PRICING AND REVENUE MANAGEMENT RESEARCH
Airline Competition and Pricing Power

Presentations to
Industry Advisory Board Meeting
November 4, 2005
PRESENTATIONS

• “Pricing and Competition in Top US Markets” (Celia Geslin)
  ▪ Fare, Traffic and Revenue Changes 2000 to 2004

• “Impacts of Airline Fare Simplification” (Maital Dar)
  ▪ MIT PODS Research Consortium
  ▪ Simulations of Revenue and Traffic Impacts

• “Adapting Revenue Management Systems” (Peter Belobaba)
  ▪ Development of New Forecasting and Optimization Algorithms
AIRLINE PRICING AND COMPETITION IN TOP US MARKETS

Célia Geslin
Objectives and Approach

**Preliminary analysis of airline pricing power in US markets:**
- How have air fares changed in domestic markets in the past 5 years?
- Differences by length of haul?
- Differences between LCC and non-LCC markets?

**Empirical analysis of largest domestic markets**
- Top 100 US 2004 Markets from O&D Plus Data
- Aggregate analysis and overall trends between 2000 and 2004
- Analysis by carrier and type of carrier (legacy, LCC)
Fares continue to decrease. On average, fares were 19.3% lower in 2004 compared to 2000.
Passenger volumes have rebounded to 2000 levels after dropping by over 11%.
Huge revenue drop of 25.4% by 2002. Slow recovery since then, but still 19% below 2000.
Carrier Market Share Losses and Gains

- Market share losses for network carriers, gains for LCCs – led by JetBlue
- Southwest is MS leader in Top 100 Markets, in both 2000 and 2004
Market Share by Carrier Group

Overall, LCC group MS increased from 26% to 37%, while Legacy group MS dropped from 60% to 53%.
Average fares have dropped by 36% in long haul markets, while short haul fares actually increased slightly compared with 2000.

Average Fares by Distance Category

Average Fare comparison 2000-2004

- Short Haul: + 0.92%
- Medium Haul: - 21.34%
- Long Haul: - 36.08%
Passengers by Distance Category

Passenger traffic in short haul markets dropped 18%, while increasing 10-13% in medium and long haul markets.

Total Passengers comparison 2000-2004

- Short Haul: -17.8%
- Medium Haul: +9.9%
- Long Haul: +13.4%
Revenues by Distance Category

Total Revenues decreased most in long haul markets despite traffic growth – down 27% overall
Markets Grouped by LCC Presence

- In 2000, 27 of Top 100 US Markets without LCC presence
- By 2004, only 10 Top 100 US Markets without LCC presence (6 when Hawaii markets excluded)
- 84 of the Top 100 US Markets with more than 10% LCC MS


- Frequency
- LCC=0
  - 2000: 27
  - 2004: 10
- LCC<10%
  - 2000: 7
  - 2004: 6
- LCC>10%
  - 2000: 65
  - 2004: 84
Average Fares and LCC Presence

- Average Fare decreased more for markets with a small 2004 LCC market share than the markets with well-established LCC presence.

- Largest (31%) decrease in fares observed for markets with new entry by LCC between 2000 and 2004.

![Average Fares Comparison (2000-2004)](chart.png)
Markets with LCC presence showed traffic growth of 4.51%.

But in O&D markets with small or no LCC market share, traffic is still 16% below the 2000 level.
Conclusions: Top 100 Markets

Overall trends in largest US markets 2000-2004

- Traffic has rebounded to peak 2000 levels
- But average fares have dropped 19%, with a corresponding total revenue decrease

Major differences identified:

- By carrier type – Legacy carriers have lost 5% market share and over 9% revenue share
- Long-haul market fares have dropped the most, with greatest traffic growth. On the other hand, short-haul traffic is down, and average fares stable. Substantially lower total revenues in all distance categories.
- Markets with LCC new entry saw the greatest drop in average fares between 2000 and 2004
Future Research

- Expand the sample to 500 or 1000 Top US Markets

- Identify relevant factors in the evolution of pricing and competition in airline markets:
  - Length of haul
  - Low-fare carrier competition
  - Hub vs. non-hub markets

- Broader questions include:
  - How has willingness to pay (price elasticity) changed? Are people less willing to pay for air travel?
  - How has airline pricing power been reduced? How can we quantify this effect?
IMPACTS OF AIRLINE FARE SIMPLIFICATION

Maital Dar
PODS RM Research Consortium

- Airline revenue management research at MIT funded in large part by PODS Research Consortium
  - Focus on forecasting and optimization models for seat inventory control (seat allocation)
  - Findings used to help guide each airline’s RM system development

