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Statistical Comparison between Flight Delays and Passenger Trip Delays

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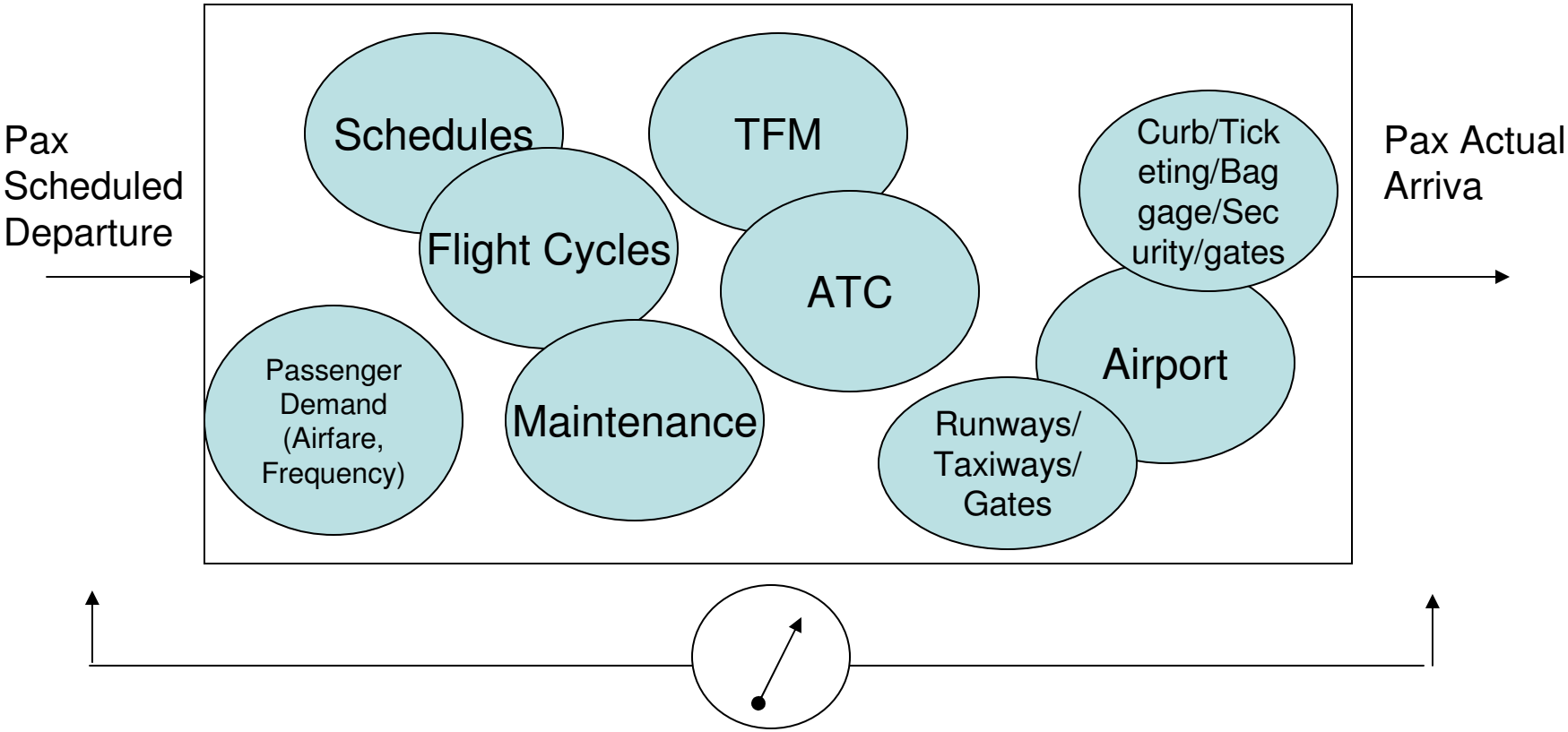
Context



- Passenger Trip Times
- Passenger Trip Delay (μ, σ)
- % Passenger On-Time (POTP)

Summary Results

- Passenger Trip Delays for Single Segment Flights = Flight Delays + Delays accrued by pax due to Cancelled Flights

1. % On-Time Passenger Trips = "% On-Time Flights"
   - % On-Time Flights = % Arrive < 15 minutes + %Cancelled Flights (DOT)

2. Average Passenger Trip Delay for Passengers Delays > 15 minutes

   = Average Flight Delay for Flights > 15 minutes + 34 mins ($p = 0.9985$)

3. Average Passenger Trip Delay for Passengers in 95th percentile

   = Average Flight Delay for Flights in 95th percentile + 150 mins ($p= 0.9704$)

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Background

Pax Trip Performance

- Primary objective of air transportation system is transportation of passengers

- Scheduled Passenger Trip Time = Time Schedule to Depart to Time Scheduled to Arrive
- Actual Passenger Trip Time = Time Schedule to Depart to Time Actual Arrive
- Passenger Trip Delay = Time Scheduled to Arrive at Destination Gate – Actual Time Arrived at Destination Gate

Why Track Pax Trip Performance?

- Consumer Protection (DOT responsibility)
- Passenger Trip reliability – critical property
  - positively correlated with airline profits:
    - Brand loyalty to Airlines
    - Brand loyalty to airports

    (Belobaba, 1987; Suzuki, 2000)
  - Poor service reliability:
    - (on specific routes) correlated with reduced airfares (Shavell, 2000)
    - Increased government funding to FAA, airports
- Leading Indicator for NAS performance

Consumer Information

- Department of Transportation (DOT) Office of Aviation Enforcement & Proceedings (OAEP) monthly report:
  - Air Travel Consumer Report (ATCR)
- ATCR:
  - "designed to assist consumers with information on the quality of services provided by the airlines"
    - Note: assumption: airlines directly control the quality of service

Consumer Information

- DOT Air Travel Consumer Report:
  - Percentage of on-time performance (OTP)
    - On-time < 15 minutes
    - plus % cancelled flights
  - Percentage of cancelled flights
  - Mishandled bags
  - Overbooking
  - Passenger complaints

Consumer Information

- Airline Quality Rating (AQR) (Bowen & Headley)
  - based on DOT ATCR data
- J.D. Powers Airport Satisfaction Report
  - Based on survey data

Flight Delays & Pax Delays

- Flight Delays are poor proxy for pax Delays
  - Bratu & Barnhart (2005)
    - Airline proprietary pax itinerary data
    - One month, one hub
      - 85.7 % pax not disrupted experience average flight delays = 15.4 minutes
      - 15.3% pax disrupted experience delays = 303 minutes
  - See also Wang, Schaefer, Wojcik (2003), Ball (200X), Mukherjee, Ball et. al (200X).

