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Influence of Capacity Constraints on Airline Fleet Mix

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Research Team

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→ Graduate Student Researchers
- Jean-David Margulici - *Airline Response to Capacity Constraints*
- Ilknur Tekin - *Regional Airline Markets*
- Wen-Bin Wei - *Airline Economics*

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Outline

→ Motivation and Scope
→ Fleet Composition Trends at LAX
→ Airline Response to Capacity Constraints
→ Aircraft Scale Economies
→ Policy Interventions

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Motivation and Scope

→ Funded by Los Angeles World Airports
- Master plan controversy
- Fleet mix identified as:
  - critical uncertainty
  - opportunity for reducing required airside capacity

→ Objectives
- Analyze fleet mix impacts of capacity constraints and other factors
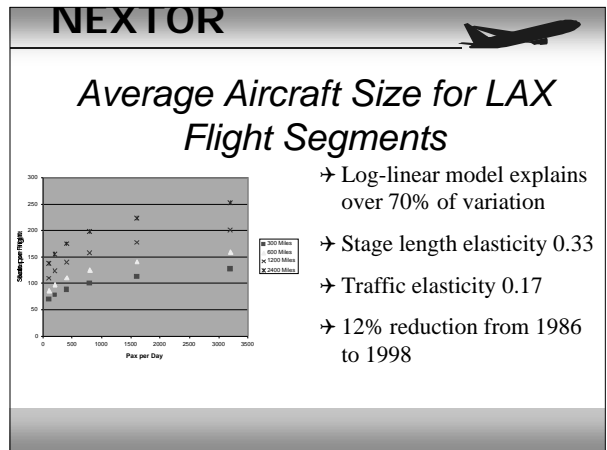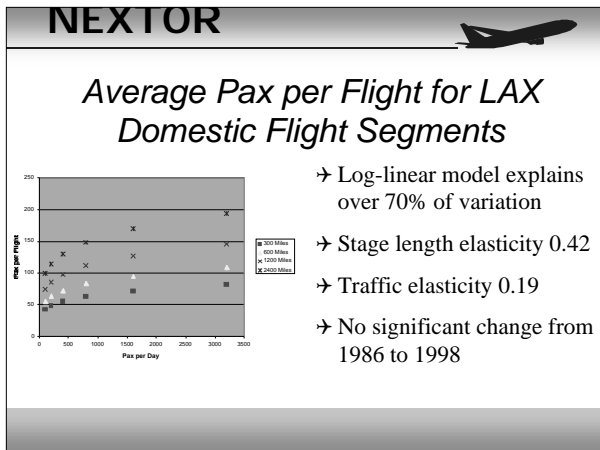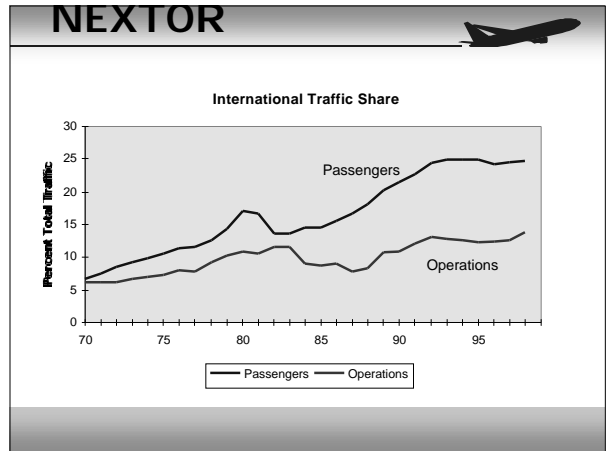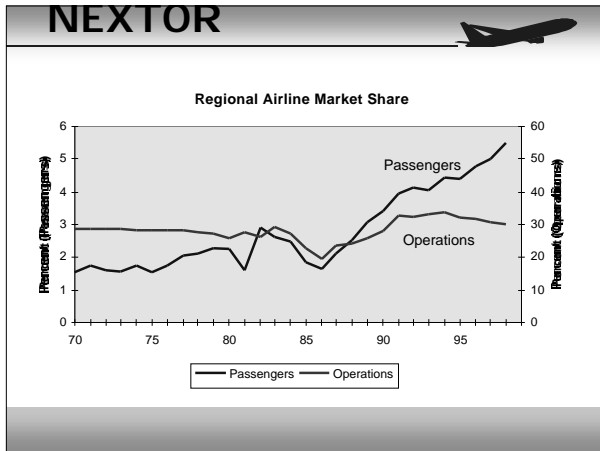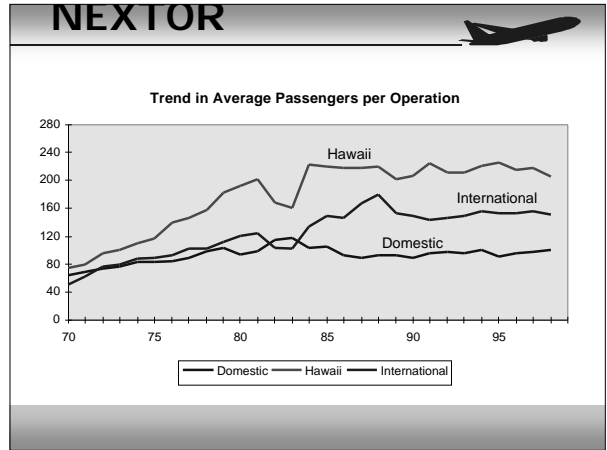- Identify and assess interventions