- Most member airlines have renewed; new member added in 2005
  - Continental Airlines
  - Scandinavian Airlines System
  - Delta Air Lines
  - Air New Zealand
  - Lufthansa German Airlines
  - Northwest Airlines
  - KLM/Air France
  - LAN Airlines (new)
Fares have been decreasing
- The lower fares are due in part to LFA competition, but not exclusively
- RM system shortcomings are also involved

Passenger choice process has changed, but RM systems have not
- Airline customers have learned how to get cheaper fares, but existing revenue management systems in use largely don’t take this new reality into account

Traditional RM systems all based on:
- Identifiable and independent demand for different fare products with restrictions associated with lower fares
<table>
<thead>
<tr>
<th>Roundtrip Fare ($)</th>
<th>Cls</th>
<th>Advance Purchase</th>
<th>Minimum Stay</th>
<th>Change Fee?</th>
<th>Comment</th>
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</thead>
<tbody>
<tr>
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<td>Tue/Wed/Sat</td>
</tr>
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<td>Sat. Night</td>
<td>Yes</td>
<td>Tue/Wed</td>
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<td>Yes</td>
<td>Thu-Mon</td>
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<tr>
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<td>Tue/Wed</td>
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<tr>
<td>1001</td>
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<td>Yes</td>
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</tr>
<tr>
<td>2083</td>
<td>B</td>
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<td>No</td>
<td>2 X OW Fare</td>
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<tr>
<td>2262</td>
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</tr>
<tr>
<td>2783</td>
<td>F</td>
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<td>none</td>
<td>No</td>
<td>First Class</td>
</tr>
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</table>
Simulation of Leg-Based RM Benefits
Differentiated Fare Structure

Revenue Gain When Both Airlines Implement EMSRb

- AL 1
- AL 2

<table>
<thead>
<tr>
<th>EMSRb ALF</th>
<th>AL 1 (%</th>
<th>AL 2 (%)</th>
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</thead>
<tbody>
<tr>
<td>78%</td>
<td>3.85</td>
<td>2.18</td>
</tr>
<tr>
<td>84%</td>
<td>8.63</td>
<td>5.72</td>
</tr>
<tr>
<td>89%</td>
<td>14.74</td>
<td>10.62</td>
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</table>
Fare Simplification:
Less Restricted and Lower Fares

• Recent trend toward “simplified” fares – compressed fare structures with fewer restrictions
  ▪ Initiated by low-fare airlines in many parts of the world
  ▪ Early in 2005, implemented in all US domestic markets by Delta, matched selectively by legacy competitors

• Simplified fare structures characterized by:
  ▪ Little or no minimum stay restrictions, but advance purchase and non-refundable/change fees
  ▪ Lower fare ratios from highest to lowest published fares, typically no higher than 5:1 in affected US domestic markets
<table>
<thead>
<tr>
<th>One Way Fare ($)</th>
<th>Bkg Cls</th>
<th>Advance Purchase</th>
<th>Minimum Stay</th>
<th>Change Fee?</th>
<th>Comment</th>
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<tr>
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<td>T</td>
<td>21 days</td>
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<td>$50</td>
<td>Non-refundable</td>
</tr>
<tr>
<td>$139</td>
<td>U</td>
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<td>$50</td>
<td>Non-refundable</td>
</tr>
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<td>$199</td>
<td>L</td>
<td>7 days</td>
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<td>$50</td>
<td>Non-refundable</td>
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<tr>
<td>$224</td>
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<td>$50</td>
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<td>0</td>
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<td>First Class</td>
</tr>
<tr>
<td>$594</td>
<td>F</td>
<td>0</td>
<td>0</td>
<td>No</td>
<td>First Class</td>
</tr>
</tbody>
</table>
LEG RM SIMULATIONS: Impacts of Fare Restriction Removal

~ 2 carriers, single market, both use EMSRb leg RM controls
~ 6 fare classes, 3.5:1 fare ratio:

<table>
<thead>
<tr>
<th>Class</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fare</td>
<td>425.00</td>
<td>310.00</td>
<td>200.00</td>
<td>175.00</td>
<td>150.00</td>
<td>125.00</td>
</tr>
</tbody>
</table>

~ BASE CASE: Restricted and Differentiated Fares

<table>
<thead>
<tr>
<th>Fare Class</th>
<th>AP</th>
<th>MIN Sat Night</th>
<th>Chg Fee</th>
<th>Non-Refund</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>5</td>
<td>14</td>
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</tr>
<tr>
<td>6</td>
<td>21</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Revenue Impact of Each “Simplification”

