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Flight Overbooking: Models and Practice

16.75J/1.234J Airline Management

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Lecture Outline

- **Overbooking Terminology and Relationships**
- **Evolution of Airline Overbooking Models**
  - Manual/Judgmental
  - Deterministic Model
  - Probabilistic/Risk Model
  - Cost-Based Overbooking Model
- **Costs of Denied Boardings and Spoilage**
- **Customer Service and Goodwill Issues**

Background: Flight Overbooking

- Determine maximum number of bookings to accept for a given physical capacity.
- Minimize total costs of <u>denied boardings</u> and <u>spoilage</u> (lost revenue).
- U.S. domestic no-show rates can reach 15-20 percent of final pre-departure bookings:
  - On peak holiday days, when high no-shows are least desirable
  - Average no-show rates have dropped, to 10-15% with more fare penalties and better efforts by airlines to firm up bookings
- Effective overbooking can generate as much revenue gain as fare class seat allocation.

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Overbooking Terminology

• Physical Capacity	CAP
• Authorized Capacity	AU
• Confirmed Bookings	BKD <= AU
• Waitlisted passengers	WL
• Go-show passengers	GS
• Stand-by passengers	SB

Overbooking Terminology (cont'd)

• No-shows	NS
• Show-ups	SU
• No-show rate	NSR
• Show-up rate	SUR
• Passengers Boarded	PAX
• Denied Boardings	DB
• Spoilage	SP

Overbooking Relationships

1. PAX = min [BKD - NS + GS + SB, CAP]

   = BKD + GS - NS + SB - DB

2. BKD = NS + SU

3. SU = PAX + DB - GS - SB

4. NSR = (BKD - SU) / BKD

5. SUR = SU / BKD = 1.0 - NSR

6. SP = CAP - PAX, only when BKD = AU

Evolution of Airline Overbooking Models

- **Overbooking models try to minimize:**
  - Total costs of overbooking (denied boardings plus spoilage)
  - Risk of "excessive" denied boardings on individual flights, for customer service reasons

- **Mathematical overbooking problem:**
  - Find OV > 1.00 such that AU = CAP * OV
  - But actual no-show rate is highly uncertain

1. Manual/Judgmental Approach

- Relies on judgment of human analyst to set overbooking level:
  - Based on market experience and perhaps recent no-show history
  - Tendency to choose OV = 1+NSR (or lower)
  - Tendency to focus on avoidance of DB

- For CAP=100 and mean NSR=.20, then:

$$AU = 100\ (1.20) = 120$$

2. Deterministic Model

- **Based on estimate of mean NSR from recent history:**
  - Assume that BKD=AU ("worst case" scenario)
  - Find AU such that AU - NSR*AU = CAP
  - Or, AU = CAP/(1-NSR)

- **For CAP=100 and NSR=0.20, then:**

  AU = 100/(1-.20) = 125

3. Probabilistic/Risk Model

- **Incorporates uncertainty about NSR for future flight:**
  - Standard deviation of NSR from history, STD
- **Find AU that will keep DB=0, assuming BKD=AU, with a 95% level of confidence:**
  - Assume a probability (Gaussian) distribution of no-show rates
- **Keep show-ups less than or equal to CAP, when BKD=AU:**
  - Find SUR*, so that AU x SUR* = CAP, and Prob[AU x SUR* > CAP] = 5%
- **From Gaussian distribution, SUR* will satisfy:**

$$Z = 1.645 = \frac{SUR^* - SUR}{STD}$$

where SUR = mean show-up rate

STD = standard deviation of show-up rate

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Probabilistic/Risk Model (cont'd)

- Optimal AU given CAP, SUR, STD with objective of DB=0 with 95% confidence is:

$$AU = \frac{CAP}{SUR + 1.645\ STD} = \frac{CAP}{1 - NSR + 1.645\ STD}.$$

- In our example, with STD= 0.05:

AU = 100 / (1-0.20 + 1.645*0.05) = 113

- The larger STD, the larger the denominator and the lower the optimal AU, due to increased risk/uncertainty about no-shows.

Probabilistic Model Extensions

1. **Reduce level of confidence of exceeding DB limit:**
   – Z factor in denominator will decrease, causing increase in AU
2. **Increase DB tolerance to account for voluntary DB:**
   – Numerator becomes (CAP+ VOLDB), increases AU
3. **Include forecasted empty F or C cabin seats for upgrading:**
   – Numerator becomes (CAP+FEMPTY+CEMPTY), increases AU
   – Empty F+C could also be "overbooked"
4. **Deduct group bookings and overbook remaining capacity only:**
   – Firm groups much more likely to show up
   – Flights with firm groups should have lower AU

4. Cost-Based Overbooking Model

- **Find AU that minimizes :**

  [Cost of DB + Cost of SP]

- **For any given AU:**

  Total Cost = $DB * E[DB] + $SP * E[SP]