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Research Activities

→ Explore Effects of Capacity Constraints and Traffic Growth on Airline Equipment Decisions
→ Analyze Regional Airline Markets from LAX and Potential for Use of Larger Aircraft
→ Analyze Trends in Transpacific Markets and Potential Use of Very Large Aircraft
→ Define and Assess Policy Alternatives to Encourage the Use of Larger Aircraft

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Fleet Composition Trends at LAX

→ Average Aircraft Size
- Passengers per operation
- Market segment trends

→ Market Share of Regional Airlines
- Passengers
- Operations

→ International Traffic

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Trend in Average Passengers per Operation

Air Carrier

Total

Commuter

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Trend in Average Passengers per Operation

Hawaii

International

Domestic

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Regional Airline Market Share

Passengers

Operations

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International Traffic Share

Passengers

Operations

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Average Pax per Flight for LAX Domestic Flight Segments

➜ Log-linear model explains over 70% of variation

➜ Stage length elasticity 0.42

➜ Traffic elasticity 0.19

➜ No significant change from 1986 to 1998

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Average Aircraft Size for LAX Flight Segments

➜ Log-linear model explains over 70% of variation

➜ Stage length elasticity 0.33

➜ Traffic elasticity 0.17

➜ 12% reduction from 1986 to 1998

Regional Service Trends

Enplaned Passengers	Regional Airline Markets	
	1988	**1998**
Over 500,000		1
200,000 - 500,000	1	4
100,000 - 200,000	1	4
50,000 - 100,000	4	4
5,000 - 50,000	12	4
500 - 5,000	6	
Total	**24**	**17**

Changes in Service Pattern

	Regional Airline Market Share (%)	
	1988	**1998**
San Diego	17	62
Palm Springs	91	79
Santa Barbara	71	74
Fresno	18	65
Monterey	16	90
San Luis Obispo	100	73
San Jose	0	10
Bakersfield	74	88

Weekly Frequency SAN-LAX

	July 88	July 98
American Eagle	130	111
Delta Connection	90	63
United Express	94	141
USAirways Express		110
Alaska	35	
Delta	48	
Pan Am	35	
United	13	14
US Air	64	
Other	49	
Total	**558**	**439**

Weekly Frequency FAT-LAX

	July 88	July 98
American Eagle	39	48
Delta Connection	11	42
United Express	32	76
USAirways Express		54
Delta	21	
US Air	40	
Total	**143**	**220**
Seats	*6,700*	*6,246*

Weekly Frequency MRY-LAX

	July 88	July 98
American Eagle	20	21
Delta Connection	18	35
United Express		70
United	21	
US Air	20	
Total	**79**	**126**
Seats	*4,803*	*3,885*