- Fully Restricted: -0.5%
- Remove AP: -16.8%
- Remove Sat Night Min Stay: -29.6%
- Remove All Restr, Keep AP: -45%
Revenues by Fare Class
Effectiveness of Traditional Leg RM
Percentage improvement over No RM Controls

<table>
<thead>
<tr>
<th>Procedure</th>
<th>EMSRb</th>
<th>FCFS</th>
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<tbody>
<tr>
<td>Fully Restricted</td>
<td>8.2%</td>
<td></td>
</tr>
<tr>
<td>Remove AP</td>
<td>9.9%</td>
<td></td>
</tr>
<tr>
<td>Remove Night Min Stay</td>
<td></td>
<td>11.8%</td>
</tr>
<tr>
<td>Remove All Restr, Keep AP</td>
<td></td>
<td>6.7%</td>
</tr>
<tr>
<td>Remove All Restr and AP</td>
<td></td>
<td>0.1%</td>
</tr>
</tbody>
</table>
Summary – Impacts of Fare Simplification

• **Simplified fares have contributed to large revenue losses for US airlines**
  - PODS simulated revenue losses in line with 15% impacts quoted by airlines

• **Fare class mix is also affected**
  - “Simplified” fare structures have changed the types of products passengers buy

• **The fundamental assumptions of RM systems:**
  - Are no longer appropriate under changing conditions
  - May even be hurting airline revenues
ADAPTING RM SYSTEMS AND MODELS

Peter Belobaba
Existing Airline RM Systems Need to be Modified for Changing Fare Structures

- **RM systems were developed for restricted fares**
  - Assumed independent fare class demands, because restrictions kept full-fare passengers from buying lower fares

- **Without modification, these RM systems will not maximize revenues in less restricted fare structures**
  - Unless demand forecasts are adjusted to reflect potential sell-up, high-fare demand will be consistently under-forecast
  - Optimizer then under-protects, allowing more “spiral down”

- **RM system limitations are affecting airline revenues**
  - Existing systems, left unadjusted, generate high load factors but do not increase yields
Models for Undifferentiated Fares

- Need to forecast demand by willingness to pay (WTP) higher fares with same restrictions (i.e., sell-up)

- “Q-forecasting” approach requires estimates of passenger WTP by time to departure for each flight
  - Approach is to forecast maximum demand potential at lowest (Q) fare, and convert into “partitioned” forecasts for each fare class

- Then, modified WTP forecasts can be fed as demand inputs to RM optimizers:
  - Standard EMSRb for Leg-based RM
  - Dynamic Programming methods
  - Network optimization methods for O+D Controls
Example of Expected WTP Behavior

• Typical values exhibit an S-shape reflecting the changing business/leisure mix across time frames
Hybrid Forecasting For Simplified Fare Structures

- **Separate forecasts for price and product oriented demand**
  - A passenger is counted as *price-oriented* if the next lower class from the one booked is closed.
  - A passenger is counted as *product-oriented* if the next lower class from the one booked was open.

- **Combine standard RM forecasts and WTP forecasts**
  - For product-oriented demand, bookings are treated as a historical data for the given class, and standard time series forecasting applied.
  - For price-oriented demand, forecasts by WTP based on expected sell-up behavior.
  - Combined forecasts fed into optimizers.
Impacts of Hybrid Forecasting

Airline 1 Hybrid Forecasting and EMSRb
Airline 2 Standard Pick-up Forecasting and EMSRb

Airline 1 revenues increase by 1.36%, with greater protection for higher classes and fewer seats sold in classes 5 and 6, leading to lower Load Factor.
New Forecasting and Optimization for Simplified Fare Structures

- Combining Hybrid Forecasting and Dynamic Programming (DP) for optimization of seat inventory further improves revenues.

![Revenues of Airline 1](chart)

- RM of Airline 1:
  - Trad RM
  - DP: +2.6%
  - DP-HF: +4.1%
Impact on Fare Class Mix: DP w/HF

Traditional RM

DP with hybrid forecasting increases revenues by capturing more high yield passengers in middle and upper classes.

DP w/ Hybrid Forecasts
Conclusions: RM Systems in “Simplified” Fare Structures

- Relaxed fare restrictions increase the importance of effective RM controls to airline revenues
  - But, traditional RM methods do not maximize revenues
  - Modifications required to better forecast consumer choice

- New approaches to “hybrid” forecasting of price- vs. product-oriented demand show good potential
  - Incremental revenue gains over traditional RM methods

- Need to estimate passenger WTP, affected by competitor’s RM method and seat availability
  - Focus of current research is how to actually ESTIMATE these values, required to generate the modified forecasts