Simulating the Dynamic Effects of Horizontal Mergers: U.S. Airlines

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Introduction

Historically, mergers evaluated using static methods:

- ► DOJ/FTC Merger guidelines
- ► Differentiated Products Models
  Berry and Pakes (1993), Berry, Levinson, and Pakes (1995),
  Nevo (2000), Hausman (various), etc

Static methods hold industry structure fixed.

Introduction

No good formal tools for evaluating:

- ▶ Potential entry/exit
- ▶ Changes in investment
- ▶ Adjustments in product characteristics/availability

that might result from a merger.

Introduction

Many reasons that dynamics should be important:

1. **Entry**
   - Entry can undo effect of merger
2. Changes in post-merger incentives
3. Market structure and performance

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1. Entry
2. **Changes in post-merger incentives**
   - Both merging and unmerged firms may change behavior post-merger
3. Market structure and performance

Introduction

Many reasons that dynamics should be important:

1. Entry
2. Changes in post-merger incentives
3. **Market structure and performance**
   - In dynamic industry, weakened relationship between market structure and performance
   - Large firms are usually efficient/high quality
   - Static measures may not tell us much about welfare/performance.

Introduction

This paper: first effort at empirically measuring dynamic effects of a proposed merger.

Our goals:

- ▶ Wide applicability
- ▶ Retain consistency with a rich underlying model
- ▶ keep simple $\Rightarrow$ avoid computing equilibria

Introduction

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Bajari, Benkard, and Levin (2007)-like approach

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Apply to three recently proposed airline mergers: UA-US, DL-NW, UA-CO

Outline

General Framework and Notation: (EP(1995)/BBL)

- ▶ States: $\mathbf{s}_t \in S \subset \mathbb{R}^G$, commonly known.
- ▶ Actions: $a_{it} \in A_i$, simultaneously chosen.
- ▶ Private Information: $\nu_{it} \sim iid\ G(\cdot|\mathbf{s}_t)$.
- ▶ State Transitions: $P(\mathbf{s}_{t+1}|\mathbf{a}_t, \mathbf{s}_t)$.

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Equilibria in these models have to be computed on a computer

General Framework and Methodology

Equilibrium Concept: Markov Perfect Equilibrium [MPE]

Strategies: $\sigma_i : S \times \mathbb{R} \to A_i$.

I.e., $$a_i = \sigma_i(\mathbf{s}, \nu_i)$$

Notes:

- ▶ This is a model of industry structure. Model allows for entry and exit, so in general number of firms is endogenous.
- ▶ If mergers are an important part of equilibrium play, they must be modeled in σ

BBL shows how to estimate model in two steps:

1. Estimate strategy functions, $\sigma_i(\mathbf{s}, \nu_i)$, and state transition function, $P(\mathbf{s}_{t+1}|\mathbf{a}_t, \mathbf{s}_t)$, nonparametrically.
2. Estimate remaining parameters using MPE conditions

Method of this paper: BBL first step only

1. Estimate the "reduced form" choice distributions,

$$Pr(a_i|\mathbf{s}_t)$$

and state transition function, $P : S \times A \rightarrow \Delta(S)$

▶ Because we are not doing the second step of BBL, do not need to worry about identification of strategy functions

▶ In principle, underlying model can be very complex (and have multidimensional unobserved shocks)

Methodology

This paper's key assumption:

Assumption 1 The same Markov perfect equilibrium profile, σ, is played for all t, whether or not the merger of interest takes place.

Recall: equilibrium strategy profile is defined for any number of firms, so it makes sense to think of holding it constant after a merger.

Need to hold policy environment fixed:

- ▶ If merger approval/nonapproval signals a change in anti-trust policy, then MPE strategies could change
- ▶ Any other contemporaneous policy changes will also be problematic

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Conclude: can only use this method for "non-game-changing" mergers.

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Conclude: can only use this method for "non-game-changing" mergers.

If assumption fails, the only way we know of to evaluate a merger is to compute a new MPE under the new policy — much more difficult.

Methodology

Why is the assumption useful?

- Under this assumption, the first stage estimates completely determine the future distribution of states and actions:

$$P((\mathbf{a}_{t+1}, \mathbf{s}_{t+1}), ..., (\mathbf{a}_{t+r}, \mathbf{s}_{t+r}) | \mathbf{a}_t, \mathbf{s}_t), \text{ for all } r$$

  whether or not merger occurs.

- Merger is simply a change in the starting state, $\mathbf{s}_t$

Methodology

Complement to existing methods

1. Need demand system to compute consumer welfare
2. Need marginal cost estimates to compute variable profits
3. Ideally would combine with BLP-like model
4. Do not need sunk costs estimates (second step of BBL), unless you want to compute total producer surplus net of sunk costs

Application: Airlines

Industry Background:

- ► Deregulated in 1978
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- ► Deregulated in 1978
- ► Several mergers in mid-1980s
- ► Then no mergers until recently
  - ► Distressed firm mergers: ValuJet-AirTran 97; AA-TWA 01
  - ► United-USAir, 2000 (blocked)
  - ► USAir-America West 2005 (approved)
  - ► Delta-Northwest 2008 (approved)
  - ► United-Continental 2010 (pending)

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- ▶ Then no mergers until recently
- ▶ Cannot model mergers using past data so will proceed under assumption that mergers are too rare to impact entry strategies
- ▶ Code-Sharing Agreements

Model

An Idealized Model of the Airline Industry

- Air transport network with K cities.

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- ▶ "Route Network": N, $J \times A$ matrix

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- Fixed number, A, of airlines (incl. pot. entrants)
- Network for airline i: $n_i \in \{0, 1\}^J$
- "Route Network": N, $J \times A$ matrix
- Routes: $m \in \{1, ..., J\}$ includes nonstops & feasible one-stops.