Weekly Frequency BFL-LAX

|	July 88	July 98
American Eagle	19	27
Delta Connection	38	49
United Express	33	56
Total	**90**	**132**
Seats	*1,787*	*4,095*

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### Airline Response to Airport Capacity Constraints

→ Based on 45 Major US Airports
  - Domestic ops by certificated carriers
  - Airport and segment level analysis

→ Analyze Variation in Average Aircraft Size and Pax per Flight
  - Congested vs. uncongested airports
  - Slot limitations
  - Other factors

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Distribution of the Average Seat Capacity over the Sample Markets
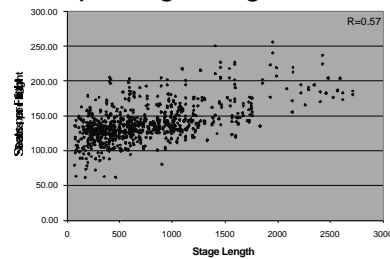
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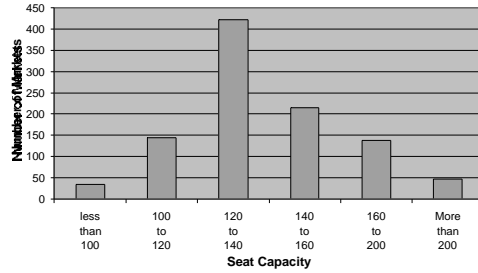
Delay vs Average Aircraft Size at Major US Airports
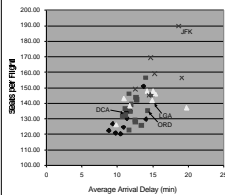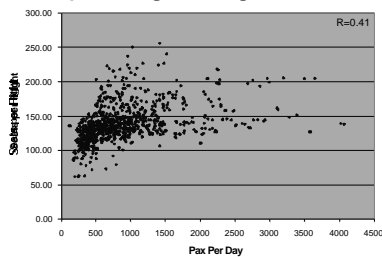
→ High simple correlation (0.7) between delay and average size

→ Average stage length is confounding factor
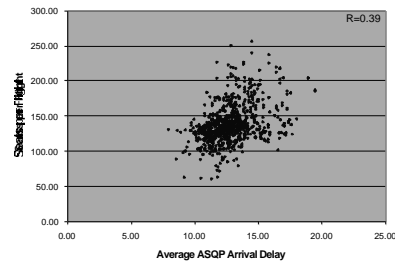
→ Impact of slot control not obvious

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Seats per Flight vs Stage Length
Sample Flight Segments, 1997

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Seats per Flight vs Pax per Day
Sample Flight Segments, 1997

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Seats per Flight vs Average Endpoint Delay
Sample Flight Segments, 1997

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Multivariate Models of Average Aircraft Size

→ Dependent variables
  - Seats per Flight
  - Pax per Flight

→ Independent Variables
  - Pax per Day (+)
  - Stage Length (+)
  - **Average Endpoint Delay (+)**
  - Route Concentration (+)
  - Slot Control Dummy (+)
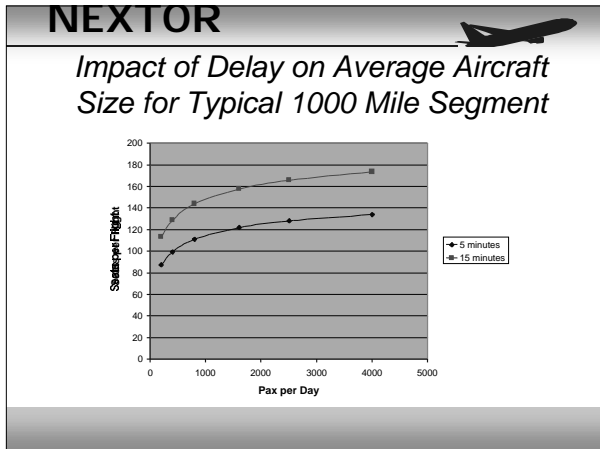 - Traffic Composition at Endpoints
  - JFK Dummy