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Methodology

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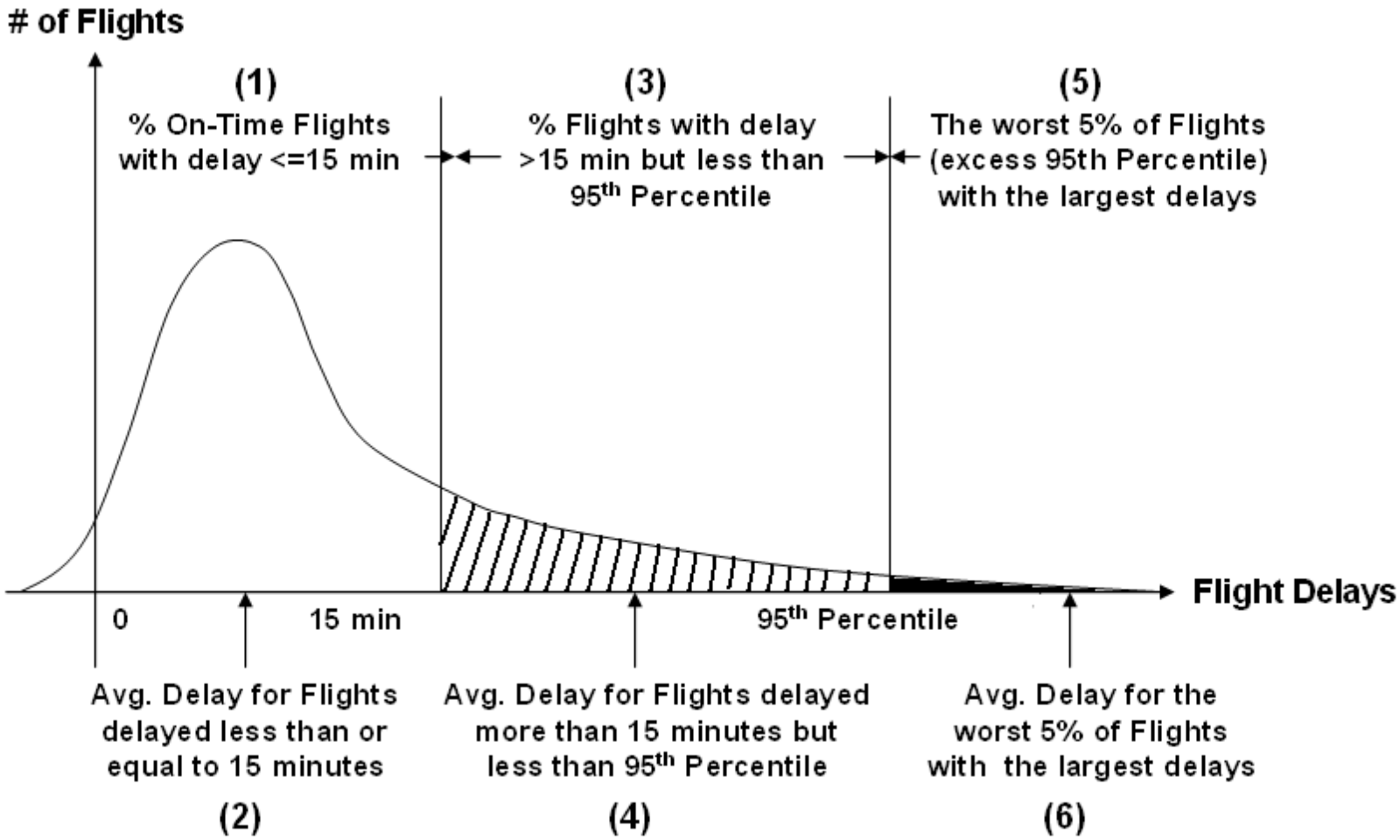
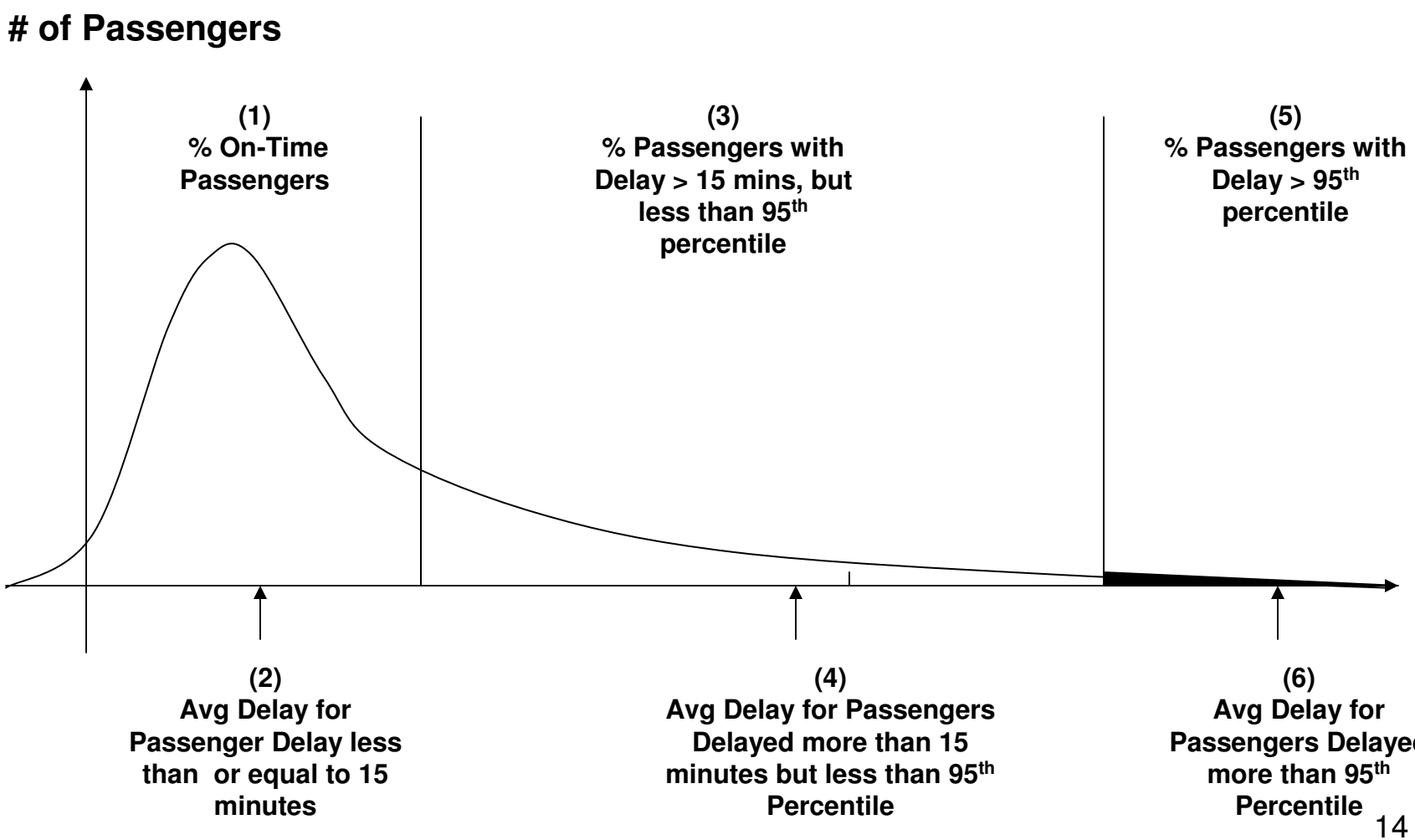
Distribution of Flight Delays