Model

Profits:

- Period profits from serving market m:

$$\pi_{im}(z_{mt}, N_t) + \epsilon_{imt}$$

- π — reduced form for profits that would result from underlying demand and cost systems.
- z_{mt} — observed city pair m characteristics
- ϵ_{imt} — unobserved random profit shifters assumed independent over time

System profits for airline i:

$$\sum_{m=1}^{J} (\pi_{im}(z_m, N) + \epsilon_{im})$$

Model

Sunk Costs:

- ▶ We imagine three types of sunk costs:
    - ▶ Costs of opening/closing an entire airline
    - ▶ Costs of opening/closing operations at an airport
    - ▶ Costs of opening/closing operations on each segment
- ▶ We can represent all these costs with the function:

$$S_{it}(n_i^t, n_i^{t+1}) = S(n_i^t, n_i^{t+1}, \omega_{it}),$$

where ω_{it} is a vector of sunk costs shocks (also independent over time)

Model

MPE strategy functions:

$$n_i^{t+1}(N_t, Z_t, \omega_{it}, \epsilon_{it}).$$

Choice distributions:

$$Pr(n_i^{t+1} | N_t, Z_t) \qquad \text{for all } i$$

Model

Choice distributions:

$$Pr(n_i^{t+1}|N_t, Z_t) \qquad \text{for all } i$$

Not possible to estimate this:

- ► Model implies probs above only identified by time variation
- ► Symmetry across airlines does not help much

Model

Instead:

► Assume that areas of the network that are "far apart" (not closely connected in the network) are essentially independent choices

► I.e. variables from parts of the network far away do not enter the choice distribution functions.

► Allows us to use variation within an airline across routes to identify strategy functions

► Can explore this empirically

Data

Main data source: T100S "segment" data

- ▶ All nonstop flights by quarter, airline, plane type, includes seats and enplaned passengers.
- ▶ Period: 2003-2008
- ▶ Top 75 airports by enplaned passengers
- ▶ Aggregated to CSA level: Top 60 CSA's
- ▶ Smallest CSA's: Anchorage, Albany, Norfolk, Boise
- ▶ 1770 segments and markets
- ▶ 10 major airlines, plus 2 groups of small carriers
- ▶ Entry/exit definitions
- ▶ Regional carriers
- ▶ Supplement with T100M, DB1B
- ▶ American Travel Survey (1995), Census

Table: Airline Route and Market Statistics, 2003-2008

Carrier	Routes						Markets		
	Avg	Min	Max	Avg Entry	Avg Exit	Turnover	Avg	Min	Max
American	224	219	232	7	8	0.067	1260	1237	1296
United	182	166	193	6	2	0.044	1331	1237	1372
Delta	230	220	241	14	14	0.122	1453	1400	1504
Continental	121	103	147	10	2	0.099	920	772	1126
Northwest	155	136	169	6	2	0.052	1173	1145	1215
USAirways	158	146	190	14	6	0.127	730	665	982
Southwest	298	269	323	15	4	0.064	937	824	1042
JetBlue	32	16	51	8	1	0.281	128	61	226
Alaska	41	37	43	2	1	0.073	115	94	123
DL + NW	373	349	386	18	14	0.086	1566	1550	1579
UA + US	309	292	341	16	7	0.074	1455	1379	1494
UA + CO	286	254	321	15	3	0.063	1485	1396	1523

Note: Turnover is computed as (average entry plus average exit over two) over average segment presence.

Table: Airline Route and Market Statistics, 2003-2008

Regressor	Avg	SD	Min	25%	50%	75%	Max
Pop1*Pop2 (*1e-12)	8.46	17.6	0.030	1.49	3.40	8.30	350
Pop1*Pop2 (*1e-12) * 2002 Dens=0	0.82	3.24	0	0	0	0.341	82.0
Log 2002 Passenger Density	7.62	5.60	0	0	10.7	12.6	16.0
Percent Tourist	0.37	0.35	0	0	0.33	0.67	1
Num Big 3 Comps.	2.06	0.92	0	1	2	3	3
Num Other Major Comps.	1.70	1.04	0	1	2	2	5
Southwest Competitor	0.48	0.50	0	0	0	1	1
Num Oth. Low Cost Comps.	0.422	0.58	0	0	0	1	2
Num Oth. Comps.	0.3	0.46	0	0	0	1	1
Number Nonstop Comps	0.78	0.99	0	0	0	1	6
Number One-Stop Comps	3.52	1.97	0	2	4	5	9
Number CS Agreements	0.051	0.23	0	0	0	0	3
Competitor Hub on Route	0.68	0.467	0	0	1	1	1
HHI Among Others (Market)	4869	4445	0	0	5085	9993	10000
HHI Among Others Large (City)	3377	1762	49	2018	3030	4200	8933
HHI Among Others Small (City)	1695	889	6	1200	1561	2023	7861
Own Share Large (City)	0.15	0.17	0	0.0367	0.089	0.19	0.94
Own Share Small (City)	0.05	0.06	0	0.0001	0.027	0.06	0.83
Present in Segment	0.09	0.29	0	0	0	0	1
Present in Market (not Segment)	0.41	0.49	0	0	0	1	1
Present at One Airport (not Both)	0.23	0.42	0	0	0	0	1
Present at Both Airports (not Market)	0.27	0.44	0	0	0	1	1
One Hub	0.135	0.34	0	0	0	0	1
Both Hubs	0.004	0.07	0	0	0	0	1
Number of Hubs	0.15	0.37	0	0	0	0	2
Hub Conv (NS dist/OS dist)	0.76	0.28	0.01	0.57	0.89	0.99	1
Dist Nearest Hub Small	440	489	0	119	286	553	4679
Dist Nearest Hub Large	1180	932	0	495	857	1797	4756
Log Pass. Dens. New Markets	2.63	4.46	0	0	0	5.2	15.8
# Nonstops Small (City)	2.28	3.10	0	0	2	3	53
# Nonstops Large (City)	8.38	11.8	0	2	4	8	56

Table: Airline Route Network Overlap A

% segs/mrkts flown by the row airline, that are also flown by the column airline. Diag=total seg/mrkts flown.

