The Evolution of the U.S. Airlines Industry: Networks, Competition, and Consumer Welfare

Nate H. Miller[1] Nicholas G. Rupp[2] Drew Van Kuiken[3] Jon Williams[4]

[1]Georgetown University

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November 20, 2024

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Concentration Is Increasing

	2000	2010	2019
American	11%	12%	21%
Continental	7%	5%	-
Delta	16%	19%	20%
Southwest	16%	23%	21%
United	12%	11%	15%
U.S. Airways	11%	10%	-
Total	**73%**	**71%**	**77%**

Rise of Market Power?

- Or network growth $\Rightarrow$ more competitive markets, higher quality for consumers

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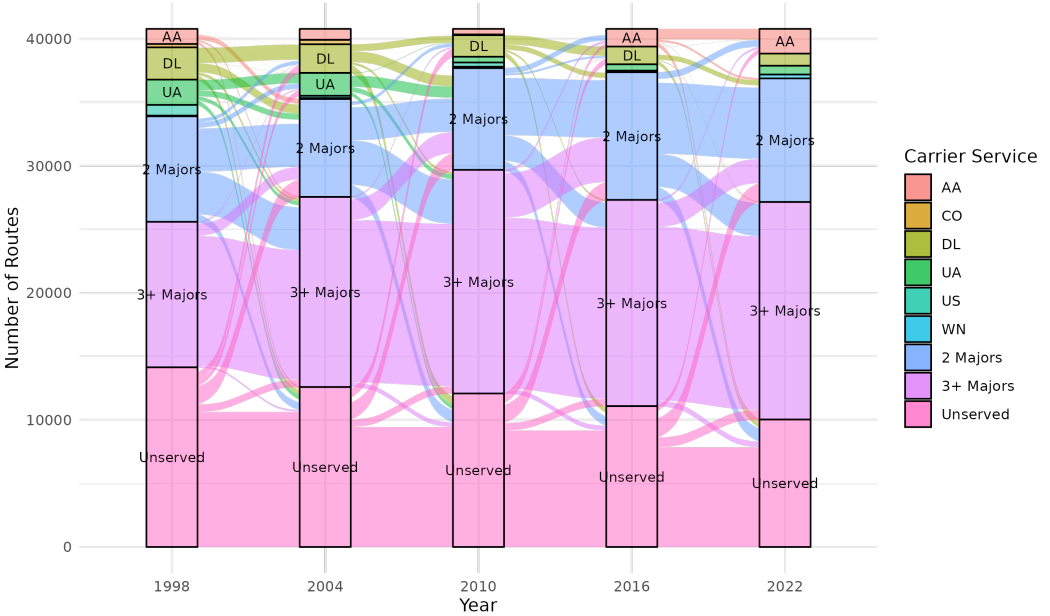
- **How have consolidation, LCC-entry, and changing airline networks shifted the level and allocation of consumer surplus?**

Data

Main dataset: DB1B, 1998-2022

- 10% sample of all domestic origin and destination passenger tickets
- Aggregated at month-market/ticket/coupon level
- We **do** know the price of the entire ticket, route flown, distance in miles
  - We **do not** know fees paid, cabin-type, or the date of purchase
- For demand model: 26,000 one-way markets, 12 airlines, **only estimated on 2015-2019**
- Markets and airlines qualify if they have at least 10 passengers/quarter in all quarters for a given year
- Smallest airlines: Virgin America, Sun Country, Hawaiian Airlines


Number of Routes
40000
30000
20000
10000
0
1998
2004
2010
2016
2022
Year
AA
DL
UA
2 Majors
3+ Majors
Unserved
Carrier Service
AA
CO
DL
UA
US
WN
2 Majors
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Unserved

Two-Level NL Demand

Log(Share Nonstop/Connect. Nest)	0.62*** (0.01)
Log(Share Air Travel/Outside Nest)	0.32*** (0.01)
Price (1000s)	-23.66*** (0.48)
Nonstop	1.34*** (0.02)
Route Miles (in 1000s)	0.35*** (0.02)
Nonstop x Average Frequency (100s)	0.17*** (0.01)
Nonstop Network Size (100s)	0.71*** (0.02)
Connecting Network Size (100s)	0.50*** (0.01)
Carrier Type	Yes
Origin-Year-Quarter	Yes
Destination-Year-Quarter	Yes
N	2,789,463