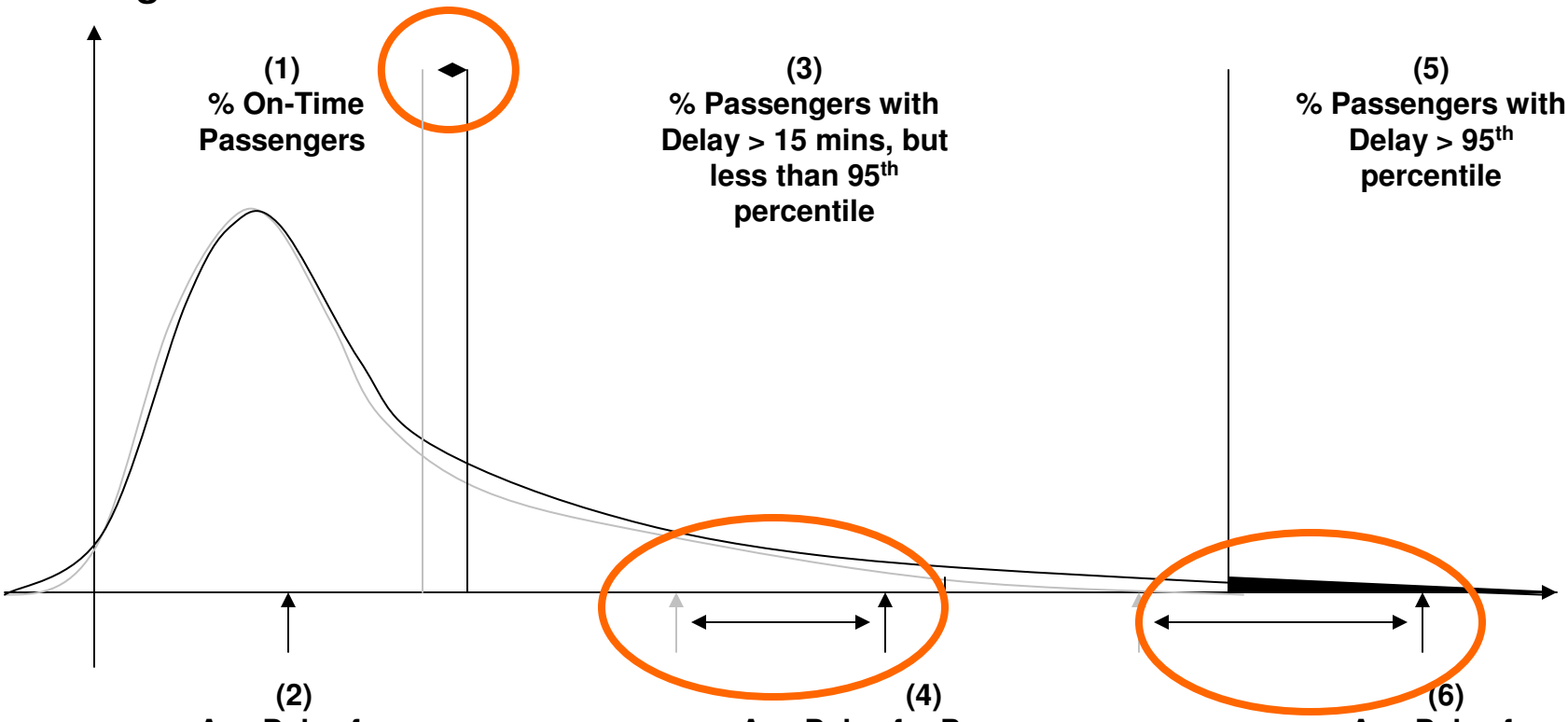
Distribution of Pax Trip Delays



Pax vs Flight Delays

# of Passengers

# of Flights



Estimated Passenger Trip Delays

- Single segment only (AOTP, T100)
  - Pax on Flights delayed < 15 minutes
    - Pax Trip Delay = Flight Delay
  - Pax on Delayed Flights
    - Pax Trip Delay = Flight Delay
  - Pax on Cancelled Flights
    - Pax Trip Delay = Delay accrued until next available flight with same airline to same destination + Flight Delay
      - Takes into account Frequency and Load Factor
- Algorithm processes each individual flight record
  - OEP-35 flights