	2008: segments	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Other	370	53	15	14	17	9	8	11	11	5	2	19	23	21
2	Other Low Cost	27	715	18	17	20	14	8	11	14	5	2	24	27	23
3	American (AA)	25	59	223	37	34	22	15	8	13	11	3	28	45	48
4	United (UA)	28	62	44	190	51	15	8	7	21	7	8	21	100	100
5	Southwest (WN)	20	45	24	30	323	11	10	4	25	2	6	14	46	37
6	Delta (DL)	15	45	22	13	15	220	20	5	12	15	2	100	22	29
7	Continental (CO)	21	41	23	11	23	29	146	7	12	19	1	34	22	100
8	Northwest (NW)	25	50	11	9	8	7	6	157	10	0	1	100	17	15
9	USAirways (US)	21	52	16	21	42	14	9	8	190	8	2	21	100	29
10	JetBlue (B6)	34	74	48	28	16	66	56	0	32	50	4	66	48	72
11	Alaska (AS)	16	28	16	37	44	9	5	5	9	5	43	12	47	42
12	DL + NW	19	47	17	11	12	60	14	43	11	9	1	366	19	22
13	UA + US	25	57	29	56	43	14	9	8	56	7	6	21	341	60
14	UA + CO	25	52	33	59	38	20	46	7	17	11	6	26	64	320

	2008: markets	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Other	370	53	89	92	63	91	74	78	62	17	8	95	94
2	Oth Low Cost	27	715	83	90	65	93	72	75	79	21	8	96	96
3	American (AA)	26	46	1272	84	62	91	80	74	58	17	4	94	88
4	United (UA)	25	47	79	1366	62	91	71	74	63	16	8	95	100
5	Southwest (WN)	22	45	76	81	1042	86	69	67	64	15	8	89	87
6	Delta (DL)	23	45	78	84	60	1489	70	71	62	15	7	100	90
7	Cont. (CO)	24	46	91	86	64	93	1125	77	65	20	4	95	90
8	Northwest (NW)	25	47	82	88	61	92	76	1145	60	16	6	100	91
9	US Air (US)	23	58	76	88	67	95	75	70	982	20	8	96	100
10	JetBlue (B6)	27	65	97	95	67	100	99	82	87	226	14	100	98
11	Alaska (AS)	24	48	43	88	70	85	40	53	60	26	123	85	89
12	DL + NW	22	43	76	82	59	94	68	72	59	14	7	1580	88
13	UA + US	23	46	75	92	61	91	68	71	66	15	7	94	1483
14	UA + CO	24	44	78	90	62	89	74	71	59	15	7	93	92

Table: Airline Route Network Overlap B

How isolated is each airline from competition?

	2008: segments	Total	with number of competitors equal to										
			0	1	2	3	4	5	6	7	8	9	10
1	Other	370	108	111	76	43	21	8	3	0	0	0	0
2	Other Low Cost	715	200	245	144	79	33	10	4	0	0	0	0
3	American (AA)	223	21	49	66	41	31	11	4	0	0	0	0
4	United (UA)	190	4	31	71	49	22	9	4	0	0	0	0
5	Southwest (WN)	323	51	94	92	64	14	7	1	0	0	0	0
6	Delta (DL)	220	64	66	35	17	21	13	4	0	0	0	0
7	Continental (CO)	146	30	45	28	13	18	9	3	0	0	0	0
8	Northwest (NW)	157	42	60	33	15	5	1	1	0	0	0	0
9	USAirways (US)	190	30	46	54	38	13	8	1	0	0	0	0
10	JetBlue (B6)	50	0	4	8	10	14	11	3	0	0	0	0
11	Alaska (AS)	43	6	17	11	3	3	3	0	0	0	0	0
12	DL + NW	366	108	125	63	33	21	13	3	0	0	0	0
13	UA + US	341	35	85	121	61	28	8	3	0	0	0	0
14	UA + CO	320	34	78	99	57	38	13	1	0	0	0	0

	2008: markets	Total	with number of competitors equal to										
			0	1	2	3	4	5	6	7	8	9	10
1	Other	370	0	2	13	35	23	52	50	86	62	34	13
2	Other Low Cost	715	0	10	24	40	64	93	143	173	112	43	13
3	American (AA)	1272	13	29	58	105	174	237	261	219	120	43	13
4	United (UA)	1366	6	21	87	113	209	271	265	218	120	43	13
5	Southwest (WN)	1042	11	49	64	83	136	169	197	168	114	38	13
6	Delta (DL)	1489	13	50	99	143	238	274	276	220	120	43	13
7	Continental (CO)	1125	7	14	33	67	152	217	242	217	120	43	13
8	Northwest (NW)	1145	15	19	59	80	153	204	234	205	120	43	13
9	USAirways (US)	982	5	21	42	55	107	152	221	203	120	43	13
10	JetBlue (B6)	226	0	0	1	3	7	21	29	50	59	43	13
11	Alaska (AS)	123	2	11	12	12	17	14	14	1	13	14	13
12	DL + NW	1580	31	97	150	249	303	312	247	135	43	13	0
13	UA + US	1483	13	57	121	204	286	342	265	139	43	13	0
14	UA + CO	1526	13	38	144	250	329	311	260	125	43	13	0

Table: Airline Route Network Overlap C

Upper triangle is # markets where these are only two carriers. Lower triangle is # markets with a third carrier.