Implied:

	Mean
Elasticity	-3.96
Marginal Cost	$66
Lerner Index	.35

The actual presentation is below

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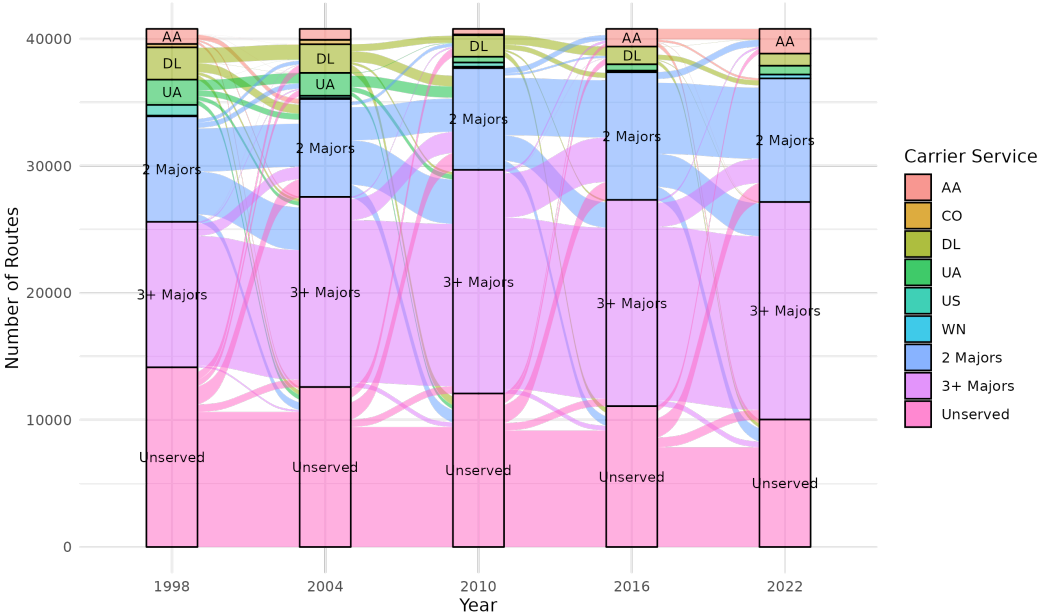
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3+ Majors
Unserved
Carrier Service
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DL
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US
WN
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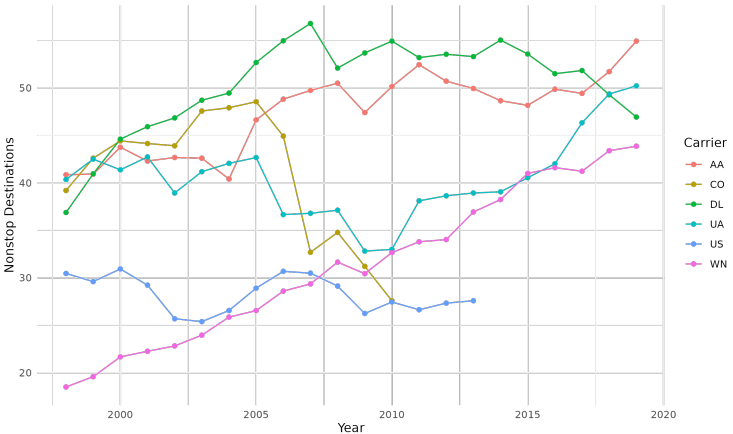
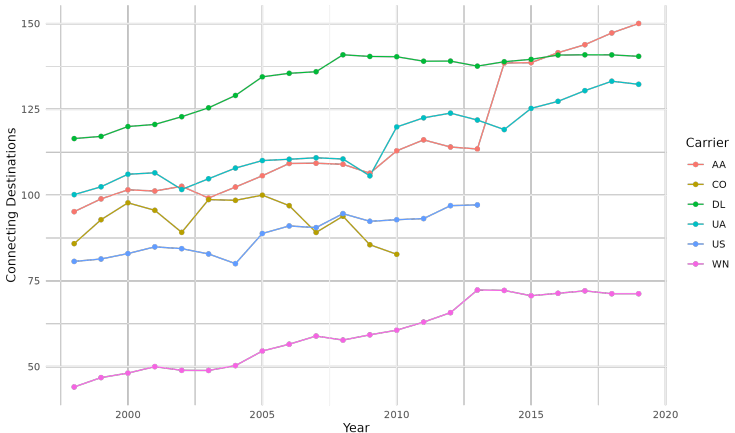
3+ Majors
Unserved

