type or single family of aircraft	✓	✗			
Point-to-point ticketing, no connecting hubs	✗	✗			
No labor unions, lower wage rates	✗	✓			
Single cabin service, no premium class	✓	✓			
No seat assignments	✓	✗			
Reduced frills for on-board service (vs. legacy)	✗	✗			
No frequent flyer loyalty program	✗	✗			
Avoid Global Distribution Systems (GDS)	?	✗			

2 fleet types - for smaller airplane

6

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Evolution of LCC Business Models

	Southwest	JetBlue	AirTran			
Single aircraft type or single family of aircraft	✓	✗	✗			
Point-to-point ticketing, no connecting hubs	✗	✗	✗			
No labor unions, lower wage rates	✗	✓	✗			
Single cabin service, no premium class	✓	✓	✗			
No seat assignments	✓	✗	✗			
Reduced frills for on-board service (vs. legacy)	✗	✗	✗			
No frequent flyer loyalty program	✗	✗	✗			
Avoid Global Distribution Systems (GDS)	?	✗	✗			

Southwest dropping

7

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Evolution of LCC Business Models

	Southwest	JetBlue	AirTran	WestJet		
Single aircraft type or single family of aircraft	✓	✗	✗	✓		
Point-to-point ticketing, no connecting hubs	✗	✗	✗	✗		
No labor unions, lower wage rates	✗	✓	✗	✓		
Single cabin service, no premium class	✓	✓	✗	✓		
No seat assignments	✓	✗	✗	✗		
Reduced frills for on-board service (vs. legacy)	✗	✗	✗	✗		
No frequent flyer loyalty program	✗	✗	✗	✗		
Avoid Global Distribution Systems (GDS)	?	✗	✗	✗		

8

does not do any of these things
- Southwest needs to make decision

2

Evolution of LCC Business Models

	Southwest	JetBlue	AirTran	WestJet	EasyJet	
Single aircraft type or single family of aircraft	✓	✗	✗	✓	✗	
Point-to-point ticketing, no connecting hubs	✗	✗	✗	✗	✓	
No labor unions, lower wage rates	✗	✓	✗	✓	✗	
Single cabin service, no premium class	✓	✓	✗	✓	✓	
No seat assignments	✓	✗	✗	✗	✓	
Reduced frills for on-board service (vs. legacy)	✗	✗	✗	✗	✓	
No frequent flyer loyalty program	✗	✗	✗	✗	✓	
Avoid Global Distribution Systems (GDS)	?	✗	✗	✗	✓	

9

Evolution of LCC Business Models

	Southwest	JetBlue	AirTran	WestJet	EasyJet	RyanAir
Single aircraft type or single family of aircraft	✓	✗	✗	✓	✗	✓
Point-to-point ticketing, no connecting hubs	✗	✗	✗	✗	✓	✓
No labor unions, lower wage rates	✗	✓	✗	✓	✗	✓
Single cabin service, no premium class	✓	✓	✗	✓	✓	✓
No seat assignments	✓	✗	✗	✗	✓	✓
Reduced frills for on-board service (vs. legacy)	✗	✗	✗	✗	✓	✓
No frequent flyer loyalty program	✗	✗	✗	✗	✓	✓
Avoid Global Distribution Systems (GDS)	?	✗	✗	✗	✓	✓

10

[handwritten: finally – one that follows the model]

US Legacy and Low Cost Airlines

Network Legacy Carriers

AA – American Airlines
UA – United Air Lines
DL – Delta Air Lines (incl. NW)
CO – Continental Airlines
US – US Airways (incl. HP)

Low Cost Carriers

WN – Southwest Airlines
B6 – JetBlue Airways
FL – AirTran Airways
F9 – Frontier Airlines
VX – Virgin America

[handwritten: Consolidation]

- Legacy group carried 67% of total US airline traffic in 2009.
- These airlines carried another 17% of total US traffic (RPMs).

