Estimating the Gains from Liberalizing Services Trade: The Case of Passenger Aviation

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Liberalization and services trade

- We know relatively little about how services trade is affected by efforts at liberalization.

  Why?

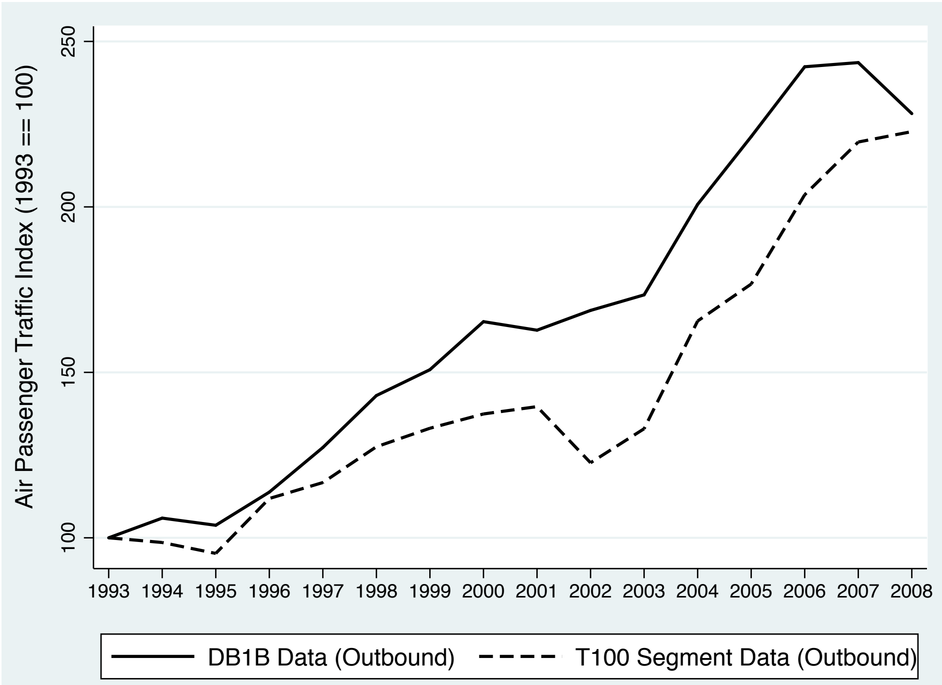
- Measurement:
  - Services trade data are highly aggregated;
  - Values, not P and Q

- Policy change is difficult to quantity:
  - Rules are complex and regulate how services are provided
  - Literature uses indices, relies on cross country comparisons

Data on aviation and policy change

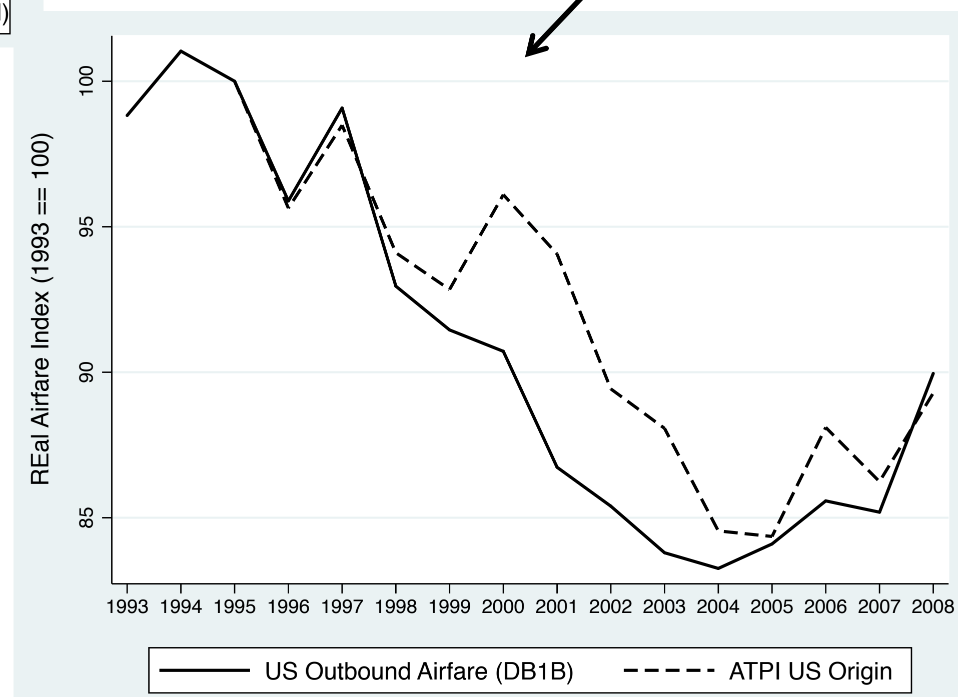
- We have detailed transactions data on U.S. passenger aviation, 1993-2008.
  - Prices, quantities for each carrier competing for precisely defined services (San Francisco -> Munich)

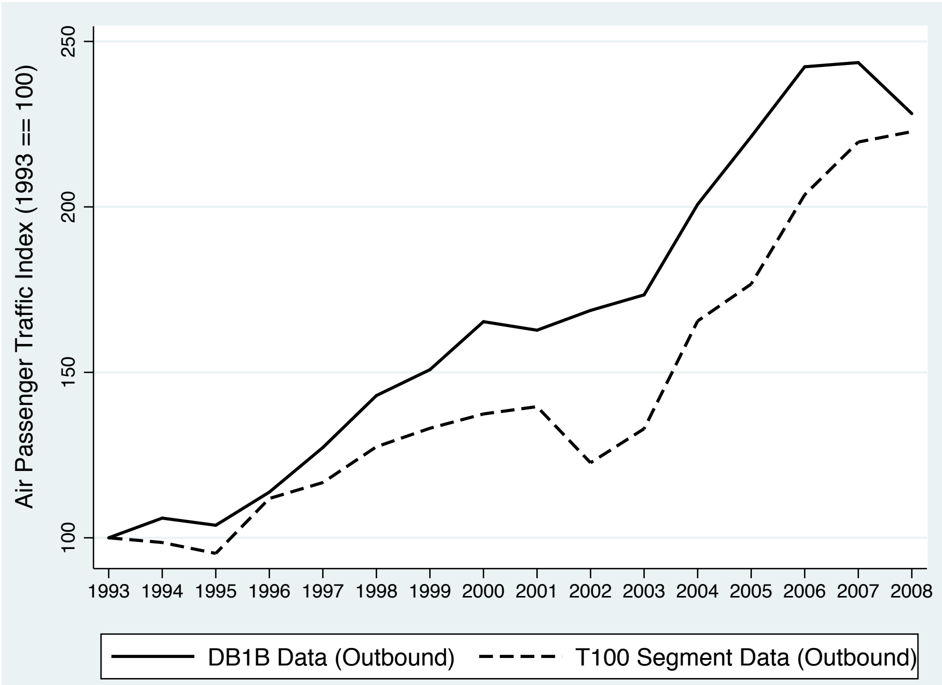
- We have a nice source of policy change:
  - From 1992-2007, the US signs 87 bilateral *Open Skies Agreements* (OSA) that liberalize aviation markets.
  - Another 21 agreements signed between 2008-2013.



The quantity of international passengers leaving the US doubles.

While prices fell 15-20%





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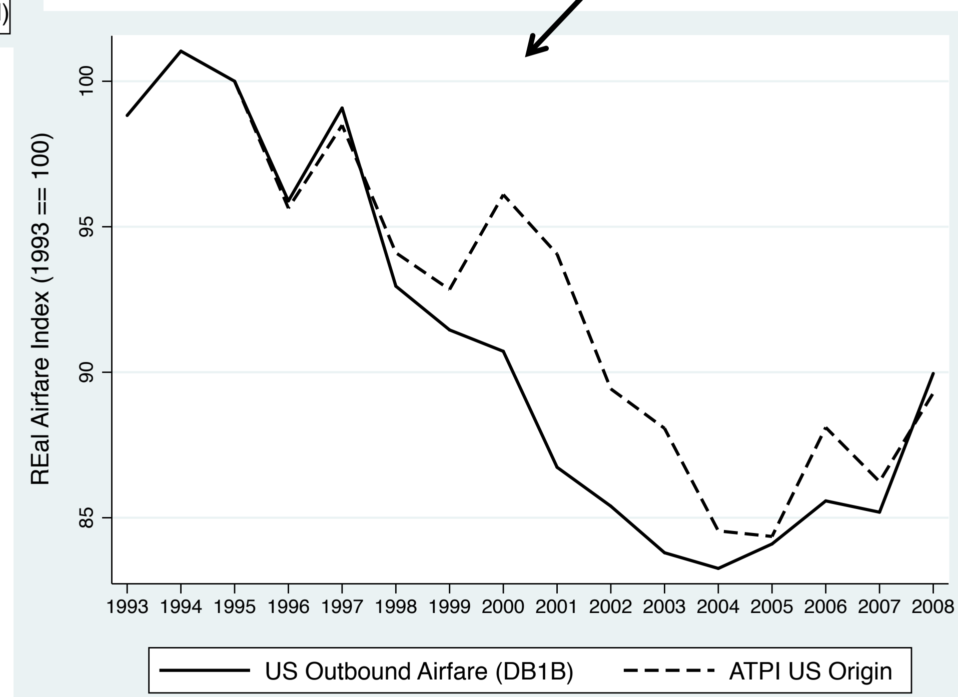


Were these changes caused by liberalization?