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Estimation Results

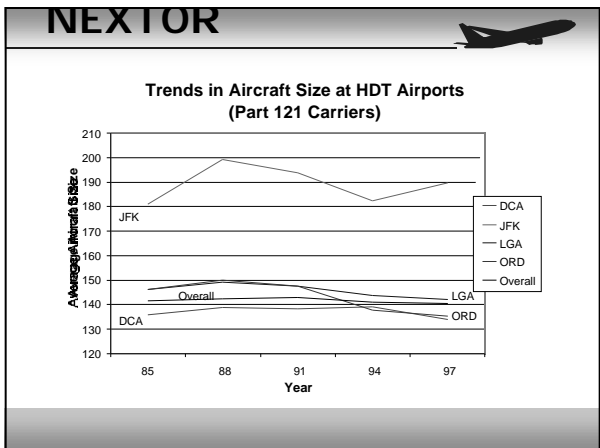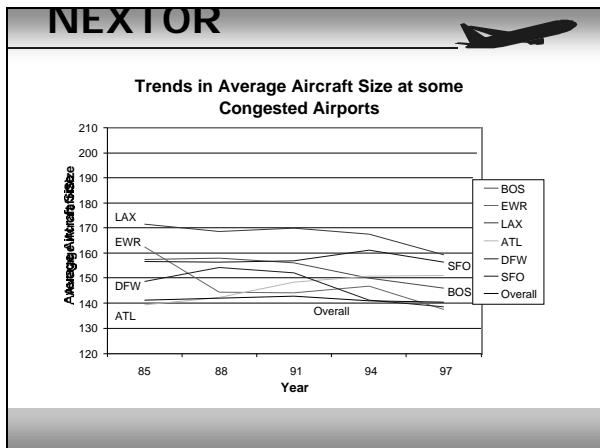→ Similar for linear and log-linear forms

→ Log-linear results:

	ln(Seats per Flight)	ln(Pax per Flight)
Intercept	-2.712	**-23.107**
ln(Pax)	**0.609**	**3.411**
ln(Pax)*ln(Pax)	-0.018	**-0.125**
ln(Stage Length)	**0.093**	0.196
ln(Concentration)	**0.178**	**0.293**
ln(Local Share)	**0.034**	-0.024
Slot	-0.020	-0.006
JFK	**0.237**	**0.334**
ln(Delay)	**0.234**	**0.311**
R^2	0.55	0.70

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Impact of Delay on Average Aircraft Size for Typical 1000 Mile Segment

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Model Limitations

→ Based on cross-sectional data

→ Does not capture dynamics of response to changes in delay, market size, etc

→ Does not capture shifts in airline strategies over time

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Trends in Average Aircraft Size at some Congested Airports

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Trends in Aircraft Size at HDT Airports (Part 121 Carriers)

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Aircraft Scale Economies

→ Choice of aircraft size is tradeoff between:
- Frequency and flexibility
- Economies of scale

→ Empirical evidence of scale economies is limited

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Aircraft Operation Cost

→ Direct Aircraft Operation Cost (DOC)
- Pilot and other flight personnel salaries
- Fuel and oil cost
- Cost of renting/leasing aircraft
- Flight equipment maintenance and depreciation

→ Indirect Aircraft Operation Cost
- Line service expense
- Control expense
- Landing fees

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Aircraft Operation Cost Function Estimation

→ Relate operation cost to:
- Aircraft size (seats)
- Average distance flown
- Crew and fuel cost

→ Data Sources
- Form 41 Database
  - Aggregate quarter data
  - Aircraft type specific direct operation cost
  - Aggregate airline-level indirect operation cost
- Time period: from 2nd quarter, 1987 to 4th quarter, 1998
- 10 Largest Airlines

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DOC Function Estimation Results

$$Cost = A(Size)^{0.77}(ALS)^{0.83}(Fuel)^{0.31}(Pilot)^{0.49}$$

Where:
  Cost=aircraft direct operation cost per flight
  A=airline specific multiplier
  Size=number of seats available per flight
  ASL=average stage length (flight distance)
  Fuel=fuel price per gallon
  Pilot=pilot cost per block hour

Results demonstrate scale economies in aircraft size.

May be mitigated by pilot pay scales.

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Airport Policy Interventions

→ Pricing

→ Rule-making

→ Planning and Design

→ Constraints