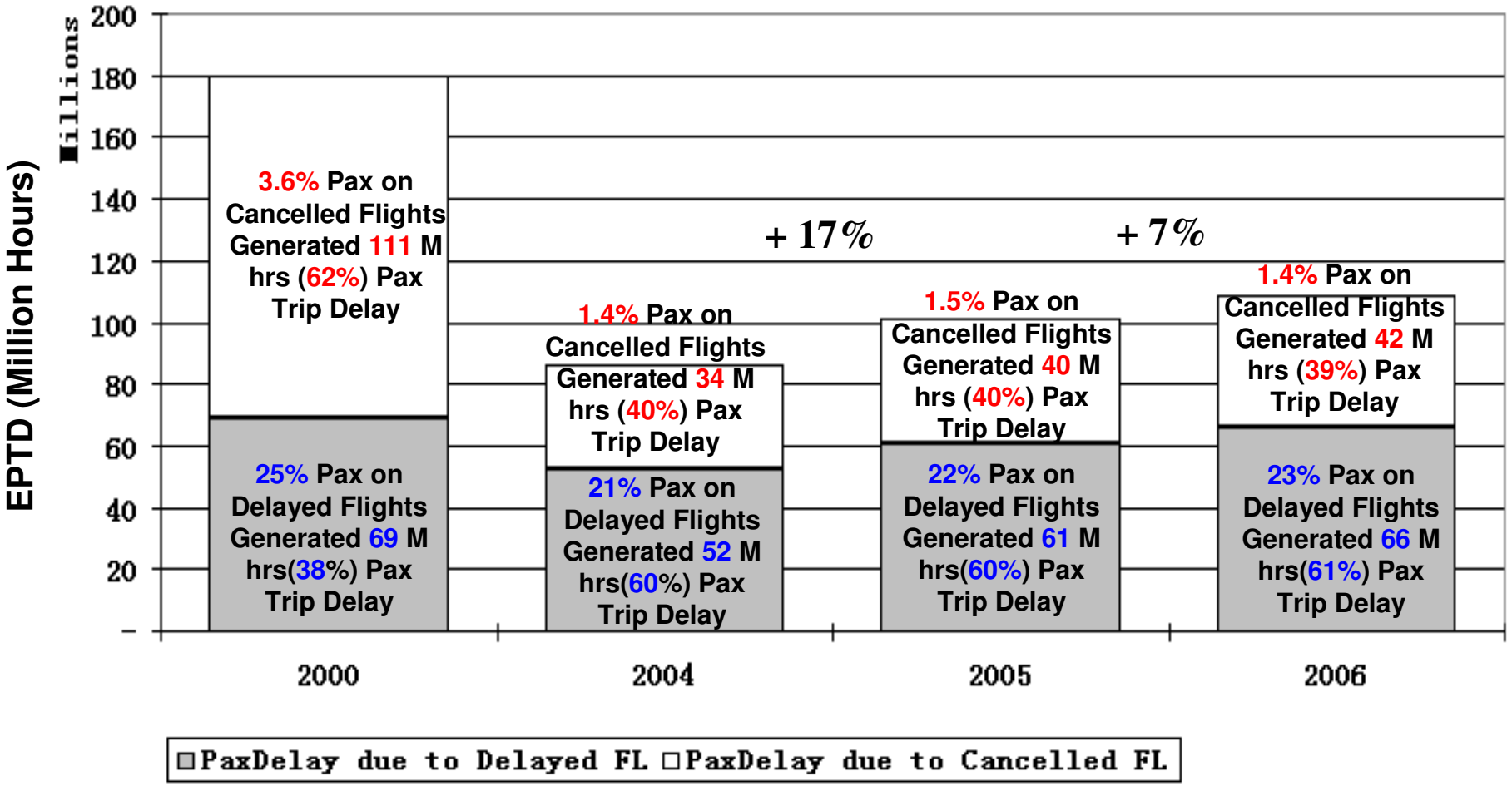
Approximations

- Uses only publicly available data
- Passenger Load Factors for flight based on “average monthly” load factors
- Re-booking on same route (no rerouting)
- Re-booking on same airline (and subs)
- Upper bound for cancelled flight delays set to 15 hours (overnight)
  - Assume pax rebooked on another airline

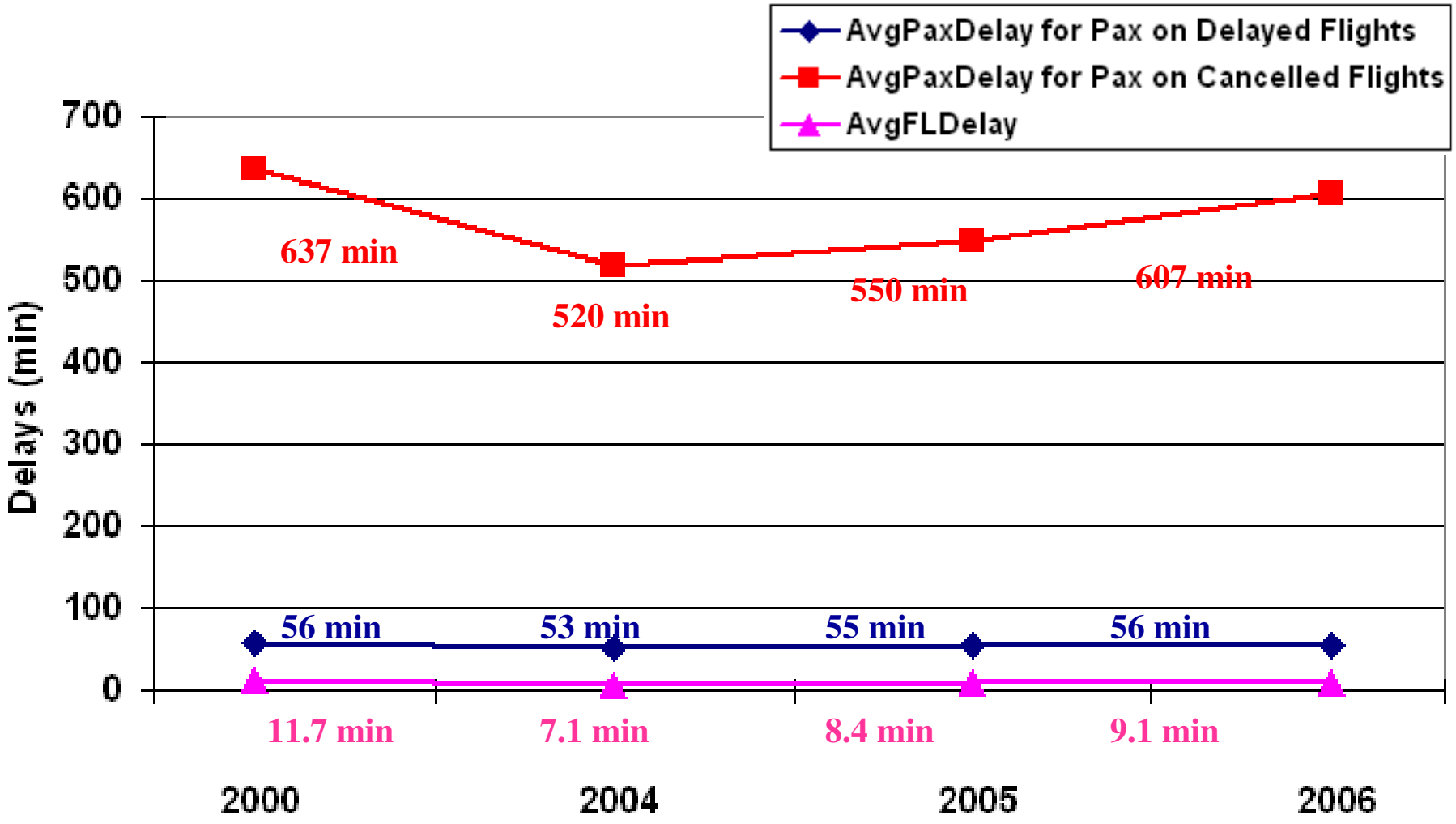
Sample Results (ORD to X)