This Paper

I. Model of passenger aviation market:

- Hub and spoke network
- Uncertain demand + consumer heterogeneity
- Capacity-constrained price competition

Predictions map tightly into our empirics

II. Diff-in-diff estimation:

How does liberalization affect:

- Carrier entry/exit;
- capacity allocation
- P, Q, quality

III. Consumer welfare calculation

Related Literature

- Market structure & competition in aviation markets:
  - Hub-and-spoke network + quantity competition:
    Caves et al. (1984), Brueckner and Spiller (1991), Brueckner (2001)
  - Hub-and-spoke network + price competition:
    Hendricks et al. (1997, 1999), Aguirregabiria and Ho (2010, 2012)
- Capacity constraints + demand uncertainty:
  Eden (1990), Dana (1999), Reynolds and Wilson (2000), Lepore (2012)
- Liberalization in aviation services:
  Brueckner and Whalen (2000), Brueckner (2003), Whalen (2007), Bilotkatch (2007), Permartini and Rousova (2013), Winston and Yan (2015), McCallum and Rysman (2016)

Outline

1. Institutional Background
2. Theoretical Model
3. Empirical analysis
4. Welfare calculations

Existing regulatory regime: Bilateral Air Service Agreements

- Early efforts at multilateral agreements failed
  - Aviation is outside General Agreement on Trade in Services
  - In place of multilateral agreement: complex web of bilaterals

- Restrictive bilateral air service agreements

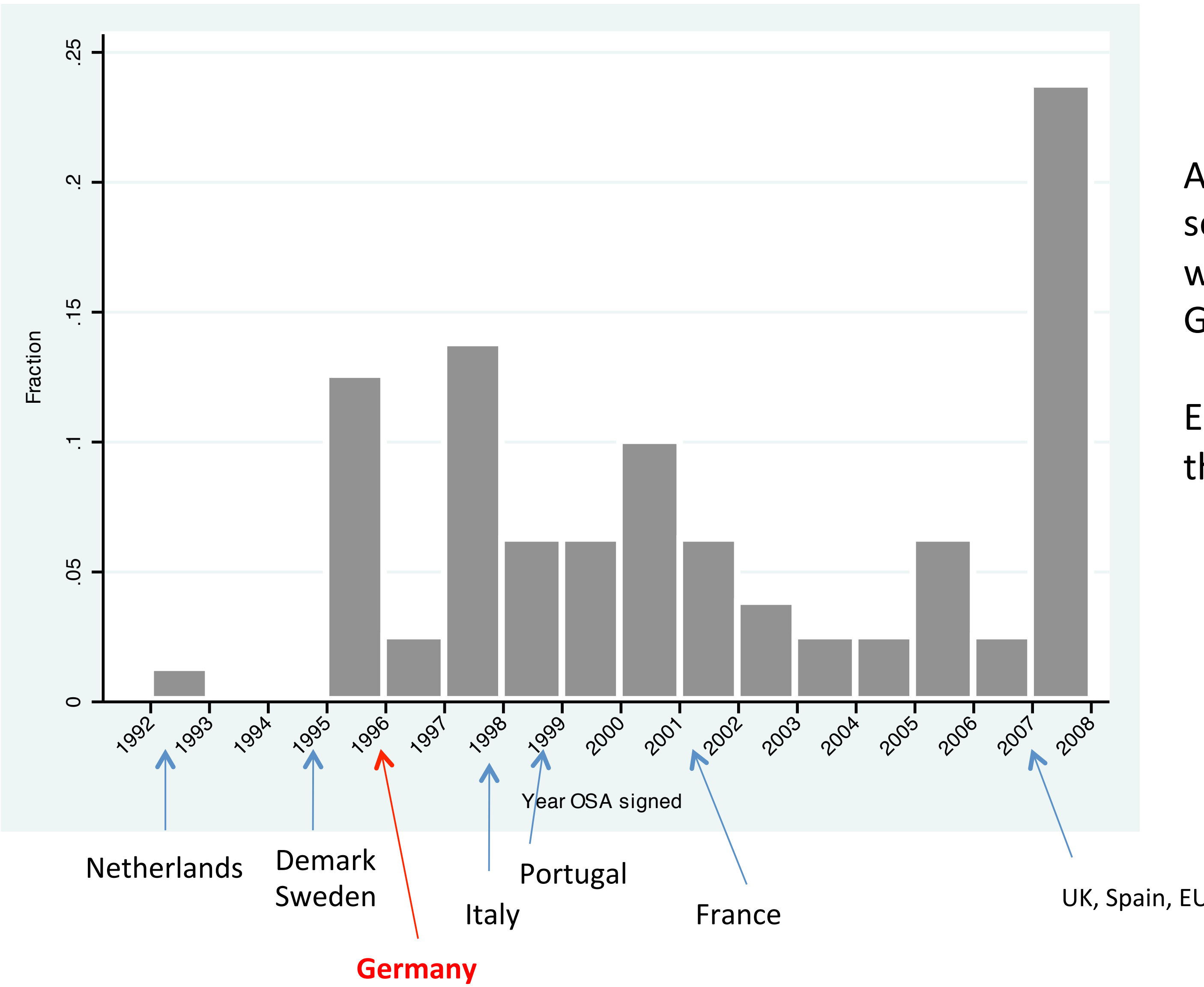
  Example: US China-Aviation Treaty (1980):

  - Entry restrictions: 2 carriers per country
  - Capacity restrictions: 2 flights per week for a given city-pair route
  - Route restrictions: flights between 4 US and 2 Chinese gateways
  - Price restrictions: price changes must be submitted to DC, Beijing for approval two months in advance.

Bilateral Open Skies Agreements (OSA)

- Starting in 1992, U.S. begins to liberalize international air services with specific partners → Open Skies Agreements
  - 106 agreements between 1992-2013
- Remove most existing restrictions (our focus)
  - No limit on entry, routes, capacity
- Grant new benefits (outside our focus)
  - Extensive "beyond" market rights
  - Allow inter-airline cooperation (alliances, codesharing)

Timing of Open Skies Agreements



Agreements are signed sequentially; order weakly correlated with GDP per capita

Europe spread throughout sample.

Endogeneity of OSAs?

- Who signs OSAs and when?
  - No clear statistical pattern in who signs OSAs
  - No clear statistical pattern in the timing of signings
- Why no systematic patterns?
  - OSAs are boilerplate agreements negotiated by U.S. State Dept.
  - US Trade Representative (Bob Zoellick): "[signing OSAs] likely has more to do with diplomatic issues than economic"
- To be conservative, we focus only on OSA signatory countries
  - identification is not from who signs, but when each country signs
  - take timing as exogenous, conditional on country characteristics

Theoretical Framework

Main Objectives:

- Characterize aviation markets using key industry features

- Understand how route and capacity restrictions affect:
  - Marginal cost of production and prices
  - Competition (carrier entry/exit)
  - Capacity allocation across routes
  - Quality: consumers valuation of flights

Model Setup

- **Consumers:**
  - have unit demands and heterogeneous reservation values
  - queue up in random order at the ticket desk (random rationing)
  - purchase lowest (quality-adjusted) price ticket that is below reservation value

- **Firms (air carriers)**:
  - Decide market entry (city-pair route)
  - Make capacity choice
  - Set pricing schedule without knowing:
    a. The reservation value of a specific customer
    b. Demand state (e.g., high or low)
    c. Where other carriers are in the pricing schedule