Nonstop Network Size

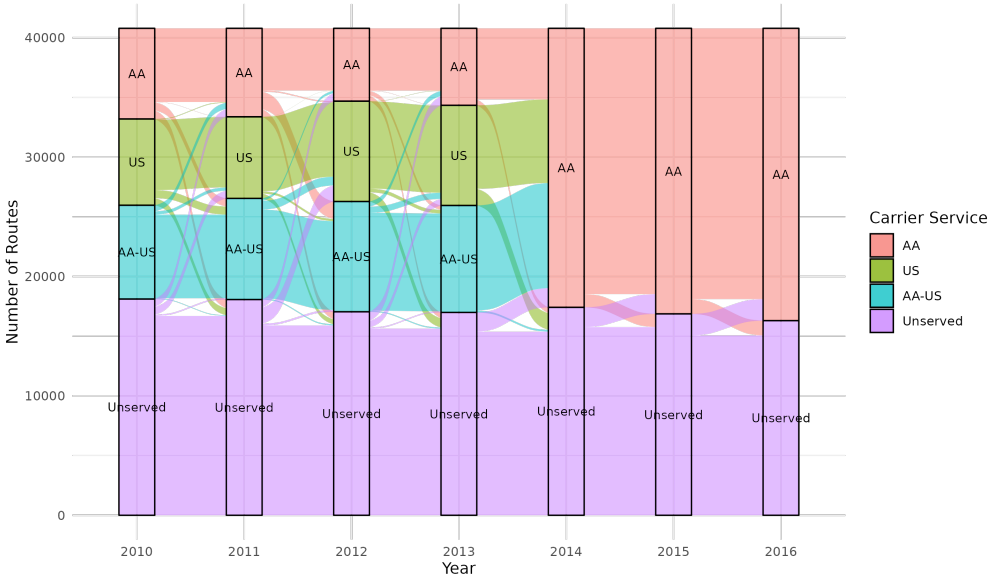


- Consolidation ⇒ network changes
- Availability of direct flights broadly increasing
- Southwest has tons of direct flights

Connecting Network Size



- Consolidation ⇒ network changes
- Size of one-stop network increasing but more slowly
- Southwest has tons of direct flights, *few connecting flights*
- Different business models?


40000
30000
20000
10000
0
Number of Routes
AA
US
AA-US
Unserved
2010
2011
2012
2013
2014
2015
2016
Year
Carrier Service
AA
US
AA-US
Unserved

This Paper:

1. Estimate demand, back out marginal costs, project marginal costs for 2015-2019

2. Fix product quality, demand/cost shocks in 2019. Project demand and marginal costs backward to 1998

3. Calculate counterfactual prices and welfare

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Estimate a two-level nested logit model of demand:

$$u_{irt} = x_{rt}\beta - \alpha p_{rt} + \xi_{rt} + \nu_{it} + (1-\sigma_2)\nu_{igt} + (1-\sigma_1)(1-\sigma_2)\varepsilon_{irt} \quad (1)$$

- ν_{it}=Air Travel/Outside Good, ν_{igt}=Nonstop/Connecting
- σ close to 1 $\Rightarrow$ substitutes, close to 0 $\Rightarrow$ MNL, nest doesn't matter. Require $1 \geq \sigma_1 \geq \sigma_2 \geq 0$
- x = {Nonstop Flag, Distance, Nonstop$\times$Average Frequency, Nonstop Network Size, Connecting Network Size}
- Instruments = {BLP Own-Product Averages, BLP Rival-Product Averages, Tax Shifters, Capacity Instruments}
- Specifications not shown = {Various FEs, Bag Fees, BLP Own/Rival Sums, Product Differentiation IVs}