Cost and Productivity Convergence

- Lower costs and improved productivity helped NLCs to return to profitability in 2006 and 2007, but deep losses in 2008 and 2009 suggest work is not done
  - Network Legacy Carriers re-structured, reduced/outsourced capacity, and cut costs while improving productivity at the mainline level
  - The network legacy carriers were once again more profitable than the LCC sector (operating profits)
- The unit cost gap has narrowed dramatically
  - NLCs have seen large drops in labor and other cost components
  - LCCs still have lower total unit costs than NLCs
- New 2009 data shows that convergence has continued
  - Labor unit costs remain very similar
  - Non-labor ("structural") unit costs for NLCs are still at least 1 cent per ASM higher than LCCs
  - Just not many areas of cost left to cut

[handwritten: how much contracting should I do $20 billion from regional carrier]

[handwritten: System more complex – costly, but good for revenue]

12

[handwritten: maybe happy in 2010 – if this is as good as it gets – bad business]

3

Slide 13 — CASM Breakdown

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CASM Breakdown

- CASM can be broken down as follows:
  - Transport Related and Fuel expenses excluded for comparisons

(handwritten: apples to apples)

(handwritten: contracting regional / hedging distorted)

Total CASM / Transport Related / Fuel / CASM ex. Transport and Fuel / Labor CASM / Non-labor CASM

13

Slide 14 — Unit Costs (excl. "Transport Related")

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Unit Costs (excl. "Transport Related")

CASM Ex Transport ($/ASM)

NLC — LCC

14

Slide 15 — Unit Costs (excluding "Transport" & Fuel Expense)

Massachusetts Institute of Technology

Unit Costs
(excluding "Transport" & Fuel Expense)

CASM Ex Transport & Fuel ($/ASM)

NLC — LCC

15

Slide 16 — Non-Labor Unit Costs (excl. Transport, Fuel and Labor)

Massachusetts Institute of Technology

Non-Labor Unit Costs
(excl. Transport, Fuel and Labor)

CASM Non-labor ($/ASM)

NLC — LCC

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Slide 17

MIT Massachusetts Institute of Technology

Labor Unit Costs

CASM Labor ($/ASM)

Legend: NLC, LCC

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Slide 18

MIT Massachusetts Institute of Technology

Changes in CASM (ex Transport & Fuel) by Airline 2001-2006

Change in CASMexTF 2001->2006

USHP -24%, UA -24%, AA -24%, DL -13%, NW -8%, CO -7%, F9 -19%, B6 -12%, FL -9%, WN 5%, TZ 8%, NK 25%

• All NLCs cut CASM exTF, with US Airways, United and American achieving almost 25% reductions.

• LCCs showed mixed unit cost performance – reductions at newer carriers (Frontier, JetBlue) and increases at older LCCs (Southwest)

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Slide 19

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Changes in Labor CASM by Airline 2001-2006

Change in CASML 2001->2006

USHP -39%, UA -33%, DL -26%, NW -22%, AA -18%, CO -11%, FL -15%, B6 -2%, F9 4%, WN 14%, NK 20%, TZ 26%

• Deepest cuts in Labor CASM at NLCs that went through Chapter 11 (US Airways, United, Delta and NWA).

• Only one LCC (Frontier) achieved substantial Labor CASM drop, while Southwest Labor CASM grew by 14%.

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Slide 20

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Changes in Non-Labor CASM by Airline 2001-2006

Change in CASMNL 2001->2006

AA -28%, UA -15%, USHP -11%, CO -4%, DL -1%, NW 5%, F9 -27%, B6 -18%, FL -6%, WN -4%, TZ -2%, NK 27%

[handwritten: "↑fleet renewal"]

• American succeeded in reducing Non-Labor ("structural") CASM the most among NLCs, followed by United and US Airways

• Frontier and JetBlue achieved notable reductions with rapid growth and longer-haul flying.

[handwritten: "took lots of $ out before going to labor"]

20

goes to media day
— writes a blog

hotel perspective

Slide 21

Massachusetts Institute of Technology

How Should We Think About the Airline Industry?

