

Network Structure and Consolidation in the US Airline Industry, 1990-2015

Federico Ciliberto¹ Emily Cook¹ Jonathan Williams²

¹University of Virginia

²UNC - Chapel Hill

Airline Competition Conference, July 2017

Question

Overarching Question and Motivation

What are the effects of consolidation on the *whole* US airline network, 1990-2015?

- Network is a difficult concept to grasp empirically.
- Key Notions: Centrality of an airport, *indirect* links between airports..
- Centrality: Degree, Closeness, and Betweenness centrality.
- Effect of consolidation on network structure ambiguous - competing forces:
 - Reduced price competition, increase profitability in routes, expanded service on connecting routes, due to network effects.
 - Decreased service, as the new consolidated entity may drop routes, competing airlines may expand to fill in the gaps.

Centrality Measures: Ideas

- *Degree = number of links out of an airport divided by number of airports:*

$$d_i(g) = \frac{\#\{k : g_{ik} = 1\}}{N - 1}. \quad (1)$$

- *Closeness = reciprocal of the average distance to every other airport*

$$C_i(g) = \left(\frac{\sum_{k \neq i} \ell(i, k)}{N - 1} \right)^{-1}. \quad (2)$$

$\ell(i, k)$ = number of links along shortest path between two airports

- *Betweenness = how frequently an airport is found on the shortest path between two other airports*

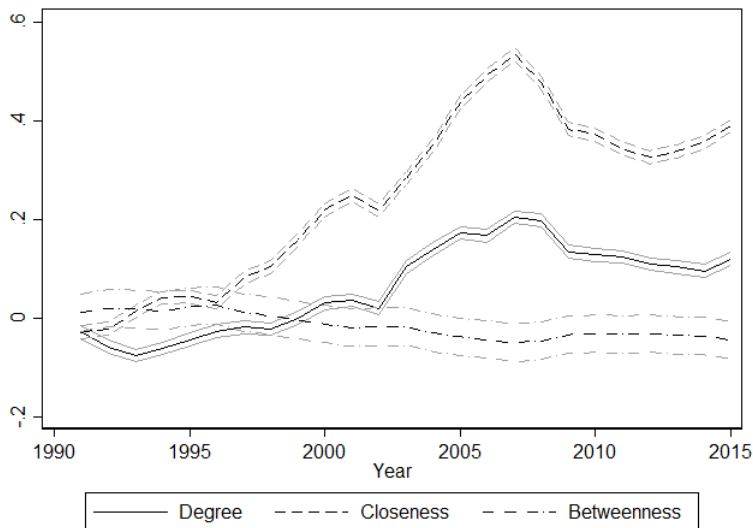
$$B_i(g^j) = \sum_{k \neq l, i \notin \{k, l\}} \frac{\frac{P_i(k, l)}{P(k, l)}}{\frac{(n_j - 1)(n_j - 2)}{2}}, \quad (3)$$

$P_i(k, l)$ = number of shortest paths between k and l with a stop at i

Centrality Measures: Data

Rank	Degree	Closeness	Betweenness
1	ATL 3.79	ATL 3.31	ATL 4.69
2	ORD 3.55	ORD 3.06	ORD 3.23
3	DFW 3.16	DFW 2.69	DFW 2.92
4	DTW 2.67	DTW 2.28	IAH 1.77
5	IAH 2.52	IAH 2.15	CLT 1.45
6	CLT 2.49	CLT 2.12	DTW 1.33
7	MSP 2.24	MSP 1.93	LAS 0.97
8	DEN 2.22	DEN 1.92	MSP 0.85
9	LAS 2.04	LAS 1.81	DEN 0.78
10	CVG 2.01	CVG 1.78	SFO 0.69
11	EWR 1.92	STL 1.69	PIT 0.62
12	STL 1.90	EWR 1.69	STL 0.49
13	PHL 1.85	PHL 1.64	LAX 0.39
14	MCO 1.71	MCO 1.53	CVG 0.30
15	PHX 1.65	PHX 1.50	PHL 0.18
16	PIT 1.59	PIT 1.48	SEA 0.15
17	LAX 1.51	LAX 1.41	EWR 0.05
18	CLE 1.50	CLE 1.38	PHX -0.02
19	DCA 1.39	IAD 1.32	MCO -0.03
20	IAD 1.37	BOS 1.26	IAD -0.04

Year FE for Degree, Closeness and Betweenness over Time



Estimates of Merger Effects

	Avg. Effect	US & HP	UA & CO	SW & FL	DL & NW	AA & US
<u>Degree</u>	-0.00743**	-0.0389***	-0.0809***	0.00193	0.00850	0.00410
<u>Closeness</u>	-0.00793*	0.000247	-0.123***	-0.00312	0.00879	-0.00853
<u>Betweenness*1[AlwaysBetween=1]</u>	-0.000746	-0.00145	0.00924	-0.00113	-0.00575	0.000389
<u>IsBetween</u>	0.00845	-0.0182	0.0715	-0.000362	0.0935***	0.0272**

Estimates of Merger Effects: Long Window

	Avg. Effect	US & HP	UA & CO	SW & FL	DL & NW	AA & US
<u>Degree</u>	-0.0220***	-0.0414***	0.0130***	0.00265	-0.0451***	-0.0181***
<u>Closeness</u>	-0.0139***	0.0184***	0.0325***	-0.0212***	-0.120***	0.0145***
<u>Betweenness*1[AlwaysBetween=1]</u>	0.00270	0.000577	3.31e-06	-0.00164	0.00506	0.00517
<u>IsBetween</u>	-0.00547	-0.0504***	0.0183**	0.0124	0.0630***	0.0154**

Estimates of Codeshare Effects

	Avg. Effect	CO & HP	AS & NW	AA & AS	CO & NW	AS & CO	US & UA	CO, DL & NW	DL & AS	CO & UA
<u>Degree</u>	0.00376**	0.0213	0.0470	-0.00681	-0.0543	-0.180***	0.181***	0.0183***	-0.0828	-0.0246***
<u>Closeness</u>	-0.00362	0.00495	0.0398	-0.00645	-0.290*	-0.287**	0.110***	0.0184***	-0.146	-0.0509***
<u>Betweenness*1[AlwaysBetween=1]</u>	0.00137	0.0129	-0.0467	0.00212	0.0582	0.0562	0.0284	-0.00300	0.0336	0.00429
<u>IsBetween</u>	0.000285	0.487***	0.153	0.00427	0.147	0.0444	0.0845	-0.0119	0.287	0.00194

Estimates of Codeshare Effects: Long Window

	Avg. Effect	CO & HP	AS & NW	AA & AS	CO & NW	AS & CO	US & UA	CO, DL & NW	DL & AS	CO & UA
<u>Degree</u>	0.00954***	0.00199	-0.00766	-0.0212***	0.00234	0.00183	0.0321***	0.0249***	0.0167*	0.00140
<u>Closeness</u>	0.00269	-0.00409	-0.0312***	-0.0155*	0.00996	0.0110	0.00155	-0.00144	0.0234**	0.00462
<u>Betweenness*1[AlwaysBetween=1]</u>	0.00244	0.00711	0.00466	0.00232	-0.00236	-0.00340	0.00366	0.000808	-0.000125	0.00193
<u>IsBetween</u>	-0.00498	-0.0137	-0.000650	-0.0152	0.00205	0.00580	-0.00723	-0.000283	-0.0270	-0.0160