More Formally…. Demand Side

- Random market demand: eD(p)
  - shock "e" *rotates* the demand curve

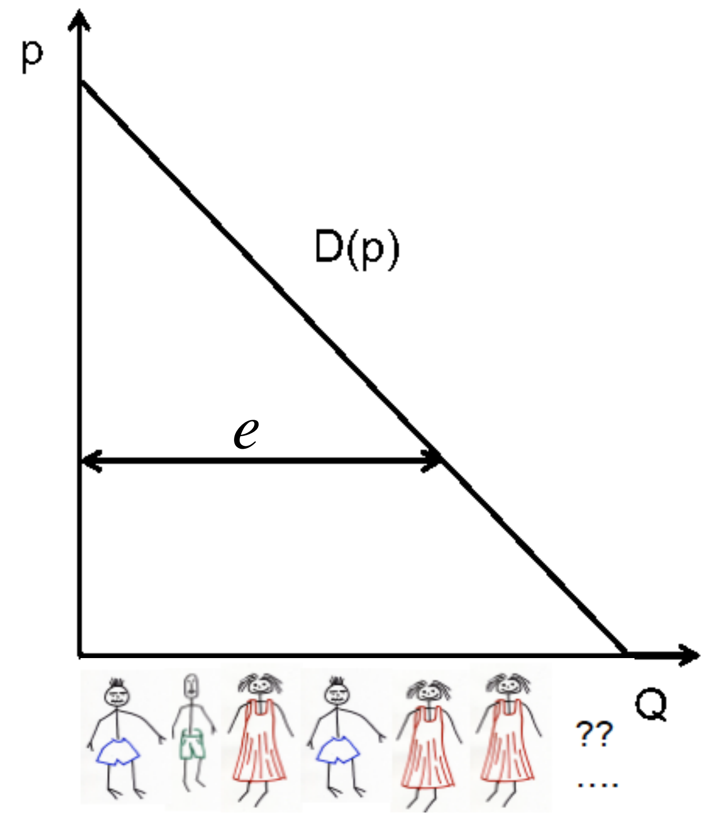
    $$e \in [0,1]; \qquad e \sim F(e)$$

  - *p* is "effective price":

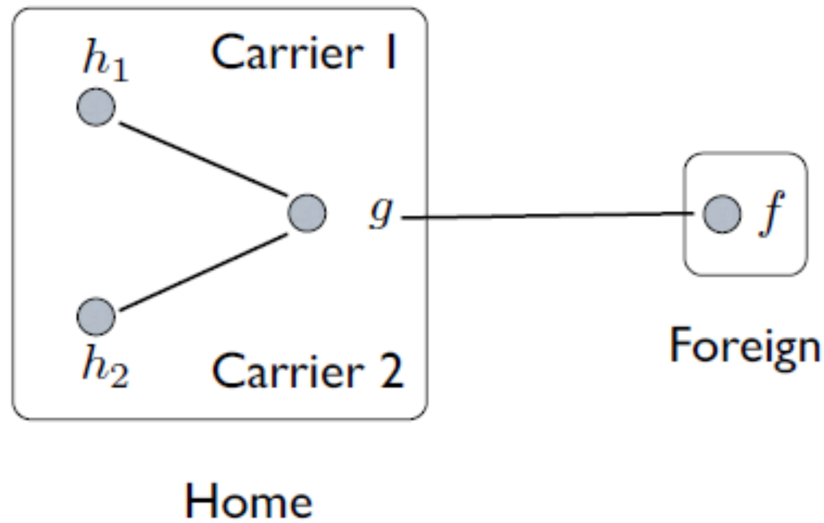
    $$p = \begin{cases} p^D & \text{if direct flight} \\ p^I/\alpha & \text{if indirect flight} \end{cases}$$

    $0 < \alpha < 1$ disutility for indirectness

  - Choke price: $\bar{p} = \inf\{p \mid D(p) = 0\}$



Supply Side



- n ≥ 1 carriers in Home
  n ≥ 1 carriers in Foreign

- Two types of cities:
  - gateways: g, f
  - non-gateway hubs: h1, h2

  Take domestic hub-spoke network as given. Simplify Foreign network.

- Carriers allocate capacity across routes at constant per-unit cost:
  λ_D = per-unit cost for direct international route
  λ_C = per-unit cost for domestic connection

Key: route restrictions increase cost of capacity
E.g.: indirect international flight h_1 to f : $\lambda_D + \lambda_C$

Timing

- Three stages:
  1. Carriers enter and form *international* networks
  2. Choose capacity and set pricing schedule
  3. Uncertain demand is realized and tickets purchased

- Focus on 2nd stage: price-capacity schedule
  - each carrier decides what number of tickets to offer at what price on each feasible route (given uncertain random demand)
  - symmetric subgame perfect equilibrium (within carrier type)

Price-Capacity Schedule

- Notation:

  $q_i(p)$ = number of units (seats) that carrier *i* prices at value *p*

  $Q_i(p)$ = total units that carrier i prices at or below *p*

  $$Q_i(p) = \int_0^p q_i(r)dr$$

- Total capacity chosen by carrier *i:* $Q_i(\overline{p}) = \int_0^{\overline{p}} q_i(r)dr$

- Market marginal quantity schedule: $q(p) = \sum_{i=1}^{n} q_i(p)$

Price-Capacity Schedule

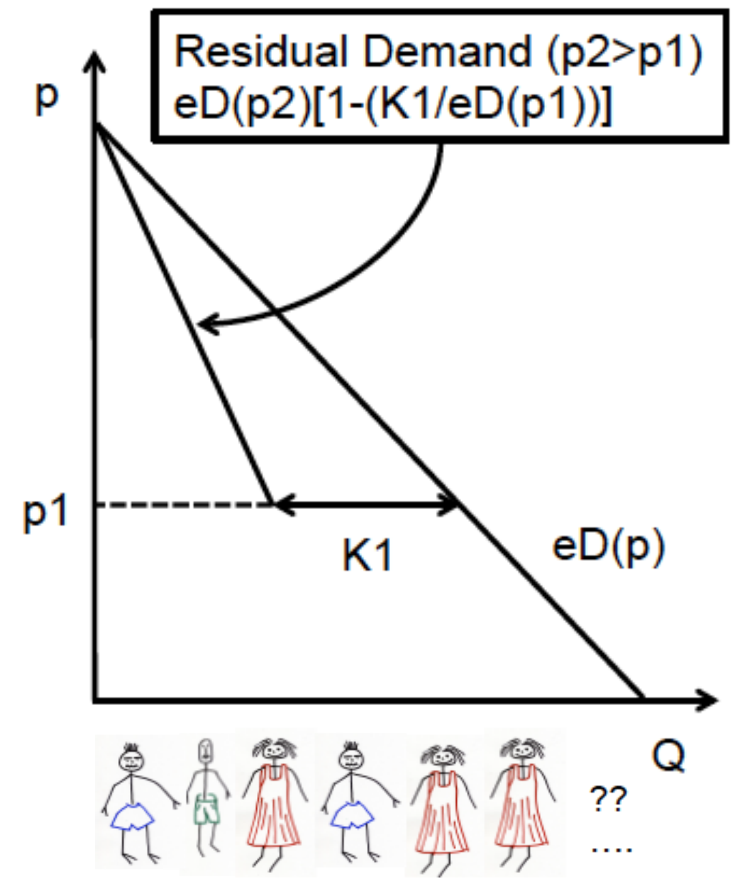
- Residual market demand at price p given demand shock e:

$$eD(p)\left[1-\int_0^p \frac{q(r)}{eD(r)}dr\right]$$

- Market clearing demand shock at price p:

$$\text{resid } D(p)=0$$

$$\Rightarrow \quad e(p,q)=\int_0^p \frac{q(r)}{D(r)}dr$$



Price-Capacity Schedule

- Probability that all units priced at p sell:

$$\text{Prob}(e > e(p,q)) = 1 - F(e(p,q))$$

- Carrier profit functions:
  - Direct service:

$$\pi_i(q_i, q_{-i}) = \int_0^{\bar{p}} \left[\left(1 - F(e(p,q)\right) p - \lambda_D \right] q_i(r) dr$$

  - Indirect service:

$$\pi_i(q_i, q_{-i}) = \int_0^{\bar{p}} \left[\left(1 - F(e(p,q)\right) \alpha p - (\lambda_D + \lambda_C) \right] q_i(r) dr$$

Equilibrium: Price-Capacity Schedule

- In equilibrium set MR equal to (constant) MC across possible demand states
  - Continuously distributed shock "e" → smooth pricing function

