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Passenger Delay Impacts of Airline Schedules and Operations

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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

- 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)
  - Sherry and Donahue (**$8.5 billion**)
    (ignoring passenger connections)

- Exact amount unknown because data is proprietary

Outline of Talk

- Passenger travel estimation

- Passenger delay estimation

- Annualized cost of passenger delays

- Regression model to simplify delay estimation

- Selected findings

Passenger Travel Estimation

- Developed statistical 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 proportions
  - Using aggregated passenger demand data to determine total number of passengers and one-stop route proportions
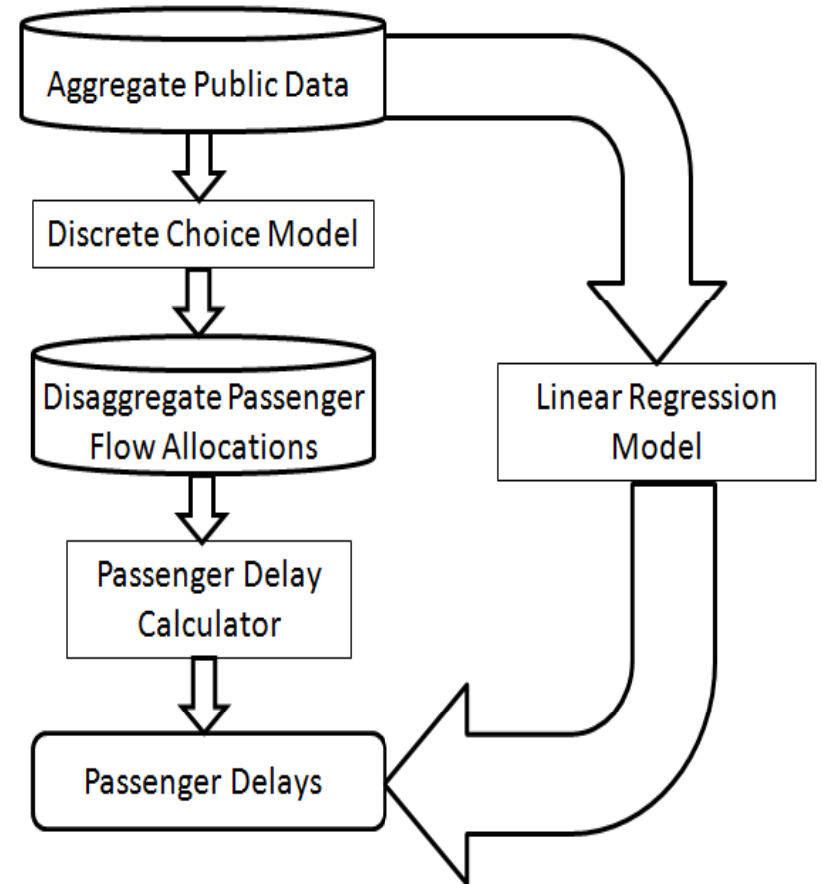
Passenger Delay Calculation

- Extension of Passenger Delay Calculator developed by Bratu & Barnhart (2005)
  - To account for multiple carriers

- Disrupted passengers are determined by analyzing historical (realized) 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 244.5 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 cancelled flights
  - 18% due to missed connections

- Average passenger delay of 30.15 minutes
  - Compared to average flight delay of 15.32 minutes

Regression Model to Bypass Passenger Allocation Procedure

- Simplified one-step approach to passenger delay estimation using public data directly

- Dependent variable = Average passenger delay

- Independent variables = Aggregate attributes of airline schedules, passenger itineraries etc
  - Average flight delay
  - Fraction of canceled flights
  - Fraction of connecting passengers
  - Fraction of flights with at least 60 minutes of delay
  - High load factor dummy

- Regression model estimated using the allocation based delay estimates

Aggregate Public Data

Discrete Choice Model

Disaggregate Passenger Flow Allocations

Linear Regression Model

Passenger Delay Calculator

Passenger Delays

Error Comparison at Different Aggregation Levels

- Regression-based estimation has slightly larger error than the complicated process

Aggregation Level	Passenger Allocation and Delay Calculation	Regression-based Delay Estimation
By Carrier-Day	11.1%	15.1%
Daily	10.3%	12.4%
Monthly	3.3%	8.0%
Quarterly	2.7%	8.0%

- Passenger delay estimation for 2008 (a sample application of the direct approach)
  - Model inputs: Flight schedules and aggregate passenger flows
  - <u>6% fewer passengers</u> and <u>6.7% lower avg. passenger delays</u> compared to 2007 resulting in <u>12.2% lower total passenger delays</u>

Finding #1

- *The ratio of average passenger delay to average flight delay is maximum for regional carriers, and minimum for low-cost carriers, owing primarily to their cancellation rates and connecting passenger percentages*
  - Overall ratio = 1.97
  - Overall Cancellation rate = 2.4%
  - Overall Connecting passengers= 27.2%

	Regional	Legacy	Low-cost
Avg Pax Delay to Avg Flight Delay Ratio	2.61 (Range: 2.27 to 2.99)	2.03 (Range: 1.65 to 2.23)	1.61 (Range: 1.49 to 1.89)
Cancellation Rate	3.4%	2.2%	1.2%
% Connecting Passengers	39.6%	31.0%	17.0%

Finding #2

- *EWR, ORD, LGA, IAD, JFK and PHL are the worst transfer airports for connecting passengers in terms of average passenger delays. These are also the only 6 airports in the US where at least 10% of the connecting passengers get disrupted.*

	6 worst airports	Other airports	Difference
Avg. Passenger Delay (min)	78.5	45.6	32.9
Avg. Due to Flight Delay (min)	23.1	15.9	7.2
Disrupted Passengers	12.2%	6.9%	5.3%

Finding #3

- *Average delay to disrupted nonstop passengers on routes with at least 10 daily flights per carrier is 30% lower than overall average; and on routes with at most 3 daily flights per carrier is 13% higher than the overall average*
  - Overall avg. delay to disrupted nonstop passengers is 443.6 min
  - With daily nonstop frequency of at least 10 flights, it decreases to 304.1 min
  - With daily nonstop frequency of at most 3 flights, it increases to 511.5 min

Finding #4

- *Average evening passenger delay (37.8 min) is 86.8% greater than average morning passenger delay (20.3 min)*
  - Main reason is that the average evening flight delay (18.5 min) is 89.4% greater than average morning flight delay (9.8 min)
  - But fraction of disrupted passengers is only 18.9% greater in evening (3.52%) than in the morning (2.96%)
  - But greater ease of rebooking for morning passengers is evident as average delay to disrupted passengers in the evening (532.6 min) is 66.3% greater than that for morning passengers (320.3 min)

Finding #5

- *Southwest Airlines has the lowest average passenger delay, nearly 55% lower than its competitors, even though its average flight delay is only 36.3% lower. Primary reason is fewer disruptions.*
    - *1.0% cancellations as compared to 2.8% for other carriers*
    - *0.4% missed connections as compared to 1.4% for other carriers*

    …because of,

    1) Fewer connecting passengers : 15.5% compared to 30.0% for other carriers

    2) Longer connections: 41.9% connections longer than 1.5 hours, compared to 36.1% for other carriers

Thank you. Questions?