ORIGIN	DEST	Flights			Passengers		
		15-OTP	Avg. Magnitude of Flight Delays	Avg. Worst-Case Magnitude of Flight Delays	15-POTP	Avg. Magnitude of PaxDelays	Avg. Worst-Case Magnitude of PaxDelays
ORD	ATL	67%	66	158	68%	112	424
ORD	BOS	69%	67	159	69%	120	467
ORD	CLE	69%	59	146	70%	116	465
ORD	CLT	75%	56	133	75%	88	298
ORD	CVG	74%	55	127	75%	110	370
ORD	DCA	77%	64	138	77%	104	337
ORD	DEN	74%	55	130	73%	81	267
ORD	DFW	75%	57	132	75%	88	271
ORD	DTW	75%	58	139	75%	92	310
ORD	EWR	58%	76	198	58%	106	396
ORD	IAD	75%	67	163	74%	106	385
ORD	IAH	78%	57	129	79%	107	350
ORD	JFK	74%	60	142	74%	181	620
ORD	LAX	73%	56	135	73%	71	217
ORD	LGA	64%	70	172	64%	114	442
ORD	MIA	68%	56	143	67%	101	409
ORD	MSP	74%	58	134	74%	90	281
ORD	PDX	70%	55	140	70%	68	209
ORD	PHL	69%	68	166	69%	116	443
ORD	SFO	70%	55	140	70%	73	251

Trends (2000 – 2006)



Trends (2000 – 2006)



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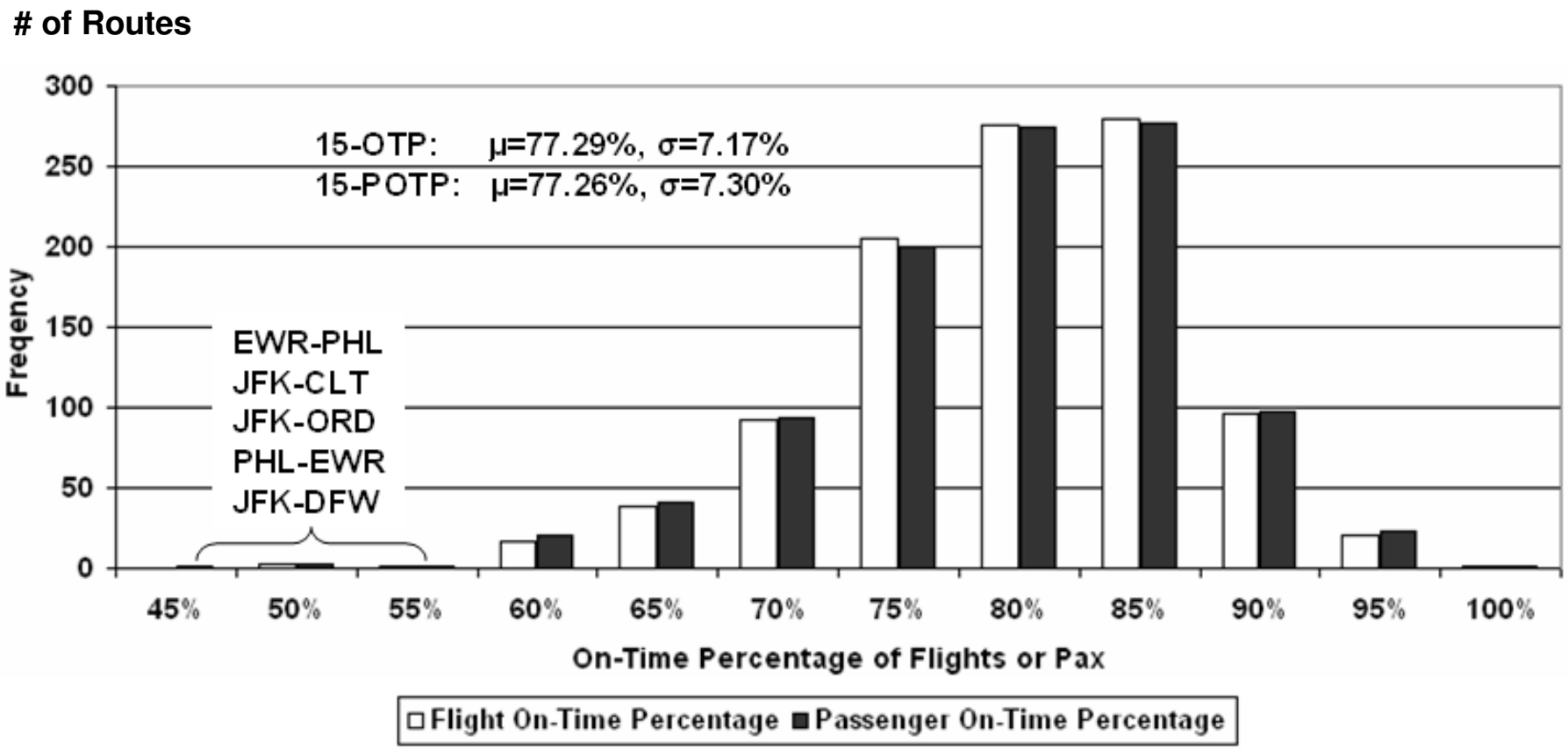
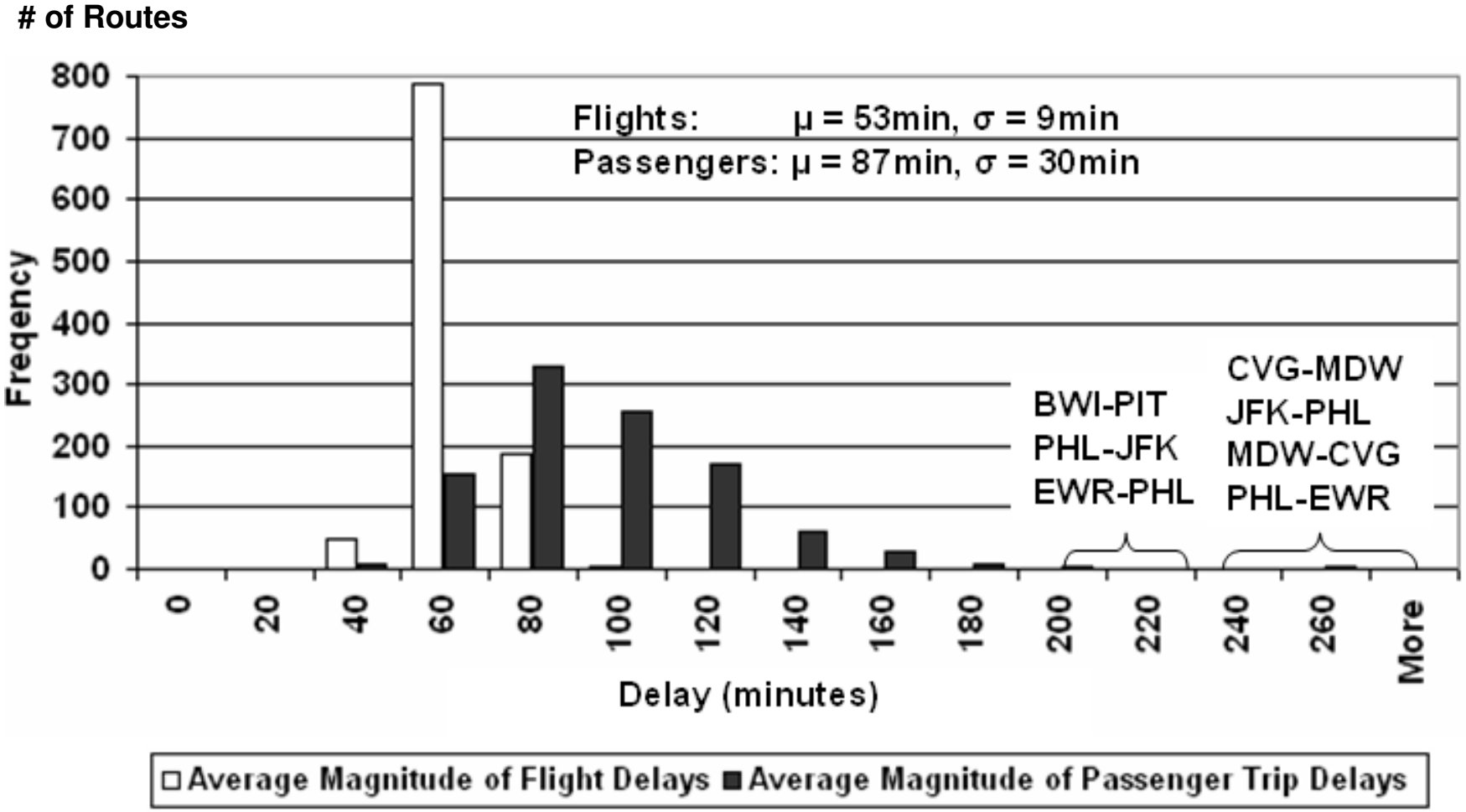
Results