- Cost differences increasingly difficult to discern and are mixed
- Increasing discussion that the hospitality industry provides a way to think about the US airline industry.
  - With that said,
    - **Network Carriers:** AA, CO, DL, UA, US – neither upscale or luxury but breadth of network – global and domestic – establishes the brand/product
    - **Southwest:** only real established brand. The carrier from which all comparisons are made – rightly or wrongly. Network today a large US footprint.
      - Southwest skews results when grouped with other LCCs/Midscales
    - **Midscales:** jetBlue, AirTran, Frontier – quality service with amenities at a market price. Network largely centered on North America and Caribbean
      - Alaska excluded due to data issues
    - **Economy:** Spirit, Allegiant – budget traveler. Reasonable quality at a low price. Network focus on secondary and tertiary markets to largest leisure destinations.
      - Excluded from this analysis due to data issues

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travel co - package
bottom fisher in Caribbean

tkts Boston Southwest already most pax. After buy AirTran #4 in revenue

Slide 22

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Total Cost per Available Seat Mile
Much More to the Story

raw cost

[Line chart: Cents Per Available Seat Mile, 1995–2009. Network, Southwest, Midscales. Values labeled 3.76¢ and 4.50¢]

Source: MIT Airline Data Project

Legend: Network — Southwest — Midscales

22

Slide 23

Massachusetts Institute of Technology

Cost per Available Seat Mile
(ex Transport Related and Fuel Expenses)

[Line chart: Cents Per Available Seat Mile, 1995–2009. Network, Southwest, Midscales. Values labeled 1.06¢ and 1.85¢]

Source: MIT Airline Data Project

Legend: Network — Southwest — Midscales

23

Very different picture
Many don't do contracting

Slide 24

Massachusetts Institute of Technology

Non-Labor Cost per Available Seat Mile
(ex Labor, Fuel and Transport Related)

[Line chart: Cents Per Available Seat Mile, 1995–2008. Network, Southwest, Midscales. Values labeled 1.27¢ and 1.87¢]

Source: MIT Airline Data Project

Legend: Network — Southwest — Midscales

24

Complexity of airline network 1st class lounges etc

6

Slide 1 (top left):

MIT Massachusetts Institute of Technology

Labor & Related Cost per Available Seat Mile

Y-axis: Cents Per Available Seat Mile (1.0 – 5.0)
X-axis: 1995 – 2009

1.34¢

Legend: ◆ Network · ▲ Southwest · ■ Midscales

Source: MIT Airline Data Project

25

Handwritten: bankruptcies · highest unit labor cost

Slide 2 (top right):

MIT Massachusetts Institute of Technology

So, Absent Structural Change in the Industry

- Continued focus on cost-cutting will remain paramount
  - But the historic pools of cost are not as readily available
    - Labor costs are not a source of saving; labor will push hard to get back
    - Distribution costs have largely been wrung out of the system
    - Fear is maintenance costs will head up; materials costs already an issue
    - The infrastructure is not the industry's friend; will continue to mute efficiency efforts
    - And fuel is an uncontrollable cost
  - So, the industry will look to exhibit capacity discipline
    - Not as easy outside of bankruptcy when contracts cannot be altered
    - The industry spends in excess of $15 billion per year with regional carriers
      - Really only large pool of expense to consider
- Capacity cuts have risk
  - Political
  - Financial

Handwritten: lots of changes though · all about price – not value

Slide 3 (bottom left):

MIT Massachusetts Institute of Technology

2009 Domestic Seating Capacity Fell Most Since 1942
Market Forces, Policy Resulted in Largest Post-WWII Contraction in Aviation History

Y-axis: Annual Percent Change In Domestic ASMs* (-20 to 100)
X-axis: Year (32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04 06 08)

-16.2   -6.9

* An available seat mile (ASM) is one seat flown one mile.
Source: Air Transport Association

Handwritten: domestic system capacity

Slide 4 (bottom right):

MIT Massachusetts Institute of Technology

Domestic Capacity Reduced in 6 of Last 9 Years
Largest Decline Expected in 2009
Pct Chg ASMs