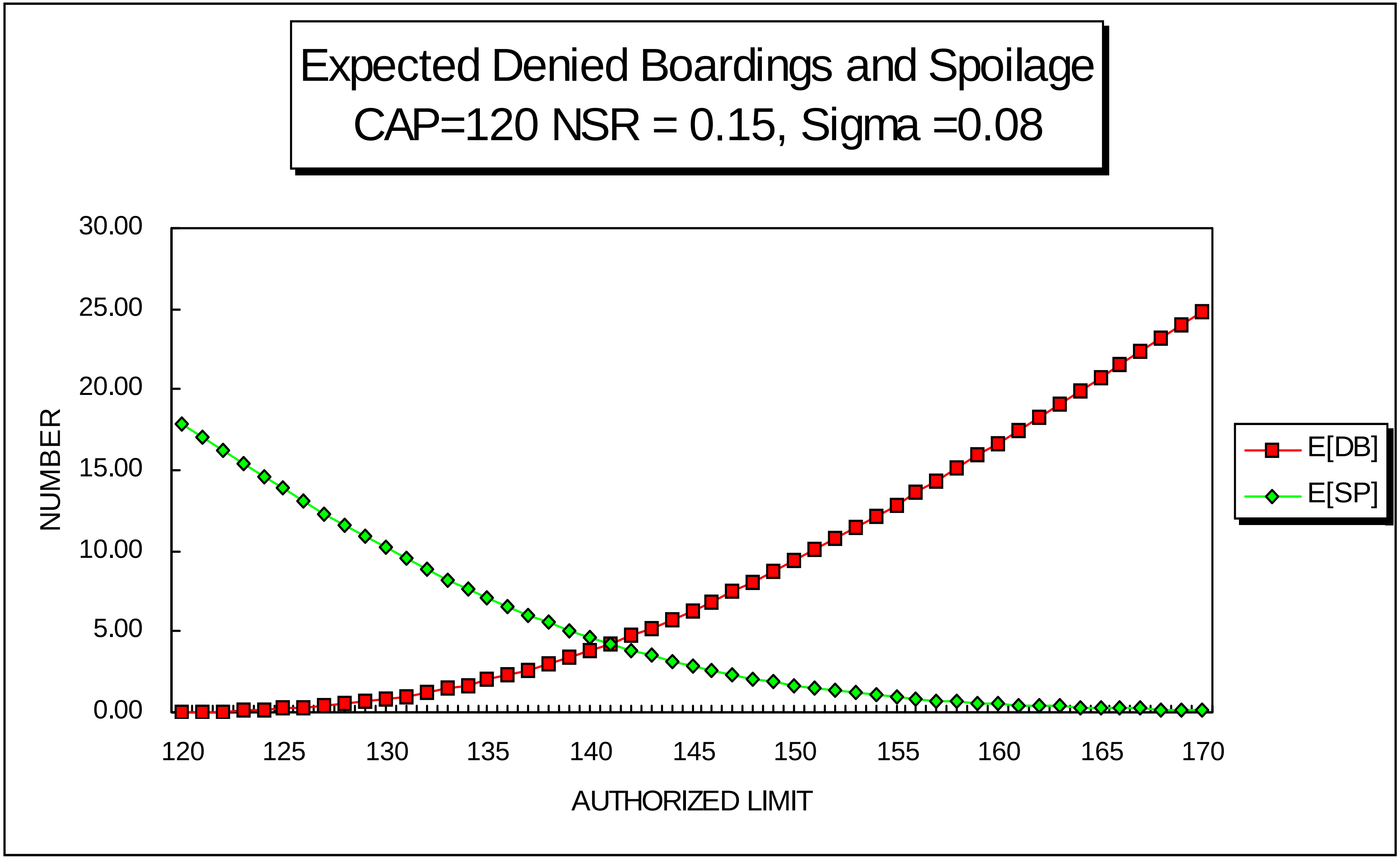
  $DB and $SP= cost per DB and SP, respectively