	2008: segments	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Other	—	72	6	2	2	3	10	11	2	1	2	14	4	13
2	Other Low Cost	55	—	20	19	26	35	12	39	19	0	3	77	41	31
3	American (AA)	14	41	—	3	14	4	0	2	0	0	0	6	3	3
4	United (UA)	16	33	26	—	2	2	0	0	1	0	2	2	0	0
5	Southwest (WN)	26	47	20	38	—	12	13	2	15	0	8	14	24	16
6	Delta (DL)	6	25	9	4	9	—	5	2	3	0	0	0	5	7
7	Continental (CO)	8	15	5	2	10	6	—	2	2	0	1	7	2	0
8	Northwest (NW)	15	25	5	5	2	3	4	—	2	0	0	0	2	2
9	USAirways (US)	9	36	9	10	26	5	4	7	—	2	0	5	0	3
10	JetBlue (B6)	2	7	2	0	0	3	2	0	0	—	1	0	2	0
11	Alaska (AS)	1	4	1	8	6	0	0	0	2	0	—	0	2	3
12	DL + NW	22	45	14	9	11	0	10	0	12	3	0	—	0	0
13	UA + US	28	71	40	0	62	11	6	14	0	0	10	0	—	0
14	UA + CO	22	51	32	0	50	10	0	9	14	2	8	0	0	—

	2008: markets	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Other	—	0	1	0	0	1	0	0	0	0	0	1	0	0
2	Other Low Cost	0	—	2	4	0	4	0	0	0	0	0	5	5	4
3	American (AA)	6	5	—	1	12	9	0	4	0	0	0	15	3	1
4	United (UA)	8	8	18	—	3	3	0	7	2	0	1	29	0	0
5	Southwest (WN)	2	3	20	33	—	14	6	0	9	0	5	18	22	9
6	Delta (DL)	8	15	31	41	19	—	2	3	10	0	4	0	16	5
7	Continental (CO)	0	0	21	1	9	19	—	5	0	0	1	14	1	0
8	Northwest (NW)	1	5	12	37	15	34	11	—	0	0	0	0	9	12
9	USAirways (US)	0	11	2	17	18	28	5	3	—	0	0	11	0	3
10	JetBlue (B6)	0	1	1	0	0	0	0	0	0	—	0	0	0	0
11	Alaska (AS)	1	0	0	11	9	3	0	0	0	0	—	4	1	4
12	DL + NW	13	31	61	77	40	0	26	0	40	0	12	—	0	0
13	UA + US	9	20	23	0	48	80	10	41	0	0	11	0	—	0
14	UA + CO	8	10	56	0	44	82	0	50	26	0	12	0	0	—

Table: Top 5 Routes by HHI Increase, Passengers Enplaned, 2008

DL-NW								
		Num Maj	HHI Passengers			HHI Departures		
CSA1	CSA2	pre	pre	post	chng	pre	post	chng
CVG	MSP	2	5066	9996	4930	5003	10000	4997
CVG	DTW	2	4918	9830	4912	4983	9860	4877
ATL	FLL, MIA	2	5230	9993	4763	5009	10000	4991
MSP	SLC	2	3526	6558	3032	3624	6655	3031
BUR, LAX, ONT, SNA	HNL	5	3520	6292	2772	3612	6472	2860
UA-US								
		Num Maj	HHI Passengers			HHI Departures		
CSA1	CSA2	pre	pre	post	chng	pre	post	chng
OAK, SFO, SJC	PHL	2	5348	9999	4651	5255	9982	4727
CLT	DEN	2	5893	10000	4107	5511	10000	4489
BUR, LAX, ONT, SNA	PHL	2	6155	9989	3834	5556	9963	4407
CLT	MDW, ORD	3	4250	7690	3440	3530	6107	2577
BWI, DCA, IAD	MSY	3	3617	6876	3259	3915	7568	3653
UA-CO								
		Num Maj	HHI Passengers			HHI Departures		
CSA1	CSA2	pre	pre	post	chng	pre	post	chng
CLE	DEN	2	5414	9988	4574	5522	10000	4478
DEN	HOU,IAH	3	3500	5889	2389	2949	5219	2270
DEN	EWR, JFK, LGA	4	3443	5223	1780	3241	4993	1752
BWI, DCA, IAD	CLE	3	3784	5058	1274	4216	6514	2298
HOU,IAH	MDW,ORD	4	3053	4296	1243	2977	4524	1547

Table: Top 6 Cities by HHI Increase, Passengers Enplaned, 2008

	Num Maj	HHI Segments			HHI Markets			HHI Passengers			p
					DL-NW						
CSA	pre	pre	post	chng	pre	post	chng	pre	post	chng	p
MEM	6	5709	6232	523	1737	2145	408	5549	6606	1057	46
CVG	6	6155	6555	400	1757	2129	372	7683	8143	460	61
MSP	6	5861	6378	517	1735	2108	373	5481	5928	447	49
BDL	7	1775	2238	463	1441	1688	247	1782	2222	440	15
DTW	7	4475	5039	564	1455	1707	252	4796	5187	391	44
IND	7	2128	2547	419	1444	1698	254	1490	1859	369	14
					UA-US						
CSA	pre	pre	post	chng	pre	post	chng	pre	post	chng	p
BWI, DCA, IAD	9	2120	2755	635	1242	1417	175	1597	2326	729	15
PHL	7	3375	3812	437	1468	1728	260	3573	4165	592	39
PIT	8	2148	2625	477	1303	1506	203	1852	2422	570	18
ALB	7	1800	2188	388	1445	1689	244	2305	2775	470	18
ORF	7	1632	1871	239	1457	1714	257	1865	2331	466	19
CLT	7	4771	5243	472	1568	1881	313	7041	7484	443	59
					UA-CO						
CSA	pre	pre	post	chng	pre	post	chng	pre	post	chng	p
CLE	7	4457	4889	432	1448	1706	258	3889	4559	670	37
EWR, JFK, LGA	8	2009	2146	137	1395	1624	229	1683	1975	292	16
OMA	7	1543	1790	247	1576	1790	214	1482	1741	259	12
DEN	9	3606	3861	255	1354	1553	199	3031	3281	250	29
MSY	8	1744	1929	185	1443	1687	244	1578	1828	250	14
HOU, IAH	8	3891	4225	334	1413	1640	227	4782	5024	242	45