Y-axis: -10% to 20%

Note: 1987 = 15%

Handwritten: Out of order

Handwritten top right: here was negotiating this, he was surprised how much he got – lost lots of friends – but needed to be done

labor was like an ATM in recessions – but before you always restored – not now

politics in outsourcing maintance – bad word in industry today

– Can't figure out Next Gen ATC – but get mandates

– never thought they would take capacity out so much – w/ hubs leveraged

Handwritten between slides: Could also stage length adjust – but then distorts how they are doing financially

7

Slide 1: Today's Mainline Capacity Is The Same as 1987

Bar chart — Y-axis: ASMs (in thousands), ranging from 200,000,000 to 600,000,000. X-axis: years 1980 to 2008.

Slide 2: The Cost of Jet Fuel: It's Still in the News

- The industry will pay more for fuel in 2010 than it did in 2009
  - Volatility less   *[handwritten: just having to plan cash — do I have enough cash to pay for tomorrow]*
- A declining dollar "fueling" the increase in oil yet again?
  - Not so much this year   *[handwritten: Currency]*
  - Surely it is not global demand
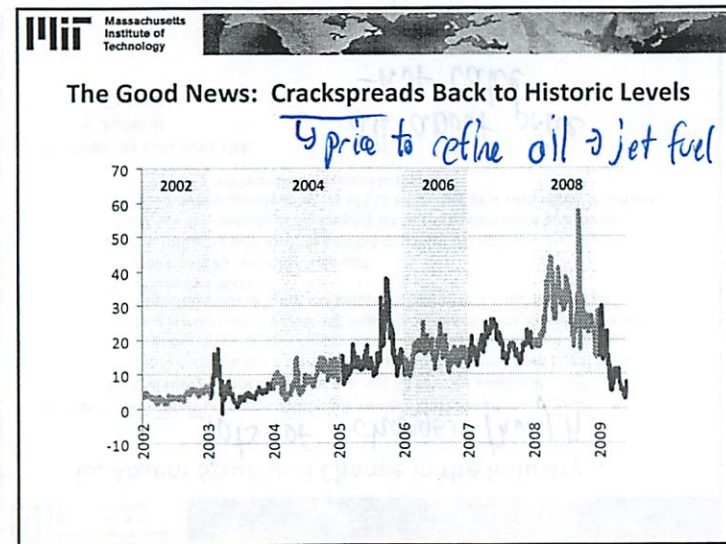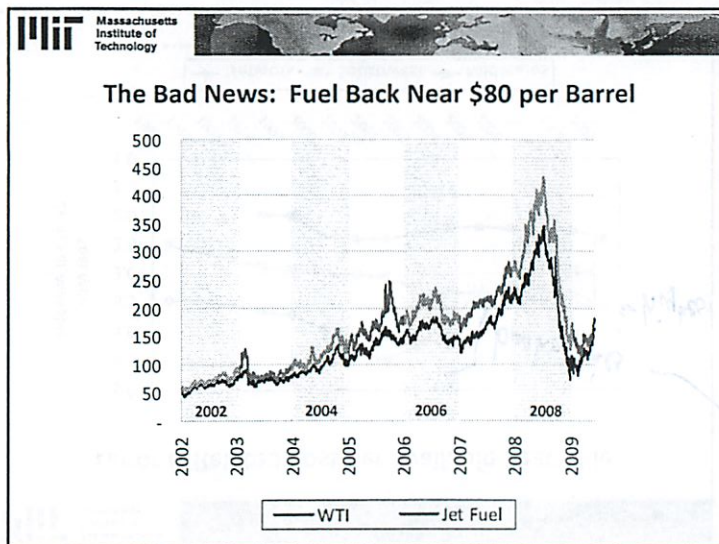- Hedging became the financial engineering instrument that separated Southwest from the pack
  - With oil trading near $80 per barrel again, new discussion of hedging strategies
    - Again, a question on whether hedging strategies is a prudent use of capital?
  - Crack spreads have declined significantly – close to historic norms
    - But, we will still sit one more storm away or one geopolitical event away from a return to 2008 levels

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[handwritten: mostly short term to plan cash]

Slide 3: The Bad News: Fuel Back Near $80 per Barrel

Line chart — Y-axis: 50 to 500. X-axis: 2002 to 2009. Legend: WTI, Jet Fuel.