Two-Level NL Demand

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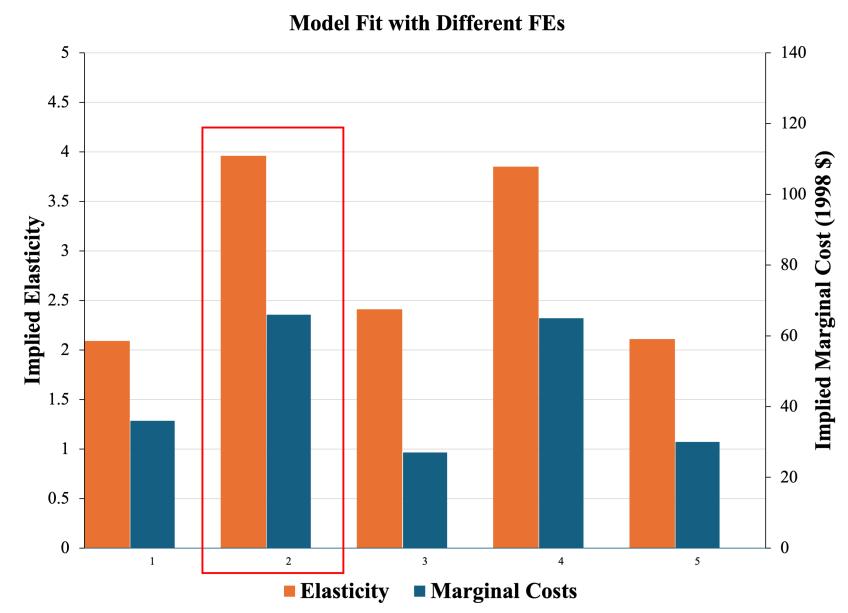
Model Fit with Different FEs
Implied Elasticity
Implied Marginal Cost (1998 $)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
140
120
100
80
60
40
20
0
1
2
3
4
5
Elasticity
Marginal Costs

Estimating Marginal Costs

To project marginal costs backwards, need a model of structural determinants of marginal cost:

$$mc_{jrt} = \sum_{c=1}^{\mathscr{C}} \mathbb{1}_{j \in c}(\gamma_{c1}\text{Distance}_r + \gamma_{c2}\text{Nonstop}_r) + \lambda_t + \lambda_{act} + \omega_{jrt} \tag{2}$$

where:

- j is a carrier, r is a route, and t is year-quarter fixed effects
- $||\mathscr{C}|| = 3$: Legacy carriers, Southwest, and Other
- λ_{act} includes fixed effects for all airports that touch route r irrespective of place in route

Carrier Type	× Distance	× Nonstop
Legacy	0.034	-13.294
Southwest	0.024	-22.623
LCC/Other	0.019	-27.500
Fixed Effects		
Year-Quarter	Yes	
Airport-Carrier Type	Yes	
R^2	0.36	
Observations	2,789,499	

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- Congestion captured by airport-carrier type-time fixed effects
- Fit is solid, but unclear how structural these structural parameters are
- When projecting backwards, time-invariant

Projecting Backwards

- Use time fixed effects from 2019q1
- Time-varying elements of demand: networks, prices. Set prices = 0, calculate later
- Time-varying elements of marginal cost: none

Projecting Backwards

- Use time fixed effects from 2019q1
- Time-varying elements of demand: networks, prices. Set prices = 0, calculate later
- Time-varying elements of marginal cost: none

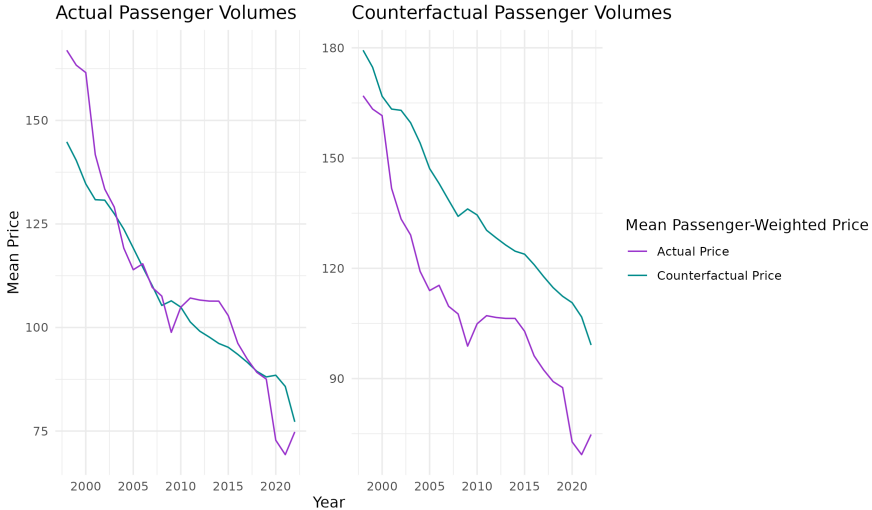
Iteratively solve:

- Prices + demand estimates imply market shares
- $\Rightarrow$ Use Nash-Bertrand assumption to find counterfactual prices based on marginal costs and share derivatives:

$$\boldsymbol{mc} = \boldsymbol{p} + \boldsymbol{\Delta}^{-1} \cdot \boldsymbol{s}/\alpha$$

Fit Assessment

Counterfactual Price Estimation

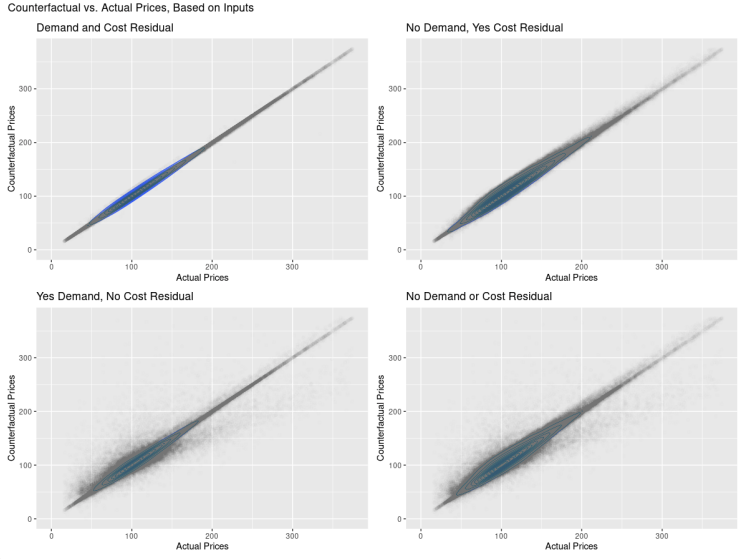


Carrier Type	× Distance	× Nonstop
Legacy	0.007	4.24
Southwest	-0.002	1.31
LCC/Other	-0.02	-4.7
Fixed Effects		
Year-Quarter-Route	Yes	
R^2	0.46	
Observations	2,789,499	

Carrier Type	× Distance	× Nonstop
Legacy	0.007	4.24
Southwest	-0.002	1.31
LCC/Other	-0.02	-4.7
Fixed Effects		
Year-Quarter-Route	Yes	
R^2	0.46	
Observations	2,789,499	

- Slightly better fit
- RMSE 1/3 the size of prior model
- Harder to project backwards - even more time varying

Fit Assessment

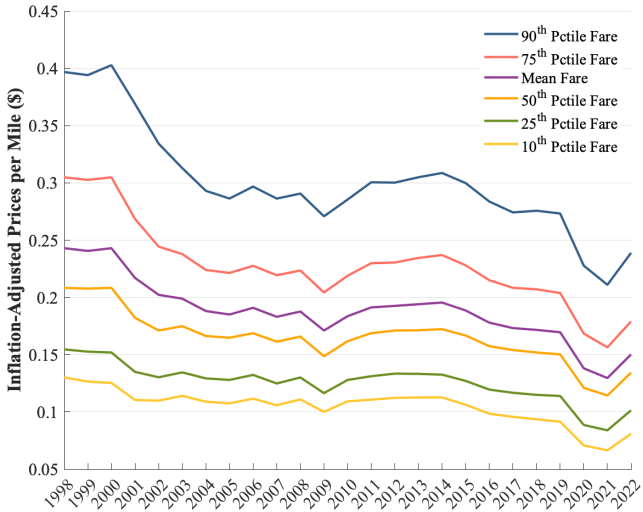


Next Steps

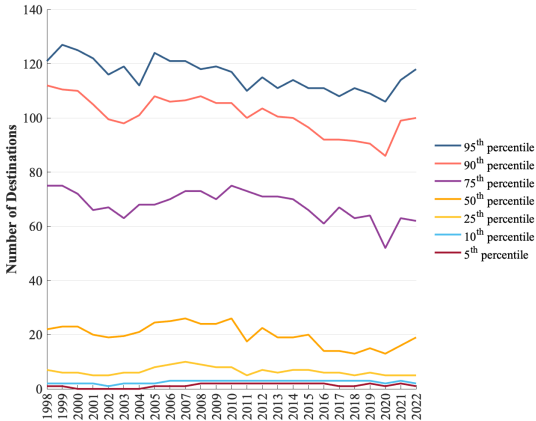
- Keep thinking about MC specifications
- Decompose changes in welfare: how much of increase in welfare is due to improved networks, increased competition, or population growth?
- Retrospective: more merger analysis, e.g., what would welfare look like if we shut down the American-US Airways merger?