Results:

Estimating Choice Probabilities:

- ► Should do this nonparametrically
- ► For now, linear probits for entry/exit/stay in/stay out across segments/time/airlines
- ► Symmetric and asymmetric strategies (hubbing versus low cost carriers, separate probits by airline)
- ► Have also done correlated Probits, did not change anything

Table: Probits for Entry/Exit/Stay, Pooled Estimates

	Hub Carriers		Low Cost Carriers		All Carriers Pooled	
Variable	Beta	SE	Beta	SE	Beta	SE
Pop1*Pop2(*1e-12)*Dens=0	6.60	15.8	20.6	11.6	16.7	6.00
Log (2002 Pass Dens)	0.089	0.012	0.066	0.021	0.093	0.0078
% Tourist	0.062	0.089	0.25	0.14	0.11	0.062
Distance > 250	0.16	0.10	0.62	0.26	0.25	0.077
Distance > 500	-0.025	0.093	-0.20	0.16	-0.16	0.068
Distance > 1000	-0.14	0.084	-0.068	0.15	-0.17	0.060
Distance > 1500	-0.19	0.10	-0.24	0.18	-0.22	0.073
Distance > 2000	-0.036	0.13	0.027	0.22	-0.054	0.090
Distance > 2500	0.11	0.18	-0.074	0.24	0.033	0.11
Distance > 3000	-0.91	0.26			-0.84	0.20
Number NonStop Comps.	-0.12	0.034	-0.17	0.082	-0.15	0.028
Number One-Stop Comps.	-0.04	0.025	-0.058	0.050	-0.020	0.018
Number CS Agreements	0.45	0.075	-0.17	0.44	0.36	0.061
Competitor Hub on Route	0.14	0.095	-0.077	0.19	0.079	0.067
HHI Among Others (Market)	-0.0000029	0.0000073	0.0000016	0.000014	-0.0000044	0.0000055
HHI Among Oths Large (City)	0.00010	0.000047	-0.00038	0.000076	0.000079	0.000034
HHI Among Oths Small (City)	0.00015	0.000092	-0.00067	0.00011	0.00013	0.000060
Own Share Large (City)	2.43	0.53	-2.62	0.67	2.05	0.35
Own Share Small (City)	2.69	0.52	-1.54	1.11	1.80	0.38
Present in Segment	3.35	0.079	4.28	0.18	3.47	0.06
Present in Market (not Seg)	0.12	0.13	0.46	0.15	0.22	0.068
Present Both Apts (not Mark)	-0.17	0.13	0.32	0.17	0.035	0.069
Number of Hubs	0.68	0.10	0.22	0.13	0.38	0.057
Hub Conv (NS dist/OS dist)	-0.14	0.20	-1.19	0.45	-0.086	0.15
Dist Nearest Hub Small	0.00037	0.00013	-0.0010	0.00026	0.000025	0.000094
Dist Nearest Hub Large	0.00013	0.000075	-0.000045	0.00011	0.00016	0.000046
Log Pass. Den. New Markets	0.032	0.0062	-0.0060	0.012	0.026	0.0043
# Nonstops Small (City)	0.016	0.013	-0.023	0.018	0.0098	0.0079
# Nonstops Large (City)	0.027	0.0042	0.051	0.0079	0.023	0.0025
USAIR 2007 Dummy	0.82	0.15			0.87	0.12

Note: all probits have year and city dummies (and no constant term).

Table: Measures of Fit by Airline: Hub and Low Cost Pooled

| | Actual Last Period Status | | | | Full Sample Simulated | |
| | Stay | | Switch | | Switchers, Whole Period | |
Airline	In	Out	In	Out	In	Out
American (25,27)	0.961	0.994	0.083	0.092	0.396	0.498
United (25,5)	0.975	0.995	0.074	0.120	0.267	0.505
Delta (34,51)	0.965	0.995	0.105	0.157	0.340	0.836
Continental (41,5)	0.973	0.997	0.172	0.193	0.662	0.911
Northwest (19,8)	0.978	0.997	0.035	0.146	0.164	0.739
USAirways (66,29)	0.967	0.993	0.182	0.162	0.372	0.609
Southwest (76,11)	0.987	0.989	0.097	0.063	0.433	0.438
JetBlue (38,0)	0.989	0.996	0.062	0.048	0.299	—
Alaska (7,1)	0.984	0.998	0.060	0.046	0.216	0.590
Note: table lists actual entries/exits in parentheses.						

Table: Measures of Fit by Airline: Separate Probits

| Airline | Actual Last Period Status | | | | Full Sample Simulated | |
| | Stay | | Switch | | Switchers, Whole Period | |
	In	Out	In	Out	In	Out
American (25,27)	0.980	0.997	0.134	0.237	0.526	0.742
United (25,5)	0.994	0.998	0.371	0.233	0.644	0.649
Delta (34,51)	0.960	0.995	0.192	0.326	0.605	0.904
Continental (41,5)	0.984	0.998	0.681	0.241	0.838	0.891
Northwest (19,8)	0.991	0.998	0.398	0.416	0.584	0.902
USAirways (66,29)	0.965	0.995	0.395	0.241	0.648	0.752
Southwest (76,11)	0.993	0.992	0.183	0.120	0.460	0.492
JetBlue (38,0)	0.978	0.997	0.382	0.185	0.767	—
Alaska (7,1)	0.998	1.000	0.305	0.159	0.698	0.993
Note: table lists actual entries/exits in parentheses.						

