Chapter 16 Revenue Management

- Airline Performance
- Protection Levels and Booking Limits
- Overbooking
- Implementation of Revenue Management

Southwest Airlines

Southwest Airlines focus on short-haul flights and is well known for its strategy of low price and high convenience.

Southwest is the second largest airline (by passengers) in the world in 2009.

More than 40 consecutive years of profitability

In June 2010, the American Customer Satisfaction Index ranked Southwest Airlines number one among all airlines for the 17th year in a row.

Cost and Revenue

- Operations Cost = Direct Cost + Indirect Cost

  = Direct Materials Cost + Direct Labor Cost + Overhead and Utilities Cost + …

- Operations Cost = Fixed Cost + Variable Cost

  = Administrative Costs + Depreciation and Interest + Production Cost + Inventory and Transportation Cost + …

- Revenue = Throughput × Average Unit Price
- Return = Revenue – Operations Cost

3

How to Improve Profitability

- Return = Revenue – Operations Cost

= Throughput × Price – Fixed Costs –Throughput × Variable Costs

Reduce fixed costs
Reduce variable costs
Increase price
Increase throughput

- If supply is fixed and perishable, fixed costs are high and variable costs are low, increasing price and/or throughput to improve profitability.

4

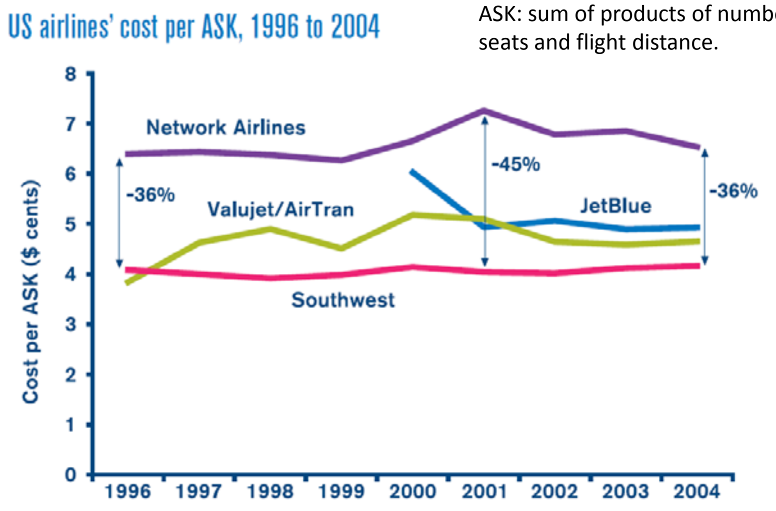
U.S. Airline Industry

- Carriers typically fill 72.4% of seats and have a break-even load of 70.4%.
- From 1995-1999 (the industry's best 5 years ever) airlines earned 3.5 cents on each dollar of sales
- Very high fixed costs and perishable capacity.
- Cost per ASM (available seat mile)
- Revenue per Passenger Mile
- More ticket sales means more revenue and more profit.

5

Airline Cost Performance

ASK: sum of products of number of seats and flight distance.



6

Southwest Performance in 2009

- Total ASM: 98 billion **(1)**
- Total passengers carried: 86.3 million **(2)**
- average passenger trip length is 863 miles **(3)**
- Total Revenue Passenger Miles =(2)*(3)=74,457M **(4)**
- Average passenger load factor=(4)/(1)=76%
- Total Revenue = 10,350 million **(5)**
- Yield ($/RPM) = (5)/(4) = 0.139