On-Time Percentage



Paired t-test cannot reject null hypthesis: μ Pax = μ Flights (p-value 0.1858)
$\chi 2$ test cannot reject null hypothesis : σ Pax = σ Flights (p-value 0.5618)

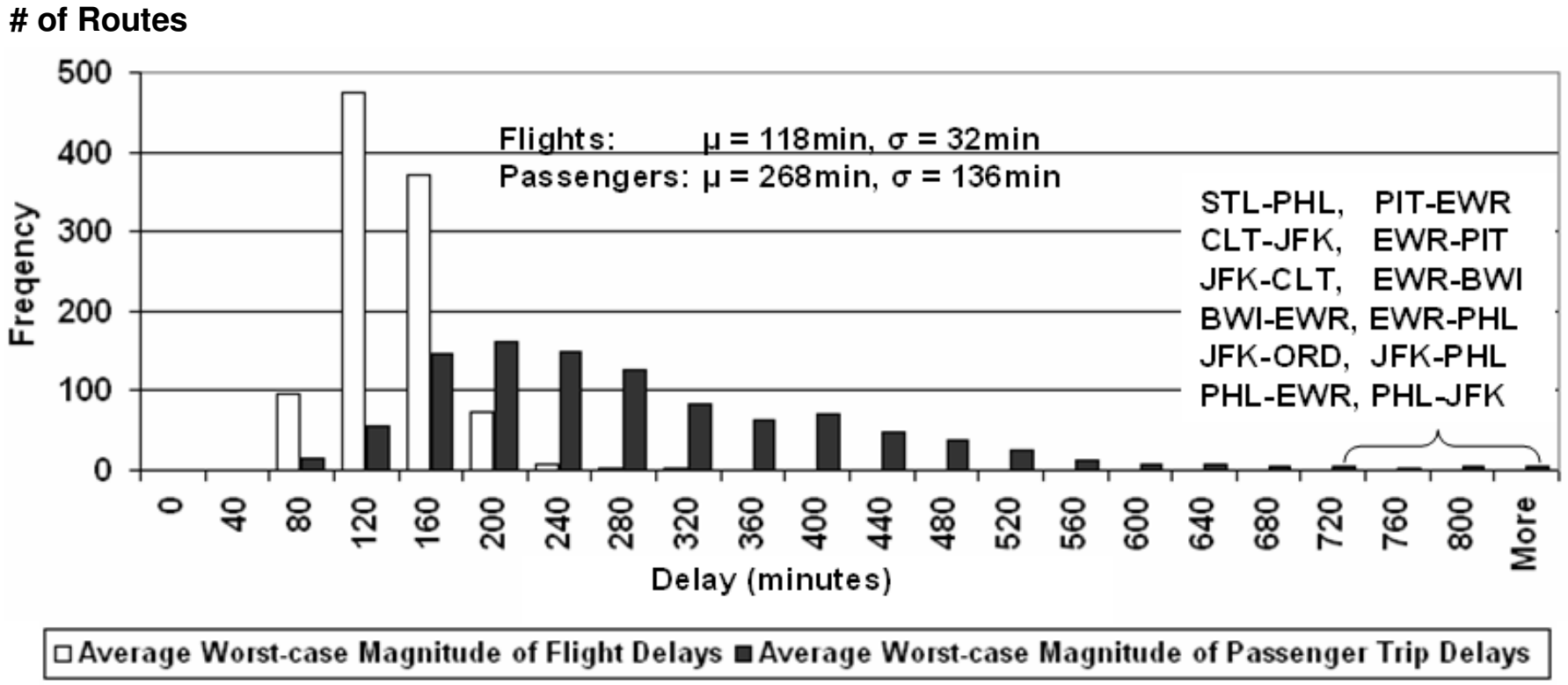
15 Mins < Delay < 95th Percentile



Paired t-test cannot reject null hypothesis: μ Pax = μ Flights + 34 mins (p-value 0.9985)

$\chi 2$ test rejects null hypothesis : σ Pax = σ Flights (p-value 0.001)

Delay > 95th Percentile Delays



Paired t-test cannot reject null hypothesis: μ Pax = μ Flights + 150 mins (p-value 0.9704)

$\chi 2$ test rejects null hypothesis : σ Pax = σ Flights (p-value 0.001)