Estimation

Comments:

- ► Most important variables (in order):
  1. Market presence
  2. Competition variables
  3. Market Density
  4. Route network variables

- ► Endogeneity: competition coeffs still upward biased?

- ► Fit is quite good, good enough that not much left to explain. E.g., when we add city shocks, they matter but don't do much.

Merger Simulations

Simulating the U.S. airline route network:

1. Start at state $\mathbf{s}_0$ (different for each scenario)
2. Take draws on entry/exit for every segment conditional on X's
3. Update dynamic X's for every market
4. Move to next period and repeat steps 2-3

Merger Simulations

- Simulate industry under four scenarios:
  1. No merger
  2. Delta-Northwest
  3. United-USAir
  4. United-Continental
- (All scenarios assume US Air-America West merger.)
- Difference in scenarios is starting value of state variables

Table: Airline Network Simulations: Next 10 years, Segments

Median number of routes served, by year

Year	0	1	2	3	4	5	6	7	8	9	10
No merger											
American	226	227	228	228	229	229	229	229	229	229	229
United	191	194	196	198	200	201	202	203	203	204	204
Southwest	336	343	351	360	369	379	388	398	407	417	427
Delta	224	223	222	222	221	220	218	217	216	215	214
Continental	147	150	152	154	156	157	158	159	160	161	162
Northwest	157	158	160	161	161	162	162	163	163	163	163
USAirways	193	199	205	210	214	219	222	226	229	232	234
JetBlue	55	61	69	77	85	93	102	111	121	131	142
Alaska	45	46	48	49	51	52	54	55	57	59	60
DL-NW merger											
American	226	230	234	237	240	242	244	245	246	248	249
United	191	196	200	204	207	210	212	214	216	217	219
Southwest	336	345	356	367	378	389	401	412	423	435	447
DL + NW	370	367	362	357	353	347	342	336	331	325	319
Continental	147	151	154	157	159	161	163	164	166	167	168
-merged-	0	0	0	0	0	0	0	0	0	0	0
USAirways	193	202	211	218	224	230	235	240	244	247	250
JetBlue	55	62	72	81	91	103	114	125	138	152	166
Alaska	45	46	48	49	51	53	55	57	58	60	62

Table: Airline Network Simulations: Next 10 years, Segments

Median number of routes served, by year

Year	0	1	2	3	4	5	6	7	8	9	10
						UA-US merger					
American	226	232	237	241	245	248	251	253	255	257	259
UA + US	346	350	353	356	360	362	364	366	367	368	369
Southwest	336	352	367	382	398	415	432	448	463	476	488
Delta	224	228	230	233	235	236	238	239	239	240	240
Continental	147	152	155	159	162	165	167	169	170	172	173
Northwest	157	161	164	168	170	173	175	177	178	180	181
-merged-	0	0	0	0	0	0	0	0	0	0	0
JetBlue	55	66	78	90	103	117	131	147	163	178	194
Alaska	45	47	49	52	54	57	59	61	63	65	68
						UA-CO merger					
American	226	231	235	239	242	245	247	249	250	252	253
UA + CO	322	324	326	327	328	328	328	328	327	326	325
Southwest	336	342	349	357	365	374	382	392	401	410	419
Delta	224	226	228	229	230	231	231	231	231	231	231
-merged-	0	0	0	0	0	0	0	0	0	0	0
Northwest	157	160	162	165	166	168	170	171	172	174	174
USAirways	193	203	212	219	225	231	237	241	245	249	252
JetBlue	55	60	65	71	76	82	89	95	102	109	116
Alaska	45	46	46	47	48	49	50	51	52	53	54

Table: Aggregate Concentration Measures: Distribution in Year 10

Number of ...	base	mean	std	min	max	q0.25	med	q0.75
				No merger				
markets with 0 carriers	23	21	3	13	35	19	21	23
markets with 1 carrier	77	66	6	51	89	63	66	70
markets with 2 carriers	120	98	10	73	142	91	97	104
markets with 3 carriers	178	135	14	97	187	125	134	144
markets with 4 carriers	221	168	17	115	224	157	167	179
markets with 5 carriers	294	212	20	156	276	199	212	226
markets with 6 carriers	398	288	28	189	373	268	288	306
markets with 7 carriers	333	366	41	256	547	339	368	393
markets with 8 carriers	101	356	48	219	521	323	354	387
markets with 9 carriers	25	59	12	29	103	51	59	68
				DL-NW merger				
markets with 0 carriers	23	24	3	15	33	21	23	26
markets with 1 carrier	80	68	6	50	89	64	68	71
markets with 2 carriers	146	103	9	76	135	96	103	109
markets with 3 carriers	219	141	14	104	193	132	141	150
markets with 4 carriers	336	210	20	152	284	197	210	224
markets with 5 carriers	429	288	29	195	379	268	287	306
markets with 6 carriers	399	430	45	276	580	398	431	461
markets with 7 carriers	113	435	52	285	611	400	434	470
markets with 8 carriers	25	72	13	33	121	63	72	80
markets with 9 carriers	0	0	0	0	0	0	0	0