- Prices rise as market nears capacity

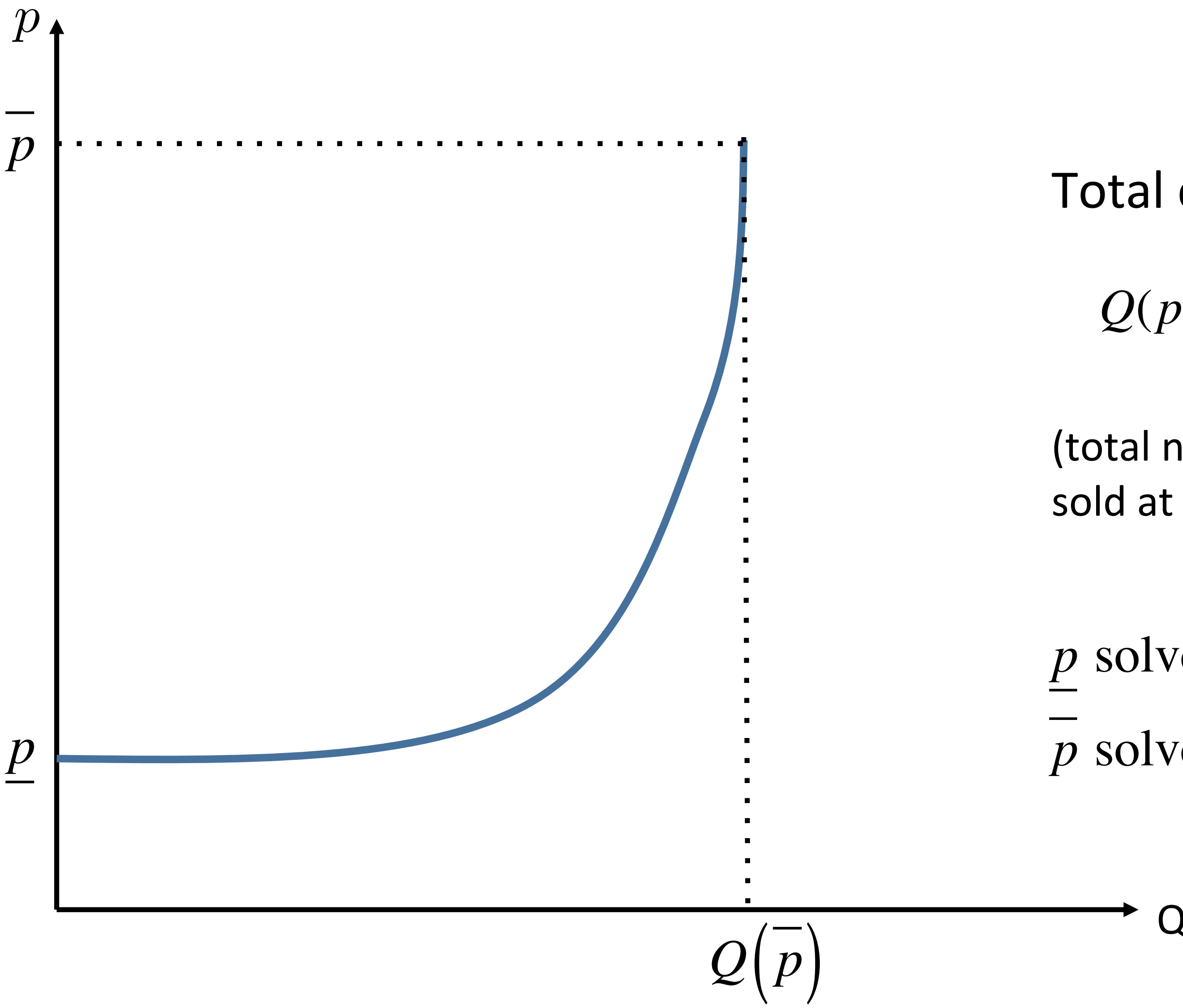
  Why?
  - expected revenue from selling ticket at price *p*: $p \cdot \underbrace{\left(1 - F(e(p,q)\right)}_{\text{Sale probability}}$

    e(p,q) high → Q(p) high and Prob (e > e(p,q)) low

    e(p,q) low → Q(p) low and Prob (e > e(p,q)) high

  - to keep MR equal across demand states => price p must rise when sale probability is low => p increases with Q(p)

Price-Capacity Schedule



Total capacity:

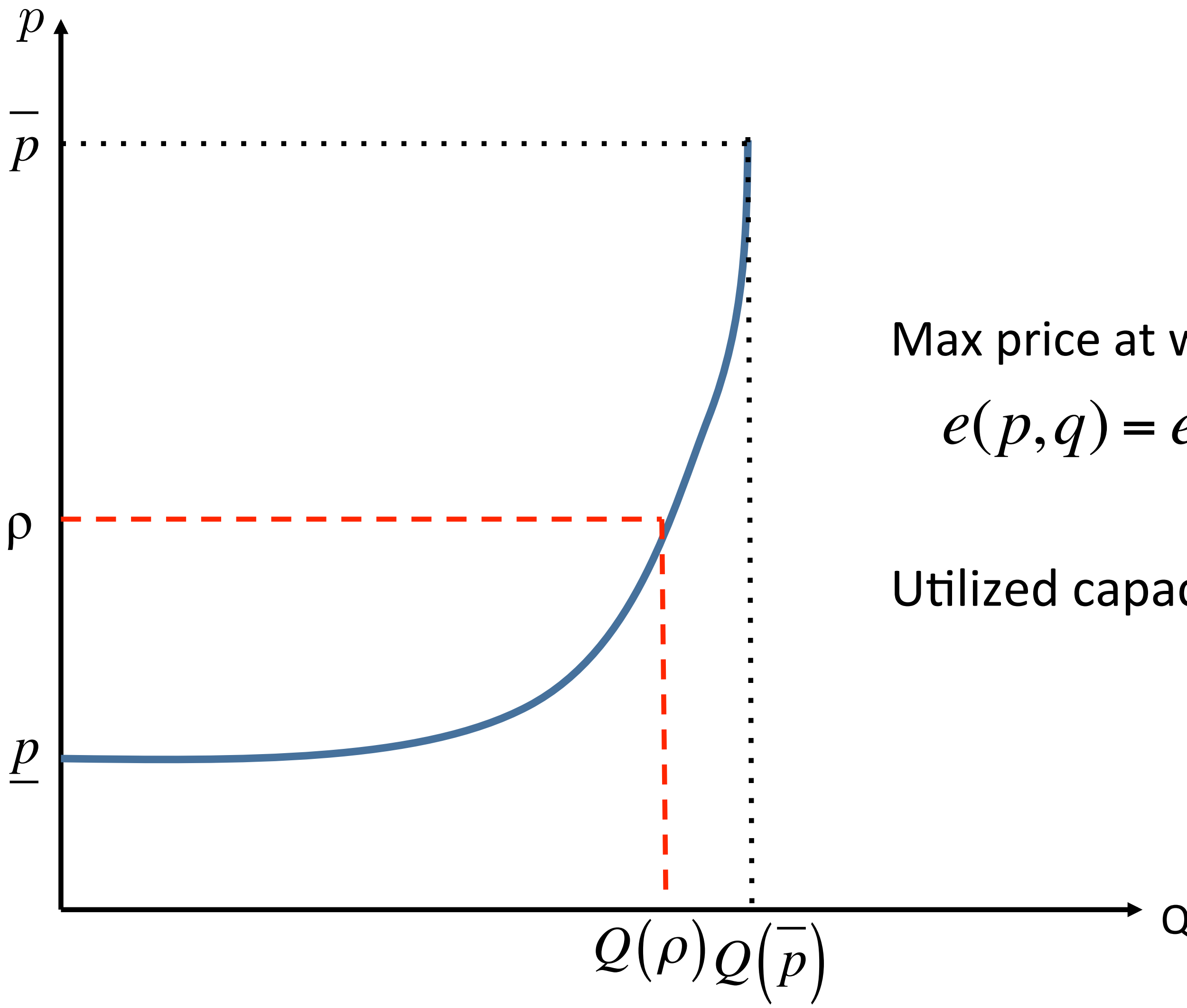
$$Q(p) = \int_{\underline{p}}^{\overline{p}} q(s)\,ds$$

(total number of tickets sold at or below max price)

