Passenger Delays

- Depend on flight delays, flight cancelations, missed connections, and re-accommodation
  - Flight delays alone are not enough (Bratu & Barnhart, 2005)
- Cost U.S. passengers billions of dollars per year
  - Exact amount unknown because data is proprietary
- Multiple methodologies, cost estimates for 2007:
  - Air Transport Association ($5 billion), U.S. Senate Joint Economic Committee ($7.4 billion)
    (ignoring flight cancelations & passenger connections)
  - Wang, Sherry, and Donahue ($8.5 billion)
    (simulating passenger connections)
Outline of Slides

• Passenger travel and delay estimation
• Annualized cost of passenger delays
• Selected findings
• Missed connection analysis
• Delays due to disruptions
• Next steps

Data Sources

• Planned flight schedules
  – Flight on-time performance data
• Flight seating capacities
  – Airline inventories, aircraft codes, monthly seat counts
• Aggregate passenger demand data
  – Monthly segment demands, quarterly 10% coupon samples
    (one-way itineraries)
• Proprietary booking data
  – One quarter for a major U.S. carrier
Passenger Travel Estimation

- Developed multinomial logit model of itinerary shares
  - Regression function includes time-of-day, day-of-week, connection time, cancelations, and seats
  - Trained on one quarter of booking data from a large carrier

- Generate potential non-stop and one-stop itineraries from flight schedule data

- Randomly allocate passengers to itineraries based on estimated logit proportions
  - Using aggregated passenger demand data to determine total number of passengers and one-stop route proportions

Passenger Delay Calculation

- Extension of Passenger Delay Calculator developed by Bratu & Barnhart (2005)

- Disrupted passengers are determined by analyzing historical flight schedule data

- Passengers are re-accommodated on alternative itineraries in the order they are disrupted
  - Attempt re-accommodation on ticketed carrier and partner carriers first, and then consider all carriers

- Maximum delay of 8 hours for daytime disruptions (5:00am - 5:00pm) / 16 hours for evening disruptions
Annualized Costs of Delays

- Estimated 245 million hours of U.S. domestic passenger delays in 2007
- Total cost of $9.2 billion
  - Assuming $37.60 per hour value of passenger time (same value as used in other reports)
- Out of all passenger delay,
  - (only) 52% due to flight delays
  - 30% due to canceled flights
  - 18% due to missed connections
- Average passenger delay of 30.2 minutes
  - Compared to average flight delay of 15.3 minutes

Finding #1

- Ratio of passenger delay to flight delay is highest for regional carriers and lowest for low-cost carriers
  - Primary drivers are cancellation rates and percentage of connecting passengers

<table>
<thead>
<tr>
<th></th>
<th>Regional</th>
<th>Legacy</th>
<th>Low-cost</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pax delay to flight delay</td>
<td>2.6</td>
<td>2.0</td>
<td>1.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Cancelation rate</td>
<td>3.4%</td>
<td>2.2%</td>
<td>1.2%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Connecting pax</td>
<td>39.6%</td>
<td>31.0%</td>
<td>17.0%</td>
<td>27.2%</td>
</tr>
</tbody>
</table>
Finding #2

- EWR, ORD, LGA, IAD, JFK, and PHL are the worst connection airports in terms of passenger delays
  - Also the only airports where at least 10% of connecting passengers are disrupted

<table>
<thead>
<tr>
<th></th>
<th>6 worst</th>
<th>All others</th>
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<tbody>
<tr>
<td>Connecting pax delay</td>
<td>78.5 min.</td>
<td>45.6 min.</td>
</tr>
<tr>
<td>Due to flight delays</td>
<td>29.4%</td>
<td>34.9%</td>
</tr>
<tr>
<td>Connecting pax disrupted</td>
<td>12.2%</td>
<td>6.9%</td>
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Finding #3

- Passenger delays are 87% higher on average in the evening than in the morning
  - Primary drivers are differences in average flight delays, percentage of passengers disrupted, and ease of rebooking

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<thead>
<tr>
<th></th>
<th>Morning</th>
<th>Evening</th>
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</thead>
<tbody>
<tr>
<td>Pax delay</td>
<td>20.3 min.</td>
<td>37.8 min.</td>
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<tr>
<td>Fight delay</td>
<td>9.8 min.</td>
<td>18.5 min.</td>
</tr>
<tr>
<td>Pax disrupted</td>
<td>3.0%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Disrupted pax delay</td>
<td>5.3 hrs.</td>
<td>8.9 hrs.</td>
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</tbody>
</table>
Finding #4

- Southwest Airlines has the lowest passenger delays, 55% lower than its competitors, even though its flight delays are only 36% lower
  - Primary drivers are infrequent disruptions, fewer connecting passengers, and longer connection times

<table>
<thead>
<tr>
<th></th>
<th>Southwest</th>
<th>Others</th>
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<tbody>
<tr>
<td>Pax canceled</td>
<td>1.0%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Pax mis-connected</td>
<td>0.4%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Connecting pax</td>
<td>15.5%</td>
<td>30.0%</td>
</tr>
<tr>
<td>Connections &gt; 1.5 hrs</td>
<td>41.9%</td>
<td>36.1%</td>
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</tbody>
</table>
Schedule Banking & Misconnections

• Missed connections depend on distributions of flight delays and connection times
• Estimated distribution of connection times depends on allocation model and potential itineraries
• Define schedule banking coefficient as coefficient of variation across hourly arrivals (std. dev. / mean)
• Higher schedule banking implies shorter connection times, which implies a higher misconnection rate

Distribution of Disruption Delays

- Morning
- Afternoon
- Evening

![Chart showing distribution of disruption delays across different time periods.](image)
Disruption Delays Regression Model

• Linear regression model to estimate re-accommodation delays for disrupted passengers
  – Includes hour of disruption, # of daily non-stop / one-stop alternatives, non-stop load factors, average departure delay, departure cancelation rate, and type of disruption (cancelation vs. misconnection)

• Second flight cancelation 105 min. worse than first, which is 83 min. worse than missed connection

• Each “planeful” of available non-stop seats reduces re-accommodation delays by 172 min

• Each min. of avg. departure delay adds 1.7 min

Hourly Disruption Delay Estimates
Next Steps

• Longitudinal analysis of passenger delays
  – Extend analyses to include years 2006 - 2010

• Assess impact of delay propagation on passengers
  – Combine passenger flows with network-based model of flight delay propagation

• Investigate airline disruption responses
  – How important are passengers in airline decision-making?