Appendix

Fares: Dropping Across the Distribution

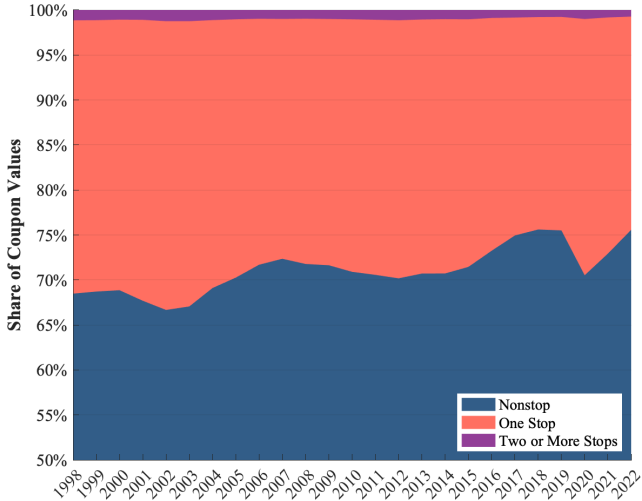


Distribution: Number of Available Nonstop Destinations

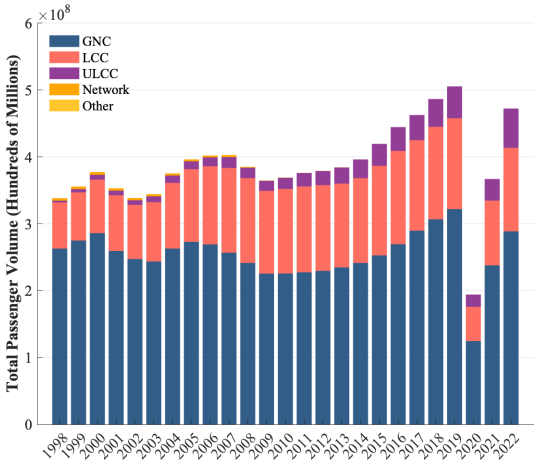


Slightly decreasing, but effect is small

Nonstop vs Connection Shares: 8 Point Jump in Nonstop Share



Passenger Volume by Airline Type: Volumes Are Way Up



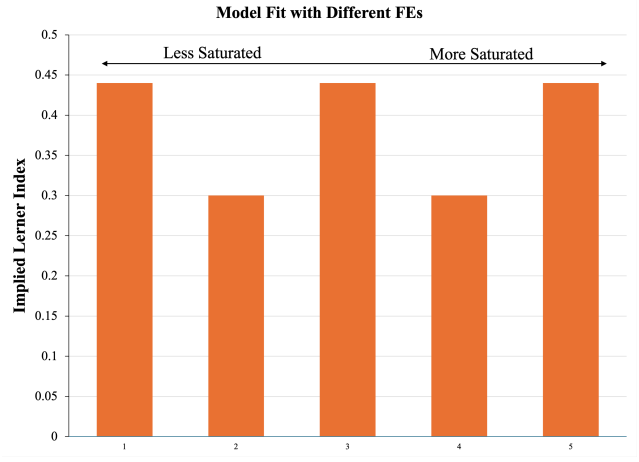
LCC + ULCC Share Increased from 20% to 40%

One-Level NL Demand

Log(Share Within)	0.51*** (0.00)
Price (1000s)	-18.64*** (0.40)
Nonstop	1.48*** (0.02)
Route Miles (in 1000s)	0.01 (0.01)
Nonstop x Average Frequency (100s)	0.13*** (0.01)
Origin Nonstop Service (100s)	0.52*** (0.02)
One-Stop Network Size (100s)	0.41*** (0.01)
Carrier-Year-Quarter	Yes
Origin-Year-Quarter	Yes
Destination-Year-Quarter	Yes
N	2,743,978

Implied:

	Mean
Elasticity	-2.69
Marginal Cost	$94
Lerner Index	.30



Berry and Jia (2010) report average lerner index of 0.60