$\underline{p}$ solves $1 - F(e(p,q) = 1$

$\overline{p}$ solves $D(p) = 0$

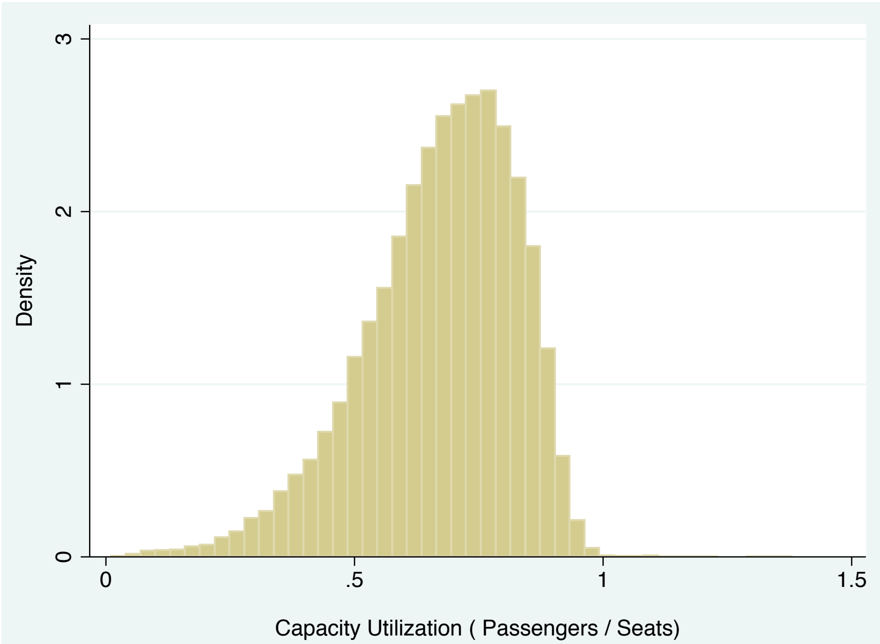
Price-Capacity Schedule



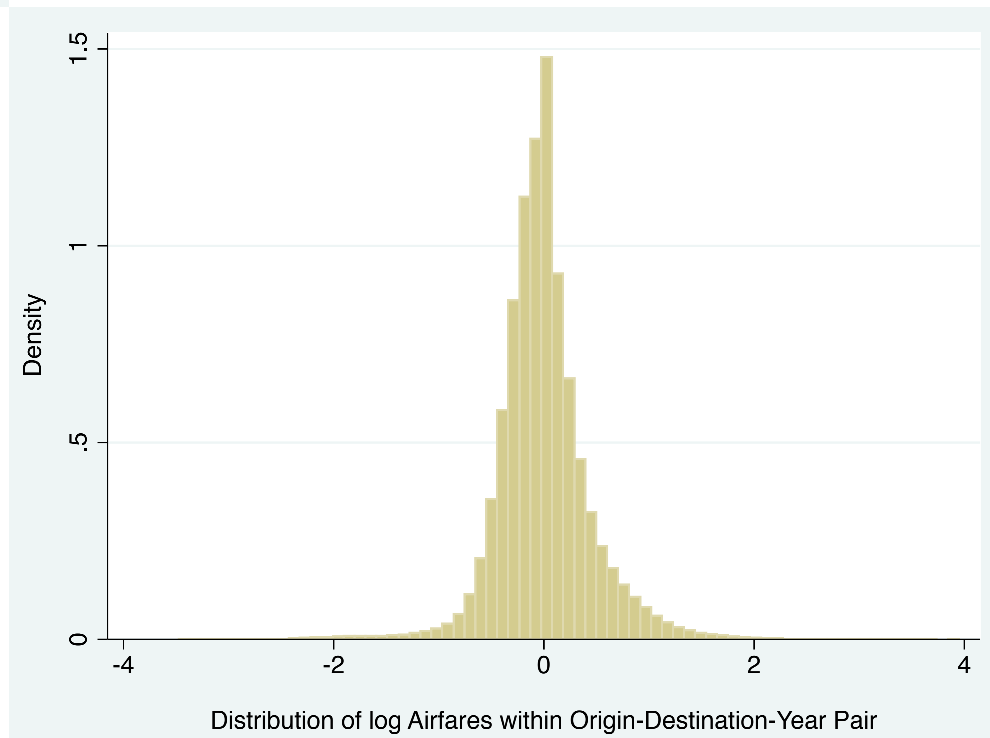
Max price at which a ticket sells:

$$e(p,q) = e \;\Rightarrow\; p \equiv \rho(e,q)$$

Utilized capacity: $Q(\rho(e,q))$



Median capacity utilization on international flights is 69%.

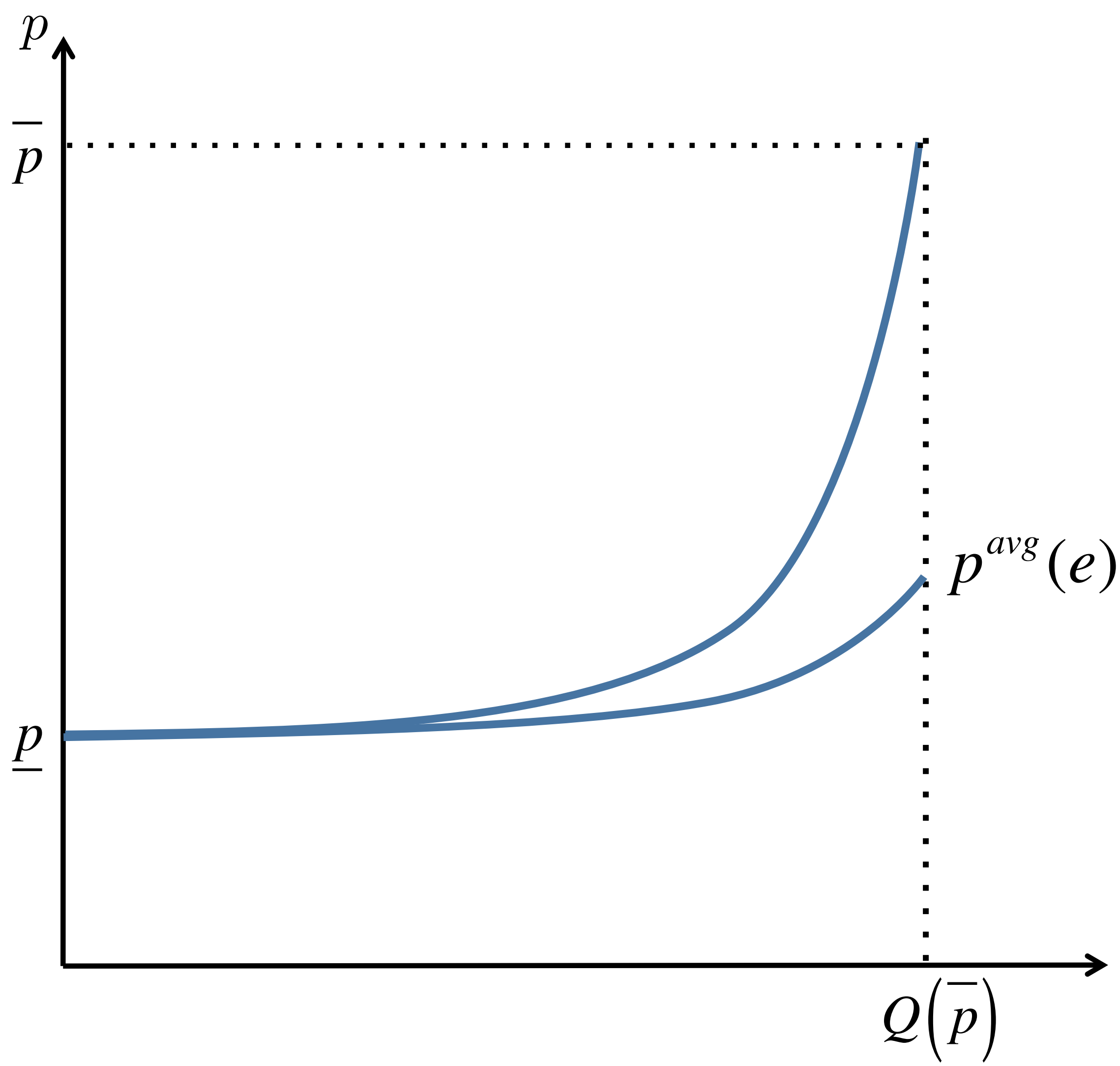


For a given city pair and year, prices vary significantly.

Stdev/mean = 0.43 log points.

90/10 = 0.93 log points.