  E[DB] = expected number of DBs, given AU

  E[SP] = expected number of SP seats, given AU

- **Mathematical search over range of AU values to find minimum total cost.**

Example: Cost-Based Overbooking Model



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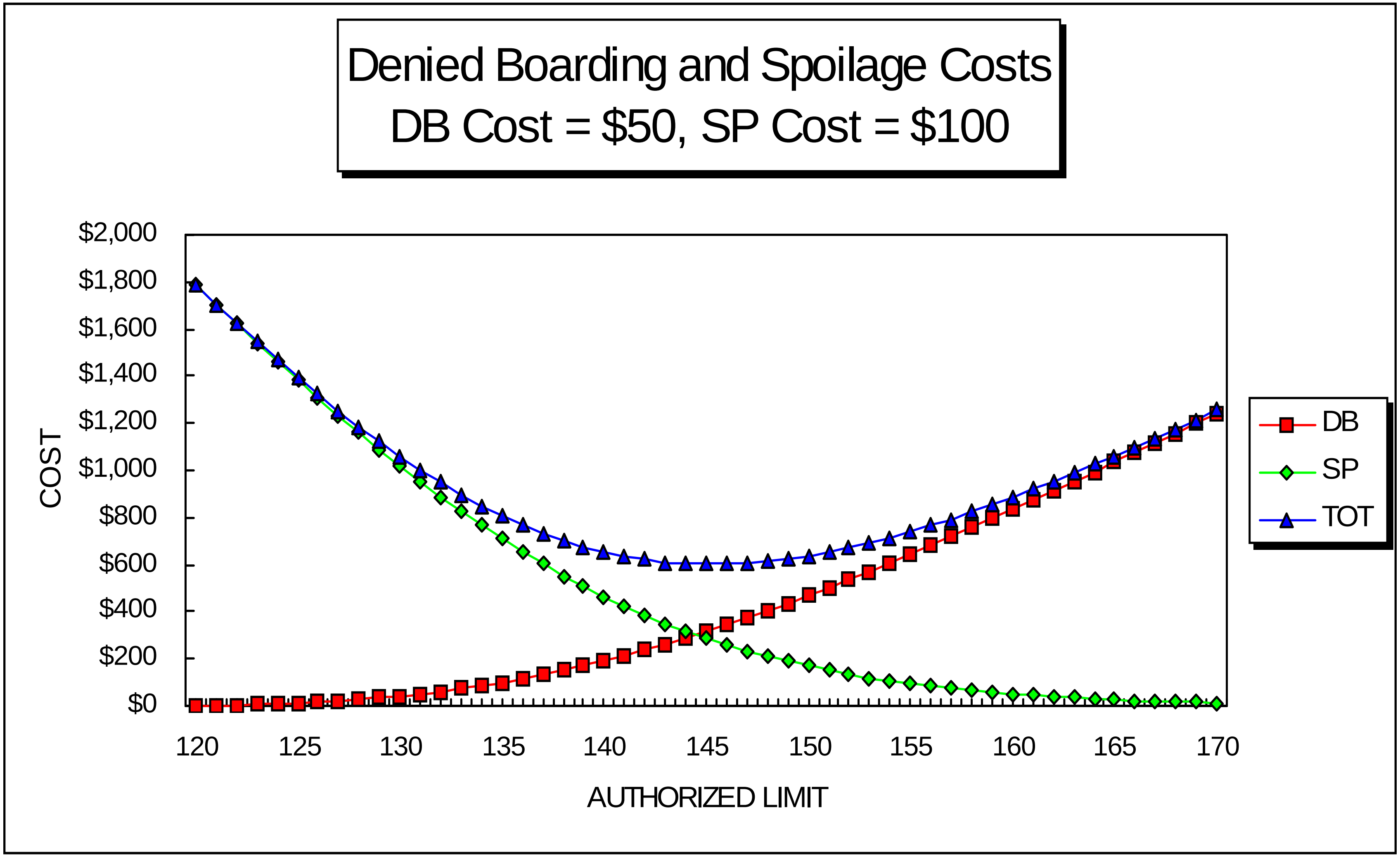

Cost Inputs to Overbooking Model

- **Denied Boarding Costs:**
  - Cash compensation for involuntary DB
  - Free travel vouchers for voluntary DB
  - Meal and hotel costs for displaced passengers
  - Space on other airlines
  - Cost of lost passenger goodwill costs

- **Many airlines have difficulty providing accurate DB cost inputs to these models.**

Cost Inputs (cont'd)

- Spoilage Costs:
  - Loss of revenue from seat that departed empty
- What is best measure of this lost revenue:
  - Average revenue per seat for leg?
  - Highest fare class revenue on leg (since closed flights lose late-booking passengers)?
  - Lowest fare class revenue on leg (since increased AU would have allowed another discount seat)?
- Specifying spoilage costs is just as difficult.

Customer Service and Goodwill

- **Many airlines tend to view aggressive overbooking in negative terms:**
  - Denied boardings associated with poor customer service and loss of passenger goodwill
- **But revenue loss of spoiled seats can be greater than DB costs:**
  - Objective is to reduce both actual costs and loss of goodwill due to denied boardings
  - Comprehensive Voluntary DB program needed

Voluntary vs. Involuntary DBs

- **Comprehensive Voluntary DB Program:**
  - Requires training and cooperation of station crews
  - Identify potential volunteers at check-in
  - Offer as much "soft" compensation as needed to make the passenger happy
- **US airlines very successful in managing DBs:**
  - 2004 involuntary DB rate was 0.62 per 10,000
  - 95% of DBs in U.S. are volunteers
  - Good treatment of volunteers generates goodwill

2004 US Involuntary DBs per 10,000