Table: Aggregate Concentration Measures: Distribution in Year 10

Number of ...	base	mean	std	min	max	q0.25	med	q0.75
				UA-US merger				
markets with 0 carriers	23	21	3	14	32	19	21	23
markets with 1 carrier	80	63	5	44	101	60	63	66
markets with 2 carriers	149	88	10	62	128	80	87	94
markets with 3 carriers	245	146	14	104	194	136	145	154
markets with 4 carriers	268	179	18	133	238	165	178	191
markets with 5 carriers	420	257	24	189	333	240	255	272
markets with 6 carriers	446	357	46	228	533	325	355	388
markets with 7 carriers	114	567	53	382	712	533	568	604
markets with 8 carriers	25	94	18	45	159	81	92	105
markets with 9 carriers	0	0	0	0	0	0	0	0
				UA-CO merger				
markets with 0 carriers	23	22	3	14	36	20	22	24
markets with 1 carrier	75	69	5	53	86	66	69	73
markets with 2 carriers	125	105	10	80	147	98	105	111
markets with 3 carriers	203	138	16	90	189	126	136	148
markets with 4 carriers	332	212	21	136	286	197	212	226
markets with 5 carriers	503	360	31	256	473	338	361	380
markets with 6 carriers	380	476	45	345	640	445	478	506
markets with 7 carriers	104	334	45	212	473	303	331	363
markets with 8 carriers	25	54	11	23	98	47	54	62
markets with 9 carriers	0	0	0	0	0	0	0	0

Merger Simulations

Initial findings:

- ▶ Major carriers respond to merger by entering more
- ▶ Low cost carriers more complex, often enter more
- ▶ Merged carrier generally enters less than no-merger case
- ▶ Two of three mergers lead to more monop/duop routes
- ▶ UA-US leads to fewer monop/duop routes

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- ▶ UA-US leads to fewer monop/duop routes

Next: "worst case" cities: entry can sometimes completely reverse merger effect

Table: City Simulations: Memphis, Segments

Median number of routes served, by year
Number of simulations: 1,000   Time dummies: year 2008

Year	0	1	2	3	4	5	6	7	8	9	10
						No merger						
American	5	5	4	4	4	4	4	4	4	3	3
United	2	2	2	2	2	2	2	2	2	2	2
Southwest	0	0	0	0	0	0	0	1	1	1	2
Delta	2	2	2	3	3	3	3	3	3	4	4
Continental	2	2	2	3	3	3	3	3	3	3	3
Northwest	38	38	37	37	37	37	37	37	36	36	36
USAirways	2	2	2	2	2	2	3	3	3	3	3
JetBlue	0	0	0	0	0	0	0	0	0	0	0
Alaska	0	0	0	0	0	0	0	0	0	0	0
HHI	5709	5709	5835	5425	5425	5425	5237	5044	4970	4970	4795
						DL-NW merger						
American	5	5	4	4	4	4	4	4	4	3	3
United	2	2	2	2	2	2	2	2	2	2	2
Southwest	0	1	4	6	8	9	11	12	13	13	14
DL + NW	39	38	36	34	33	31	30	29	27	26	25
Continental	2	2	2	2	3	3	3	3	3	3	3
-merged-	0	0	0	0	0	0	0	0	0	0	0
USAirways	2	2	2	2	2	2	3	3	3	3	3
JetBlue	0	0	1	2	3	4	5	6	7	8	8
Alaska	0	0	0	0	0	0	1	1	1	1	1
HHI	6232	5928	5156	4527	3950	3607	3117	2944	2739	2703	2634

Table: City Simulations: Philadelphia, Segments

Median number of routes served, by year
Number of simulations: 1,000   Time dummies: year 2008

Year	0	1	2	3	4	5	6	7	8	9	10
						No merger					
American	5	5	4	4	4	4	4	4	4	4	4
United	5	5	5	5	5	5	5	5	5	5	5
Southwest	15	16	16	17	18	19	19	20	21	21	22
Delta	5	5	5	5	5	5	4	4	4	4	4
Continental	2	2	2	3	3	3	3	3	3	3	3
Northwest	4	4	4	4	4	4	3	3	3	3	3
USAirways	41	41	41	41	41	40	40	40	40	40	40
JetBlue	0	1	3	4	5	6	7	8	9	10	11
Alaska	0	0	0	0	1	1	1	1	1	2	2
HHI	3375	3257	3175	3015	2869	2760	2820	2763	2714	2623	2585
						UA-US merger					
American	5	5	5	4	4	4	4	4	4	4	4
UA + US	41	40	39	37	36	35	33	32	31	30	29
Southwest	15	19	23	26	30	34	38	42	46	50	53
Delta	5	5	5	5	5	5	5	5	5	5	4
Continental	2	2	2	3	3	3	3	3	3	3	3
Northwest	4	4	4	4	4	4	4	4	4	3	3
-merged-	0	0	0	0	0	0	0	0	0	0	0
JetBlue	0	3	7	10	13	16	19	23	27	31	36
Alaska	0	1	1	2	3	4	4	5	5	6	6
HHI	3812	3270	2934	2675	2541	2466	2460	2448	2494	2557	2642

Merger Simulations

However, this is by no means always the case...

Table: City Simulations: Cincinatti, Segments

Median number of routes served, by year
Number of simulations: 1,000   Time dummies: year 2008

Year	0	1	2	3	4	5	6	7	8	9	10
	No merger										
American	4	4	4	4	4	4	4	4	4	4	4
United	3	3	3	3	3	3	3	3	3	3	3
Southwest	0	0	0	0	0	0	0	0	0	0	0
Delta	49	49	49	49	49	49	48.5	48.5	48	48	48
Continental	3	3	3	3	3	3	3	3	3	3	3
Northwest	2	2	2	2	2	2	2	2	2	2	2
USAirways	2	2	3	3	3	3	3	3	3	3	3
JetBlue	0	0	0	0	0	0	0	0	0	0	0
Alaska	0	0	0	0	0	0	0	0	0	0	0
HHI	6155	6155	5977	5977	5977	5977	5950	5950	5923	5923	5923
	DL-NW merger										
American	4	4	4	4	4	4	4	4	4	4	4
United	3	3	3	3	3	3	3	3	3	3	3
Southwest	0	0	0	0	0	0	0	0	0	0	0
DL + NW	49	49	49	49	49	49	49	50	50	50	50
Continental	3	3	3	3	3	3	3	3	3	3	3
-merged-	0	0	0	0	0	0	0	0	0	0	0
USAirways	2	2	3	3	3	3	3	4	4	4	4
JetBlue	0	0	0	0	0	0	0	0	0	0	0
Alaska	0	0	0	0	0	0	0	0	0	0	0
HHI	6555	6555	6358	6358	6358	6358	6358	6226	6226	6226	6226