Slide 4: The Good News: Crackspreads Back to Historic Levels

[handwritten: ↳ price to refine oil → jet fuel]

Line chart — Y-axis: -10 to 70. X-axis: 2002 to 2009.

8

lines going up
– grew through recessions

Cheap Fuel and Readily Available Credit Built "An Industry Too Big"

Traffic, Capacity and Load Factors for US Airlines

Legend: Load Factor — RPMs — ASMs

can't simply (raise fares)

The Revenue Environment

- To many, the fix is a simple raise of fares. Down nearly 19% in 2010. Fares up nearly 19% in 2009
  - The intense level of competition signals that this is not a viable option
  - Transparency makes increasing fares only difficult
  - Operating profit for both NLCs and LCCs is elusive when passenger expenses are subtracted from passenger revenue only
  - New revenue sources sought by all
- The absolute level of fare reductions realized by the NLC sector since 2000 is significant
  - With fare reductions of this order of magnitude, the revenue line cannot write the check that labor expects in the next round
  - Let alone pay the fuel bill
  - Moreover, fare premiums exist but against a much smaller base fare for the NLC sector
    - Except for US Airways and America West
- The LCC sector has been increasing their fares to compensate for increasing costs
  - But still have to price well below their direct competition
  - Given current statements about demand by the LCC sector, will their decision to slow capacity plans have a negative impact on profitability?

BA could analyze if Jet Fuel/Air Transport related oil
– Stop fuel converging

Percent of Southwest Unit Cost Advantage v. Network Carriers Attributed to Fuel (Hedges)

Source: MIT Airline Data Project

need cash to buy the options – NLCs didn't

Fuel Cost per Available Seat Mile
The Oil Story is Not Over

Legend: Network — Southwest — Midscales

2 cents

Source: MIT Airline Data Project

Massachusetts Institute of Technology

Decreasing Real Fares Became the "Great Enabler"
Expectations for Industry Stakeholders Not Based in Long-Term Reality

Chart: Cents per Revenue Passenger Mile (1978 = 100), 1978–2008
— Domestic Real Yield — International Real Yield — System Real Yield

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Massachusetts Institute of Technology

The Focus Must Remain on Vigilant Cost Controls
And New Revenue Sources

- Not just for the Network Legacy Carriers because
  - On balance average domestic fares today are 13% less than fares charged in 2000 (a high water mark)
    - but jet fuel costs were $38/bbl "in the wing"
  - Increasingly difficult to extract premiums over and above the average fares charged by the competition
  - Raising fares can only partially offset increases in fuel
    - The move to ancillary charges

- Not just for the "Low Cost" Carriers because …
  - While able to charge more, the group still finds itself pricing well below competitors
  - Growth is slowing and without growth, costs will naturally creep higher and higher
  - Therefore, other revenue sources necessary

- For the industry because …
  - $80 jet fuel seems to now be more the rule than the exception

38

Handwritten notes:

Unit revenue fell 50%

needs to find model
— to be profitable
Consolidation
— around the globe
— cost synergy
alliances does the revenue network effects

- scary for companies
- fees
  - PR perspective
  - suitcases burn gas
  - how fee thing got started
  - lost creditability as fuel ↓
- not transparent
- but he thinks it should not be legislated

AA wants to do honorable thing + pay bills + pensions
- but not competive
- management is just a nice guy
- missed window
  - have $5-6/billion in cash
  - $700 million whole
  - very old fleet
  - amazing what its done w/ balance sheet

Legacy Carriers
- they sell hotels + cars online

Aligant
  - rock bottom price
  - packages
  - Orlando + Las Vegas

Politicians selling infrastructure
 - for big pay day

Why regional so expensive?
  - cross subsidizes low fares
  - industry trying to dump 50 seat planes
  - delta dropped 200/500 planes
  - don't make economic sense
     - at ~~less~~ than $150/oil
        more