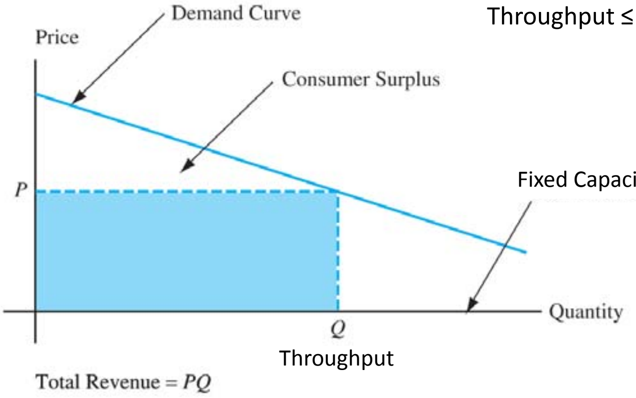
Comparing Airline Performance in 2010

2009	Revenue	Cost	RPM	ASM	RPM/ASM	Yield	Cost/ASM	Margin
Southwest	10,350	10,088	74,457	98,002	75.97%	0.14	0.10	2.5%
American	17,886	18,888	122,418	151,774	80.66%	0.15	0.12	-5.6%
JetBlue	3,286	3,007	25,955	32,558	79.72%	0.13	0.09	8.5%
United	23,906	23,529	180,299	220,144	81.90%	0.13	0.11	1.6%

2010	Revenue	Cost	RPM	ASM	RPM/ASM	Yield	Cost/ASM	Margin
Southwest	12,104	11,116	78,047	98,437	79.29%	0.16	0.11	8.2%
American	19,823	19,336	125,486	153,241	81.89%	0.16	0.13	2.5%
JetBlue	3,779	3,446	28,279	34,744	81.39%	0.13	0.10	8.8%
United	28,040	25,637	184,580	220,060	83.88%	0.15	0.12	8.6%

8

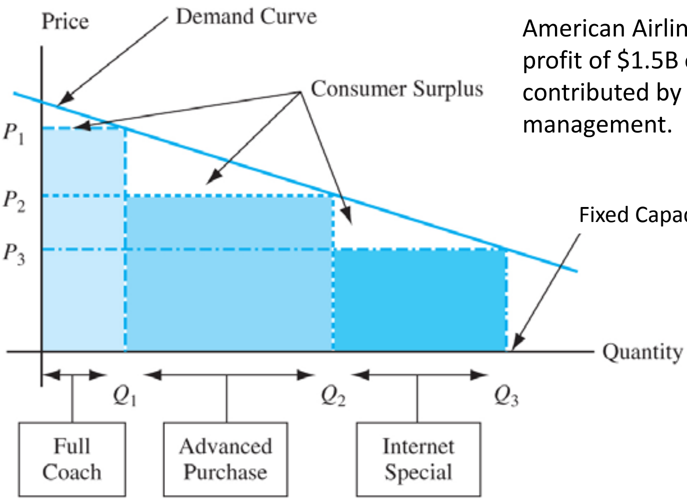
Price vs. Throughput



Throughput ≤ Capacity

9

Revenue Management by American Airlines



American Airlines estimated a profit of $1.5B over 3 years contributed by revenue management.

10

Matching Demand When Supply is Fixed

- Examples of fixed but perishable supply:
  - Travel industries (fixed number of seats, rooms, cars).
  - Advertising time (limited number of time slots).
  - Size of the MBA program.
  - Doctor’s availability for appointments.
- Revenue management is a solution:
  - Offer low prices so that there is enough demand to consume the supply.
  - Limit the amount of supply sold at low prices in order to satisfy customers willing to pay high prices.

11

Hotel Revenue Management

- The Park Hyatt Philadelphia, 118 King/Queen rooms.
- Regular fare is r_H= $225 (high fare) targeting business travelers.
- Hyatt offers a r_L= $159 (low fare) discount fare for a mid-week stay targeting leisure travelers.
- Demand for low fare rooms is abundant.
- Most of the high fare demand occurs within a few days of the actual stay.

12

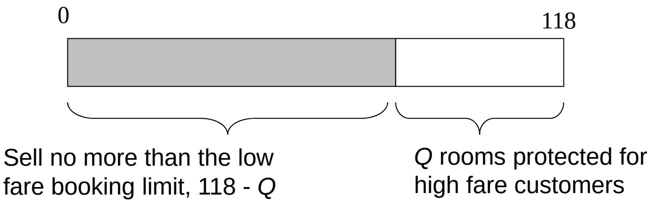
Protecting Levels and Booking Limits

- Choice 1: Do not accept low fare reservation. Hope that high fare customers will eventually show up.
- Choice 2: Accept low fare reservations without any limit.
- Choice 3: Accept low fare reservations but reserve rooms for high fare customers
- Objective: Maximize expected revenues by controlling the sale of low fare rooms.