Table: City Simulations: DC, Segments

Median number of routes served, by year
Number of simulations: 1,000   Time dummies: year 2008

Year	0	1	2	3	4	5	6	7	8	9	10
No merger											
American	10	10	9	9	9	9	8	8	8	8	8
United	42	43	44	44	45	45	46	46	46	47	47
Southwest	34	35	36	37	38	39	40	41	42	43	44
Delta	6	6	6	6	6	6	6	6	6	6	6
Continental	3	3	3	3	3	3	3	3	3	3	3
Northwest	4	4	4	4	4	4	4	4	4	4	4
USAirways	27	28	29	30	31	32	33	33	34	35	35
JetBlue	7	7	7	7	7	8	8	8	8	8	9
Alaska	2	2	2	2	2	2	2	2	2	2	2
HHI	2120	2138	2178	2182	2200	2182	2221	2228	2234	2250	2235
UA-US merger											
American	10	10	10	10	10	10	10	10	10	10	10
UA + US	45	46	47	48	48	49	49	50	50	50	50
Southwest	34	35	36	37	38	39	39	40	41	42	42
Delta	6	6	7	7	7	7	8	8	8	8	8
Continental	3	3	3	3	3	3	3	4	4	4	4
Northwest	4	4	4	4	4	4	4	5	5	5	5
-merged-	0	0	0	0	0	0	0	0	0	0	0
JetBlue	7	7	8	8	8	8	8	8	8	8	9
Alaska	2	2	2	2	2	2	2	2	2	2	2
HHI	2755	2784	2737	2765	2771	2798	2762	2711	2719	2726	2695

Table: City Simulations: NYC, Segments

Median number of routes served, by year
Number of simulations: 1,000   Time dummies: year 2008

Year	0	1	2	3	4	5	6	7	8	9	10
	No merger										
American	28	30	31	33	34	35	37	37	38	39	40
United	6	6	7	7	7	7	7	7	8	8	8
Southwest	0	1	2	3	5	6	7	8	9	9	10
Delta	39	40	41	42	43	44	44	44	45	45	45
Continental	49	49	49	50	50	50	50	50	50	50	50
Northwest	4	4	4	4	4	4	4	4	4	4	4
USAirways	14	13	13	12	12	11	11	10	10	10	10
JetBlue	28	29	29	30	31	32	32	33	34	35	36
Alaska	1	1	1	1	1	1	1	1	1	1	1
HHI	2009	1993	1954	1954	1916	1914	1897	1893	1865	1865	1851
	UA-CO merger										
American	28	31	33	36	38	40	41	43	44	45	45
UA + CO	49	49	49	49	49	49	49	49	49	49	49
Southwest	0	1	2	3	5	6	7	8	8	9	9
Delta	39	41	42	44	45	46	47	48	48	49	49
-merged-	0	0	0	0	0	0	0	0	0	0	0
Northwest	4	4	4	4	5	5	5	5	5	5	5
USAirways	14	14	14	13	13	13	12	12	12	12	11
JetBlue	28	28	29	29	30	30	31	31	32	32	33
Alaska	1	1	1	1	1	1	1	1	1	1	1
HHI	2146	2115	2085	2081	2020	2008	2006	1997	1995	1986	1996

Merger Simulations

Model suggests "de-hubbing" in Cleveland under UA-CO...

Table: City Simulations: Cleveland, Segments

Median number of routes served, by year
Number of simulations: 1,000   Time dummies: year 2008

Year	0	1	2	3	4	5	6	7	8	9	10
	No merger										
American	3	4	4	5	5	5	5	6	6	6	6
United	3	3	4	4	4	4	5	5	5	5	5
Southwest	6	6	6	5	5	5	5	5	5	5	5
Delta	4	4	5	5	5	5	6	6	6	6	6
Continental	41	43	44	45	46	47	48	49	49	50	50
Northwest	3	3	3	3.5	4	4	4	4	4	4	4
USAirways	3	4	4	5	5	6	6	6	6	7	7
JetBlue	0	0	0	0	0	0	0	0	0	0	0
Alaska	0	0	0	0	0	0	0	0	0	0	0
HHI	4457	4346	4192	4097	4105	4072	3953	3925	3925	3900	3900
	UA-CO merger										
American	3	4	4	5	5	5	6	6	6	6	6
UA + CO	41	41	40	40	39	39	38	38	38	37	37
Southwest	6	6	7	7	8	8	8	9	9	9	10
Delta	4	4	5	5	5	6	6	6	6	6	6
-merged-	0	0	0	0	0	0	0	0	0	0	0
Northwest	3	3	3	4	4	4	4	4	4	4	4
USAirways	3	4	4	5	6	6	6	6	7	7	7
JetBlue	0	0	0	0	1	1	2	2	2	3	3
Alaska	0	0	0	0	0	0	0	0	0	0	0
HHI	4889	4615	4321	3994	3651	3569	3339	3279	3214	3079	3031

Two sets of conclusions:

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   - Pros: quite general and simple, rigorous, widely applicable
   - Cons: cannot evaluate wholesale policy change

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   - Major carriers respond to merger with entry
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To do: robustness, nonparametrics