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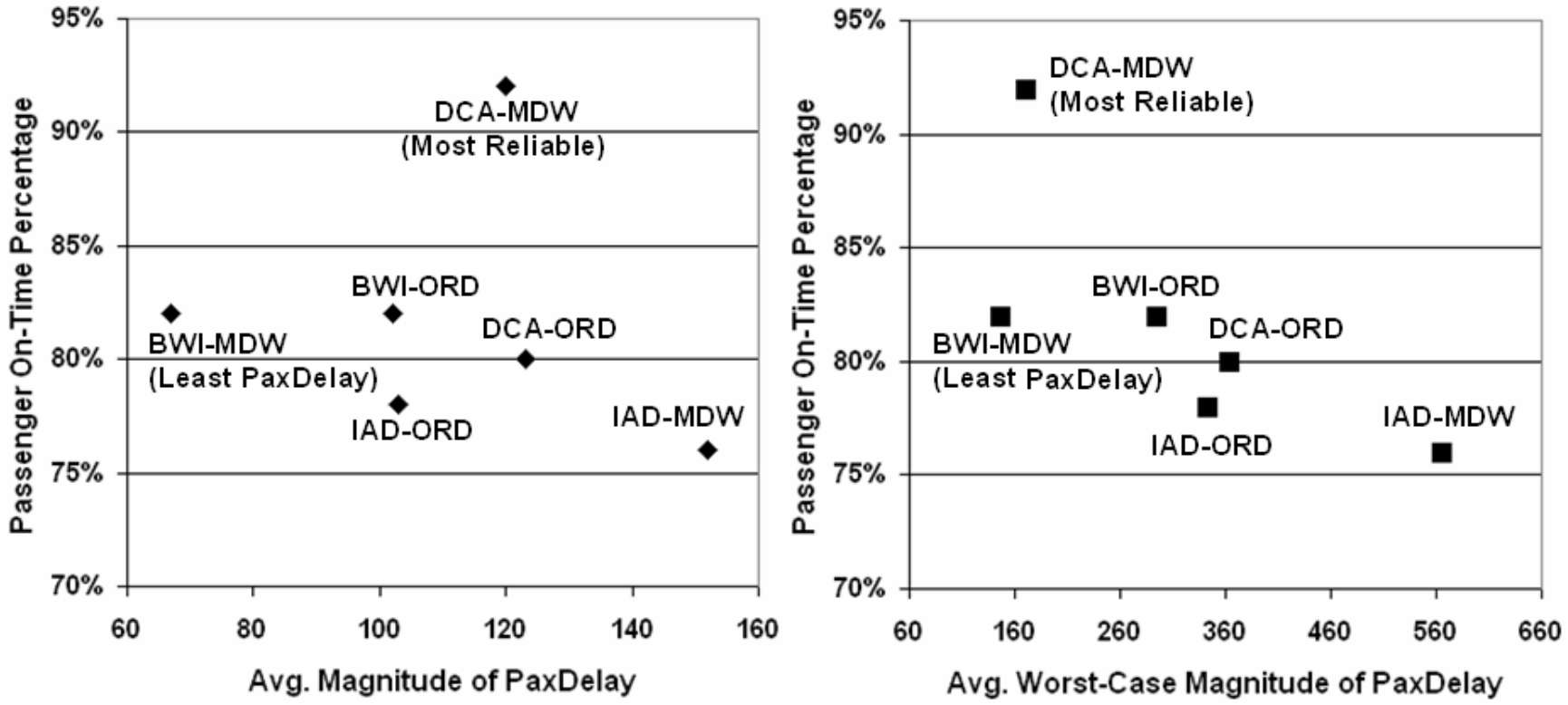
Conclusions

Consumer Protection

- Flight Delays cannot serve as proxy for Passenger Trip Delays
- Recommendation:
  - DOT publish metric for Estimated Passenger Trip Delays in ATCR
  - Estimated parameter (based on average monthly Load Factor and assumed airline re-booking policies)

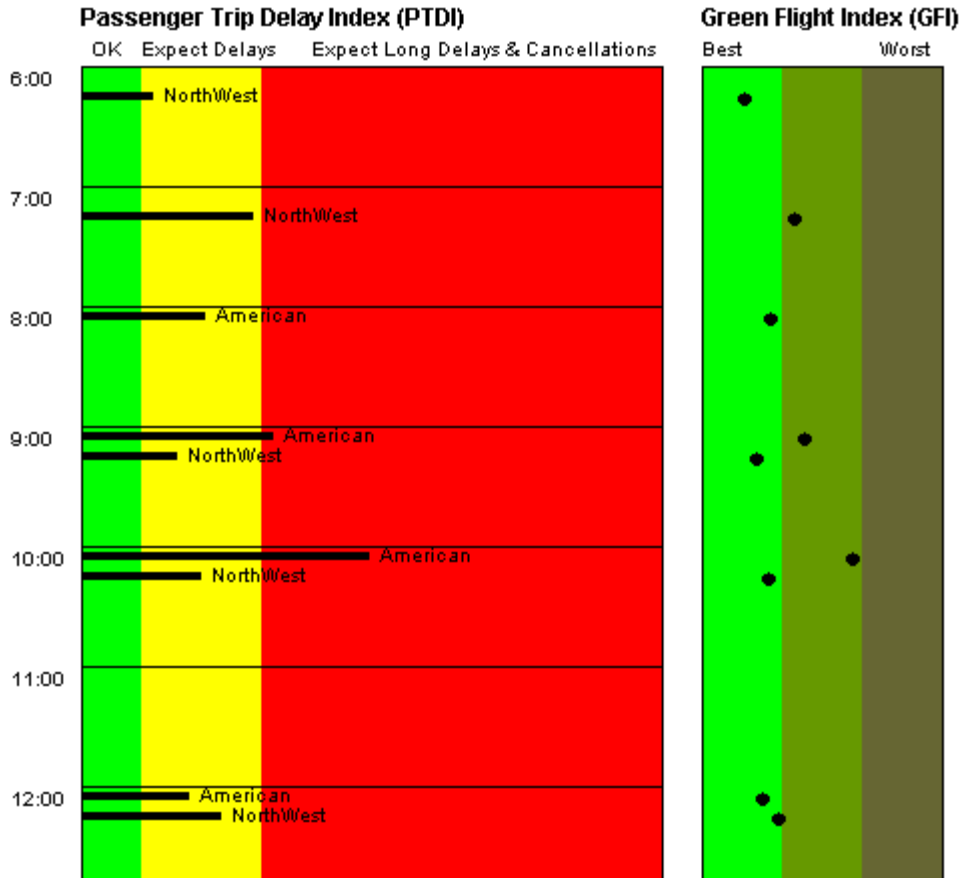
Consumer Choice

Washington to Chicago Markets



Recommendation: DOT publish data comparing route options in ATCR (reflects network effects)