13

Yield Management Decisions

- The *booking limit* is the number of rooms you are willing to sell in a lower fare.
- The *protection level* is the number of rooms you reserve for a higher fare class.
- Let *Q* be the protection level for the high fare class.
- The booking limit on the low fare class is 118 – *Q*:



14

The Connection to the Newsvendor Problem

- A single decision before uncertain demand is realized.
- D = number of high fare customers, Q = protection level
- If *D* < *Q* then you protected too many rooms
  - Cost of over-protection … some rooms are empty which could have been sold to a low fare customer.
- If *D* > *Q* then you protected too few
  - Cost of under-protection … some rooms could have been sold at the high fare instead of the low fare.
- Choose *Q* to balance the overage and underage costs.

15

Optimal Protection Level

- Overage cost:
  - If *D* < *Q* we protected too many rooms and could have sold those empty rooms at the low fare, so $C_o = r_L$.
- Underage cost:
  - If *D* > *Q* we protected too few rooms and could have sold D-Q more rooms at the high fare, so $C_u = r_H - r_L$
- Optimal high fare protection level: $F(Q^*) = \frac{C_u}{C_o + C_u} = \frac{r_H - r_L}{r_H}$
- Optimal low fare booking limit = 118 – Q^*

16

Hyatt Example

- Critical ratio: $$\frac{C_u}{C_o + C_u} = \frac{r_h - r_l}{r_h} = \frac{225 - 159}{225} = \frac{66}{225} = 0.2933$$
- Poisson distribution with mean 27.3.

Q	F(Q)	Q	F(Q)	Q	F(Q)
10	0.0001	20	0.0920	30	0.7365
11	0.0004	21	0.1314	31	0.7927
12	0.0009	22	0.1802	32	0.8406
13	0.0019	23	0.2381	33	0.8803
14	0.0039	24	0.3040	34	0.9121
15	0.0077	25	0.3760	35	0.9370
16	0.0140	26	0.4516	36	0.9558
17	0.0242	27	0.5280	37	0.9697
18	0.0396	28	0.6025	38	0.9797
19	0.0618	29	0.6726	39	0.9867

- 24 rooms should be *protected* for high fare customers.

17

Expected Lost Sales of the Hyatt Example

- How many high-fare customers will be refused?

C2 f_x =POISSON(A2,27.3,FALSE)

	A	B	C	D	E	F	G
1	demand	lost sales	probability				
2	25	1	0.0720	0.0720			
3	26	2	0.0756	0.1511			
4	27	3	0.0764	0.2292			
5	28	4	0.0745	0.2980			
6	29	5	0.0701	0.3507			
7	30	6	0.0638	0.3829			
8	31	7	0.0562	0.3934			
9	32	8	0.0480	0.3836			
10	33	9	0.0397	0.3570			
11	34	10	0.0319	0.3185			
24	47	23	0.0002	0.0039			
25	48	24	0.0001	0.0023			
26	49	25	0.0001	0.0013			
27	50	26	0.0000	0.0008			
28		expected lost sales=		4.0952			

Expected lost sales = 4.10

18

Related Calculations

- How many high-fare customers will be refused?
  - *Expected lost sales* = 4.10
- How many high-fare customers will be accommodated?
  - *Expected sales* = *Expected demand* - *Lost sales* = 27.3 - 4.1
- How many rooms will remain empty?
  - *Expected left over inventory* = *Q* - *Expected sales* = 24 - 23.2
- What is the expected revenue?
  - \$225 x *Exp. sales* + \$159 x *Booking limit* = \$20,166.
  - Without yield management worst case scenario is \$159 x 118 = \$18,762.

19

Environments for Revenue Management

- There are distinguishable customer segments who are willing to pay different prices.
- The same unit of capacity can be sold to different customer segments.
- Capacity is fixed and perishable.
- High gross margins (so that the variable cost of additional sales is low).
- Capacity can be sold in advance.
- Competition from a low price competitors.