Consumer Choice



LGA - DTW

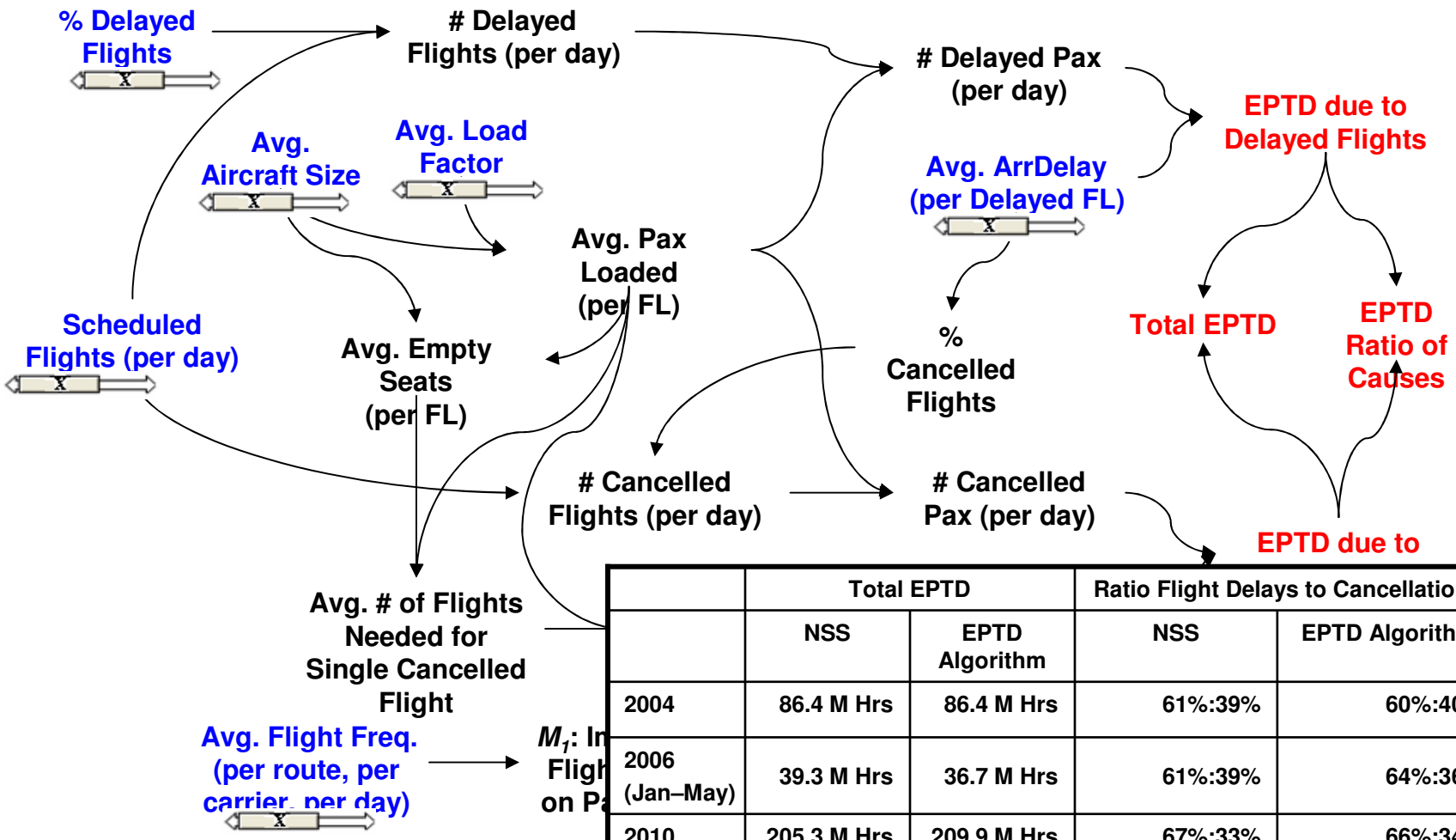
- www.GreenFlights.INFO
- Passenger Trip Delay Index (PTDI) = Expected Value for Pax Trip Delay
  - By airline flight
- Green Flight Index (GFI) impact of delays on weighted emmisions index

Traffic Flow Forecasting

- Metrics ATO-P Customer's-Customer
  - Leading Indicator for:
    - Flight Delays
    - Airline behavior change
    - TRACON/Airport "Pressure Points"
  - Inform "Passenger Bill of Rights" discussion

Mega-Trend Forecasting
(NAS Strategy Simulator Module)

Blue: Inputs
Red: Outputs



	Total EPTD		Ratio Flight Delays to Cancellations	
	NSS	EPTD Algorithm	NSS	EPTD Algorithm
2004	86.4 M Hrs	86.4 M Hrs	61%:39%	60%:40%
2006 (Jan–May)	39.3 M Hrs	36.7 M Hrs	61%:39%	64%:36%
2010	205.3 M Hrs	209.9 M Hrs	67%:33%	66%:34%

Airline

- Customer Service Coordination (CSC) Unit
  - Not AOC, dispatch, flight ops
- Study feasibility of managing passenger trip times (delays)
  - Apply algorithm to passenger itineraries
  - Manage AOC/Dispatch to “optimize” passenger flow
- Optimum “load factor”

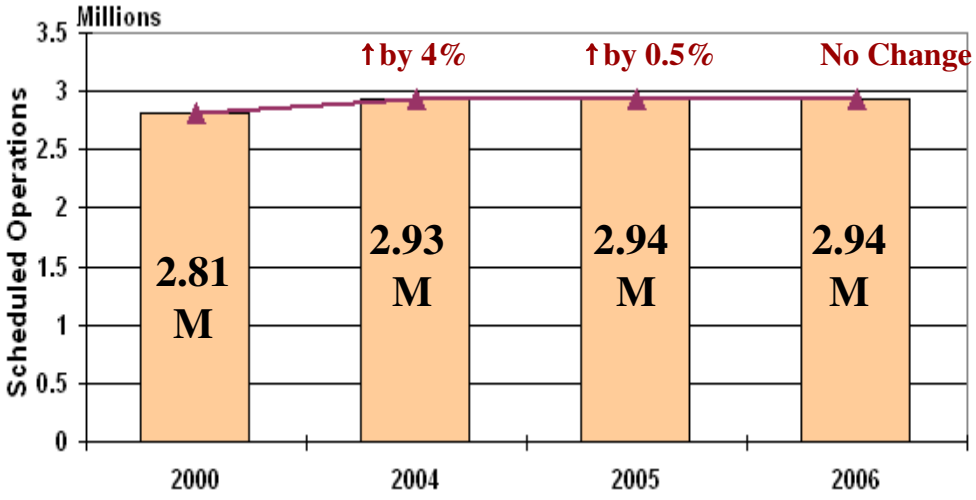
Future Work

- Multi-segment flights
  - Connecting passengers
  - Diverted flights
- Improvements to algorithm
- Access to sponsors

Back-up Slides

Trends in Schedule Operations and Enplanements

Annual Scheduled #Operations



Annual Enplanements