20

20

Ugly Reality: Cancellations and No-Shows

- Approximately 50% of reservations get cancelled.
- In many cases (car rentals, hotels, full fare airline passengers) there is no penalty for cancellations. Some customers do not show up even if there is a penalty.
- Problem:
  - the company may fail to fill the seat (room, car) if a customer does not show up.
  - This is a problem even if the customer does not get a refund for cancellation.

Overbooking to Protect Revenue

Overbooking—accept more reservations than supply

Example: On average there would be 10 cancellations or no-shows. So the hotel can accept 10 more reservations.

Too many overbooking: some customers may have to be denied a seat even though they have a confirmed reservation.

Not enough overbooking: waste of capacity, loss of revenue

Overbooking Example

No-shows d	Probability $P(d)$	Reservations Overbooked x	Cumulative Probability $P(d < x)$
0	.07	0	0
1	.19	1	.07
2	.22	2	.26
3	.16	3	.48
4	.12	4	.64
5	.10	5	.76
6	.07	6	.86
7	.04	7	.93
8	.02	8	.97
9	.01	9	.99

expected number of no-shows = 0(0.07)+1(0.19)+…+9(0.01)=3.04

Expected opportunity loss = 3.04 × $40 = $121.60

Cost of too many overbooking: $100 for accommodation at some other hotel and additional compensation.

Cost of not enough overbooking: $40 per room.

		Reservations Overbooked									
No-shows	Probability	0	1	2	3	4	5	6	7	8	9
0	.07	0	100	200	300	400	500	600	700	800	900
1	.19	40	0	100	200	300	400	500	600	700	800
2	.22	80	40	0	100	200	300	400	500	600	700
3	.16	120	80	40	0	100	200	300	400	500	600
4	.12	160	120	80	40	0	100	200	300	400	500
5	.10	200	160	120	80	40	0	100	200	300	400
6	.07	240	200	160	120	80	40	0	100	200	300
7	.04	280	240	200	160	120	80	40	0	100	200
8	.02	320	280	240	200	160	120	80	40	0	100
9	.01	360	320	280	240	200	160	120	80	40	0
Expected loss ($)	—	121.60	91.40	87.80	115.00	164.60	231.00	311.40	401.60	497.40	560.00

Overbooking for Hyatt's Reservation System

- Hyatt offers a r_L= $159 (low fare) discount fare for leisure travelers and requires advance reservation.
- Number of no-shows (*X*) is Poisson with mean 8.5
- How many rooms (*Y*) should be overbooked (sold in excess of capacity)?
  - Underage cost C_u: if $X > Y$ (insufficient overbooking).
  - Overage cost C_o: if $X < Y$ (too many overbooking).

Hyatt's Overbooking Cost

- Cost of too many overbooking: $350 for accommodation at some other hotel and additional compensation.
- Cost of not enough overbooking
  - If the reservation is refundable, then the hotel loses at least $159 for each empty room.
  - If the reservation is not refundable, the hotel still loses at least $159. (Had it accepted 1 more reservation)

Overbooking Solution

- Optimal overbooking level: $F(Y) = \frac{C_u}{C_o + C_u}.$
- Critical ratio: $\frac{C_u}{C_u + C_o} = \frac{159}{350 + 159} = 0.3124$
- Poisson distribution with mean 8.5
- Optimal overbooking is Y=7.
- If the Hyatt accepts 125 reservations, then there is about a *F*(6)=25.62% chance they will have more customers than rooms

Q	*F*(*Q*)	*Q*	*F*(*Q*)
0	0.0002	10	0.7634
1	0.0019	11	0.8487
2	0.0093	12	0.9091
3	0.0301	13	0.9486
4	0.0744	14	0.9726
5	0.1496	15	0.9862
6	0.2562	16	0.9934
7	0.3856	17	0.9970
8	0.5231	18	0.9987
9	0.6530	19	0.9995

Revenue Management Challenges …

- Demand forecasting is a necessary for setting protection levels and overbooking quantities.
- Dynamic decisions for changing fares and forecasts.
- Variable capacity
  - Different aircrafts, ability to move rental cars around.
- More risky to accept group reservations. More costly to turn away group reservations.
- Multi-leg passengers/multi-day reservations
  - Turning away more valuable customers is more costly.