Average Pricing Function

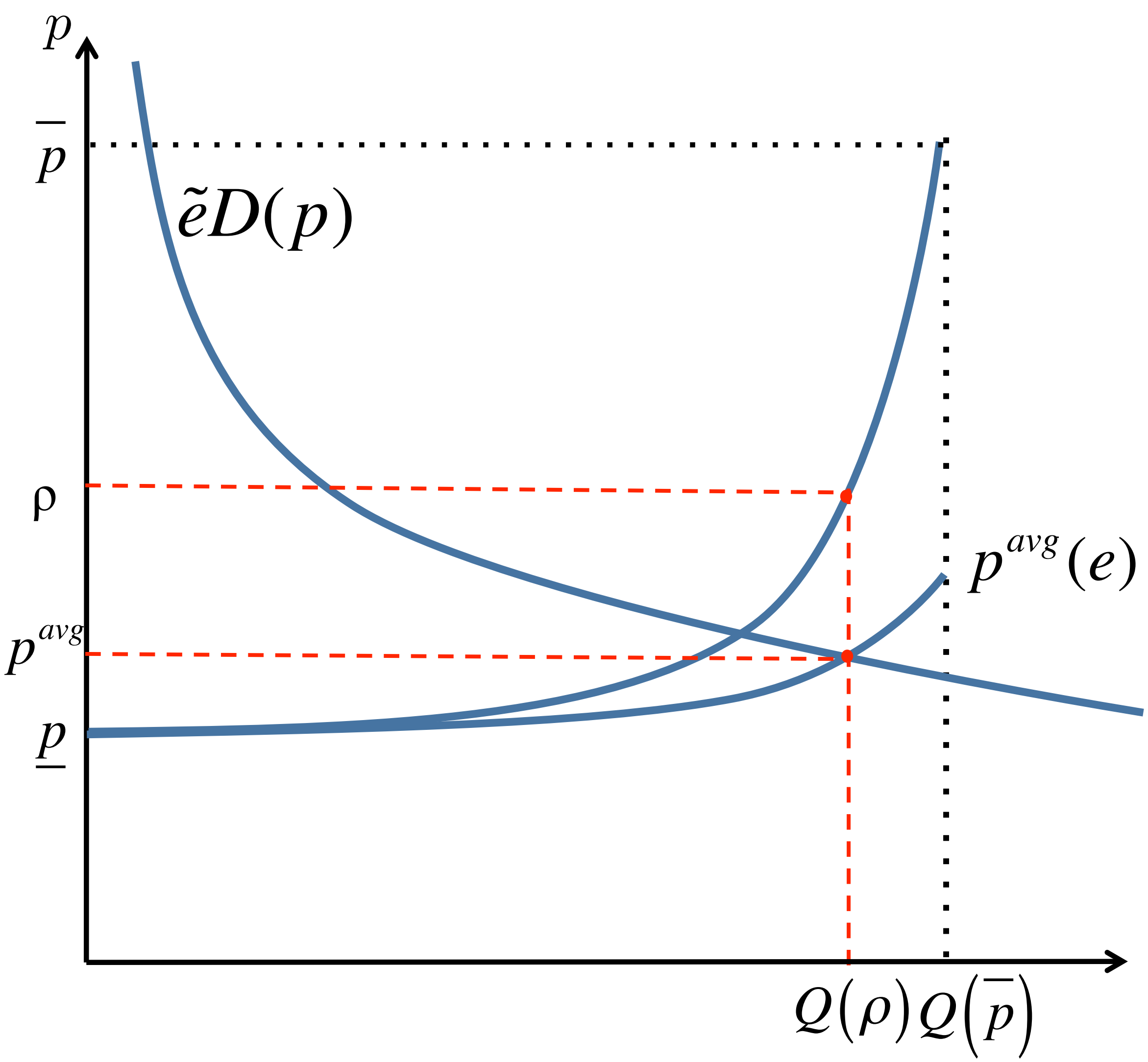


Average ticket price is defined as:

$$eD(p^{avg}) = Q(\rho)$$

→ price at which the quantity of tickets demanded is equal to the cumulative market quantity of tickets.

Particular Realization of Demand



Average ticket price:

$$\tilde{e}D(p^{avg}) = Q(\rho)$$

Max observed price:

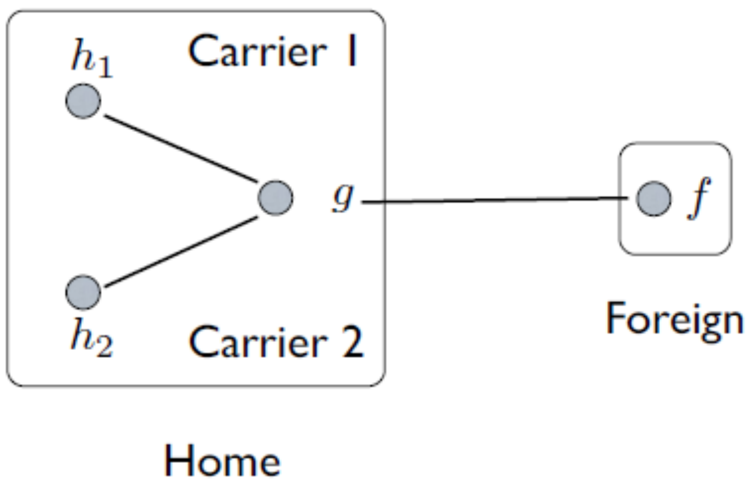
$$\rho(\tilde{e},q)$$

Under-utilized capacity:

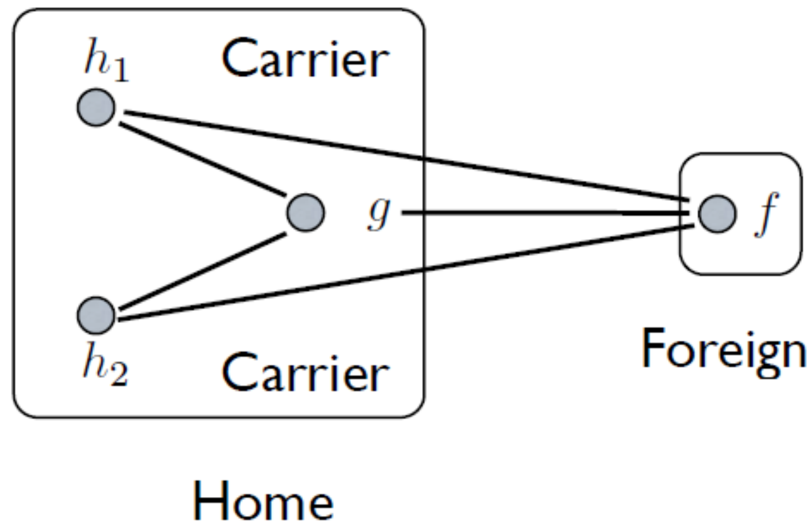
$$Q(\rho) < Q(\overline{p})$$

Route restrictions & Liberalization

Pre-OSA



Post-OSA



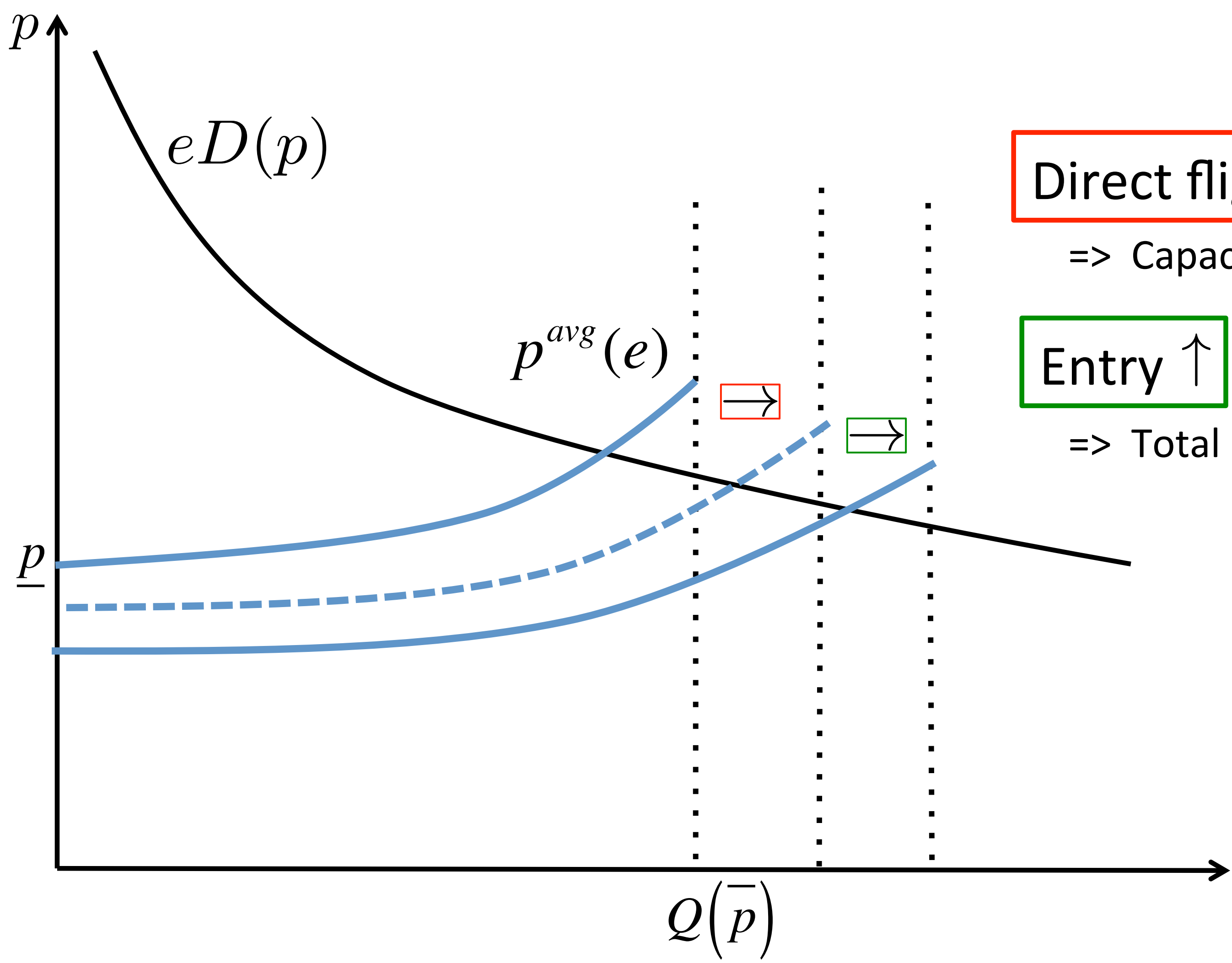
OSA effect on non-gateway hubs (h1, h2):

- Number of carriers goes up: foreign carriers can now serve Home hubs
- Increase consumer valuation by offering direct service
- Larger market capacity: lower costs of capacity from less indirect routing

OSA effects on gateways:

- Relax (possibly binding) capacity constraints for consumers at g

Liberalization Effects on Non-Gateway Hubs



Direct flights ↑

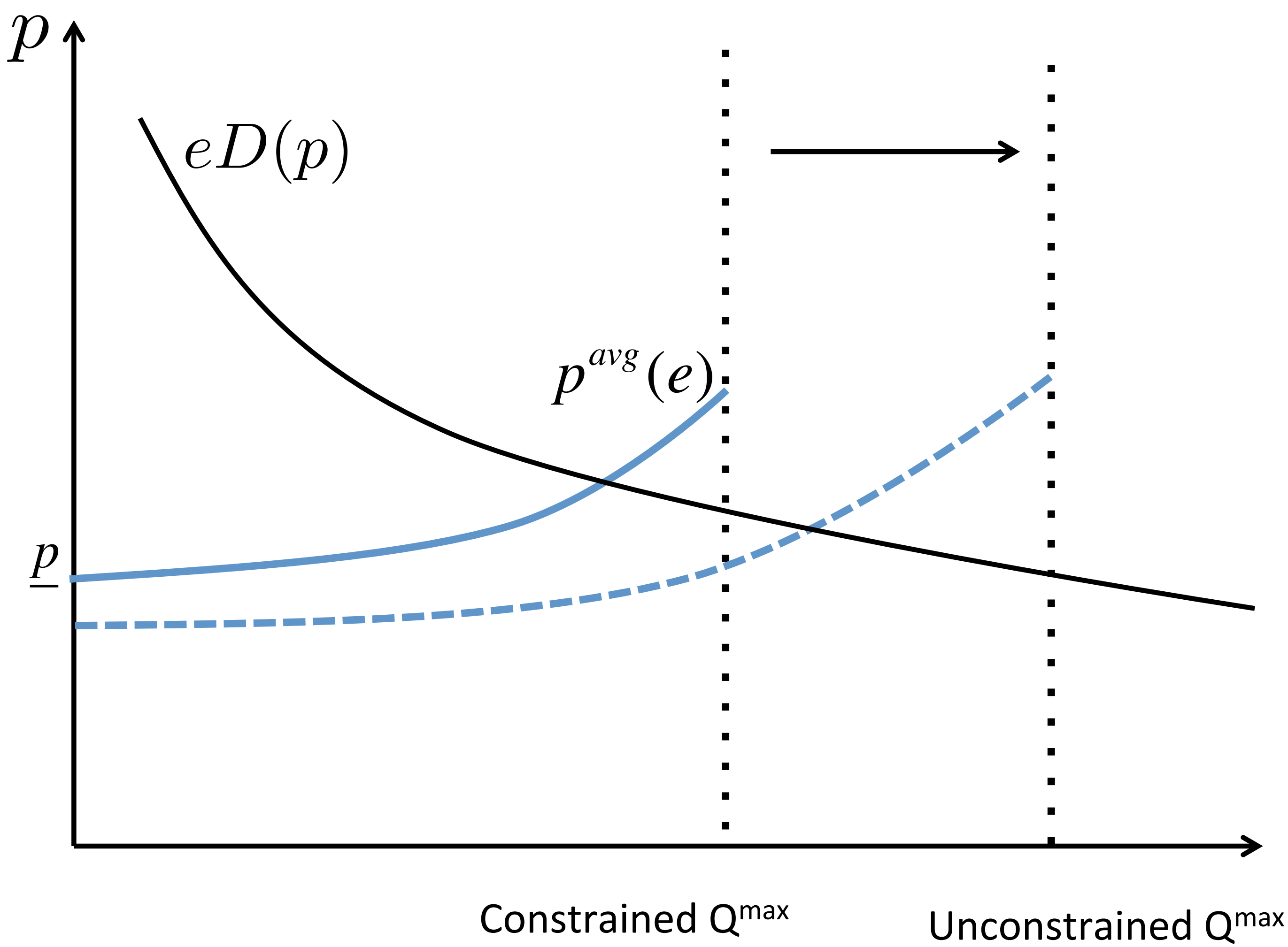
=> Capacity costs fall

Entry ↑

=> Total capacity increases

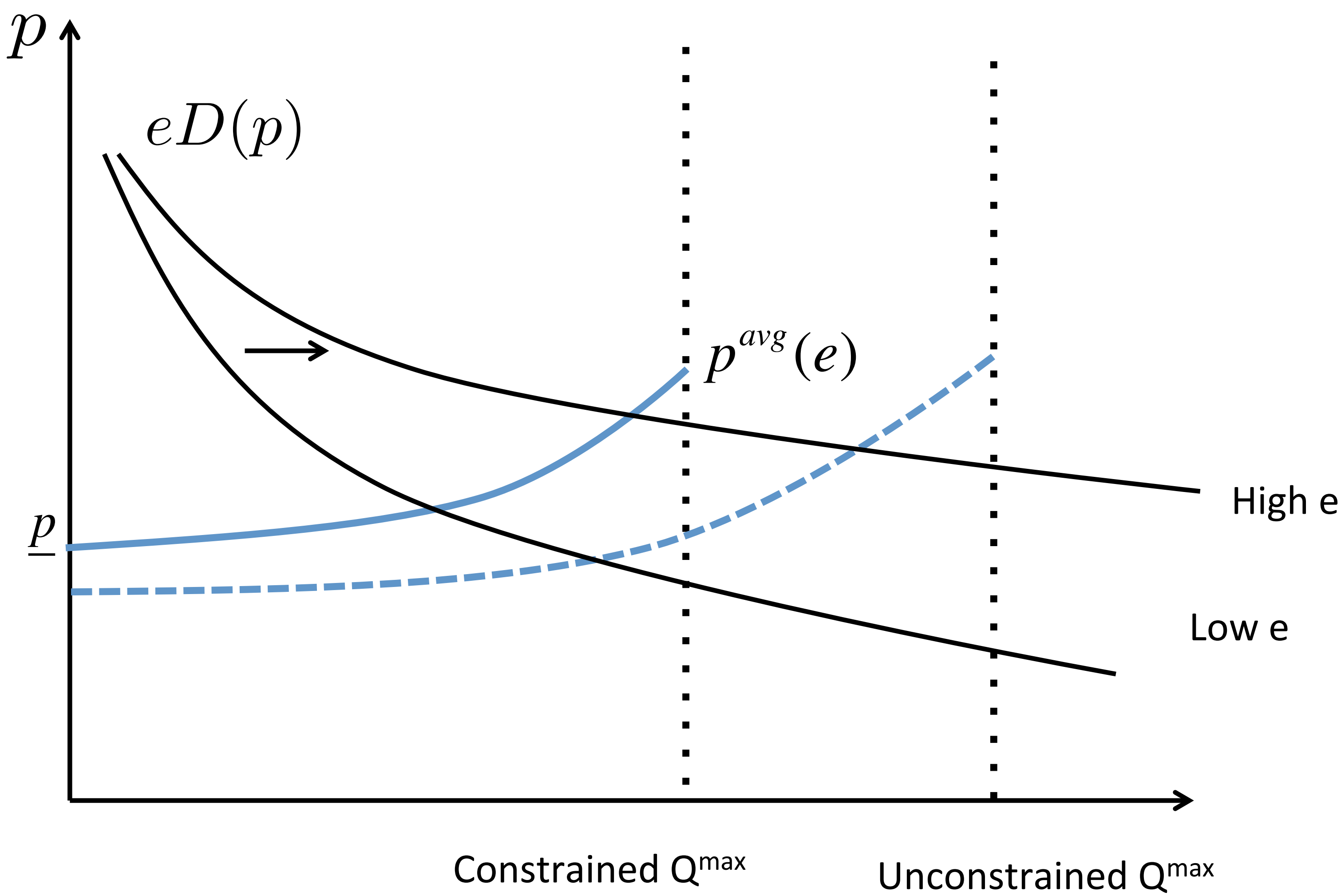
Allowing direct flights, foreign entry: raises capacity and Q; lowers average prices

Liberalization Effects on Gateways



Relax capacity constraints: increases capacity, lowers average price

P, Q effects depend on the ex-post demand state



Empirics

- Evidence for key channels of the model:
  - Passenger growth through provision of new routes
  - Carrier entry and capacity expansion in non-gateway hubs
- Consumer welfare:
  - estimate changes in prices, quantities, quality
  - combine these into changes in quality-adjusted prices after liberalization
- Diff. in diff. estimations

Data Sources

- **T 100 International Segment Data**
  - Traffic data by route (city-pair) x carrier
  - All non-stop flight segments crossing the US border
  - Number of passengers, departures, available seats

- **Origin-Destination Passenger Survey**
  - *Transaction* data: 10% sample of int'l airline tickets
  - air fare, service characteristics (fare class, distance flown, # segments, transit airports)
  - all segments of the itinerary and carrier(s)

Estimate the impact of OSA on U.S. International Air Traffic

- DID regression for U.S. traffic to country *d*:

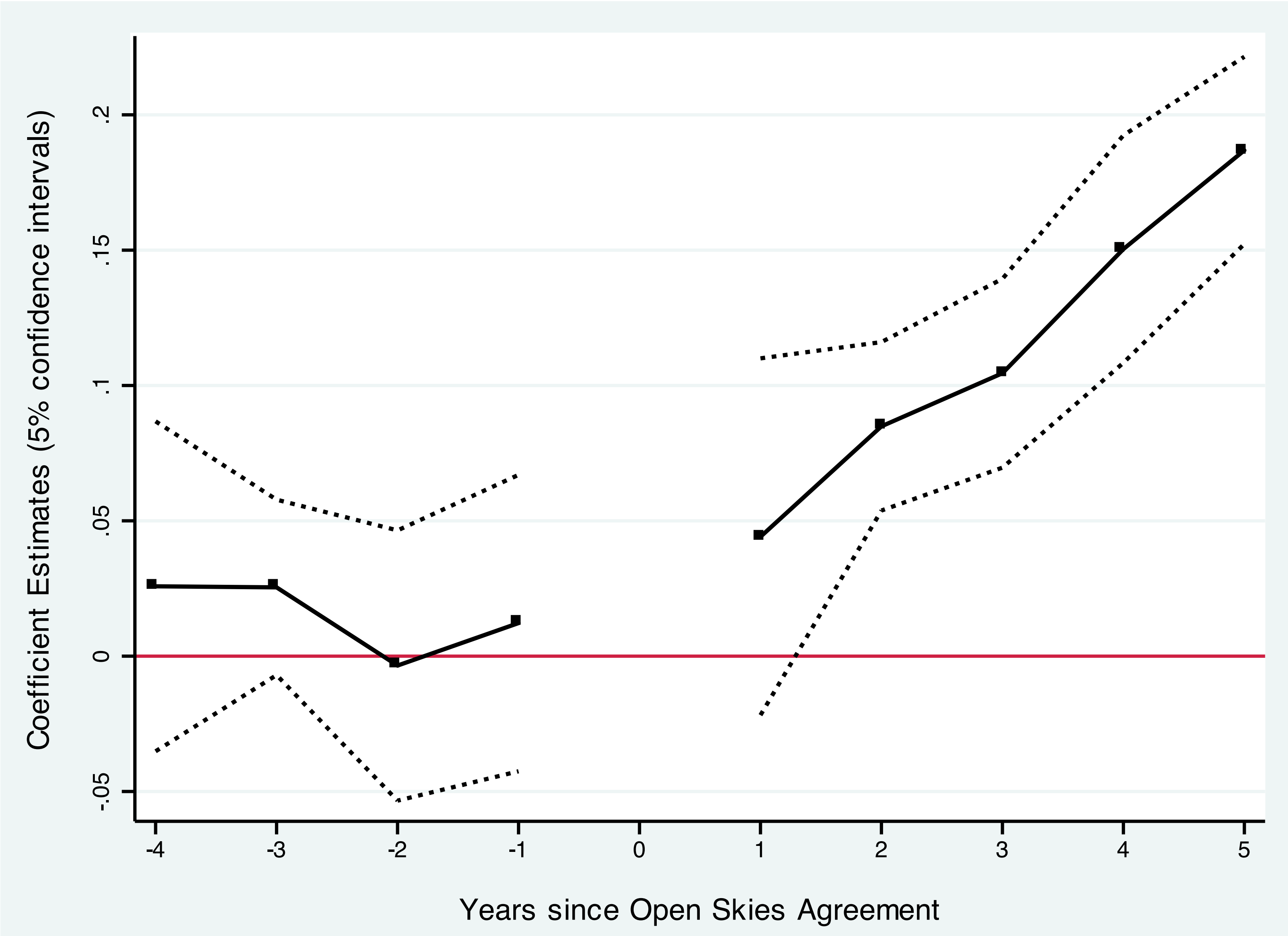
$$\ln Y_{dt} = \beta_1 OSA_{dt} + X\beta + \alpha_d + \alpha_t + \varepsilon_{dt}$$

- OSA = 1 for any year that the agreement is in effect

- Y is a measure of passenger traffic:
  - total number of passengers
  - number of distinct city-pair routes (extensive margin)
  - average passenger per route (intensive margin)

- X are destination-year controls:
  - income, population, 9/11 crisis, Visa Waiver Program,
  - region specific trends

Pre-Existing Trend: Total Traffic



OSA Effect on Total Traffic

	Total Air Traffic	Margins of Adjustment	
		Extensive	*Intensive*
Panel A			
OSA	0.204**	0.148***	0.056
	[0.082]	[0.041]	[0.085]
Observations	918	918	918
R-squared	0.235	0.235	0.133
Panel B			
Year OSA == 0	0.108	0.102*	0.006
	[0.103]	[0.059]	[0.104]
Year OSA == 1	0.206*	0.185***	0.021
	[0.122]	[0.058]	[0.128]
Year OSA == 2	0.356***	0.193***	0.163
	[0.130]	[0.060]	[0.129]
Year OSA == 3	0.199	0.128*	0.071
	[0.189]	[0.069]	[0.196]
Year OSA == 4	0.402***	0.164**	0.238
	[0.154]	[0.067]	[0.152]
Year OSA == 5+	0.331**	0.208***	0.124
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OSA Effect on Capacity

	Total Seats	Share Seats Pre-OSA Gateway
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Year OSA == 3	0.276*	-0.050*
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Year OSA == 4	0.422***	-0.078**
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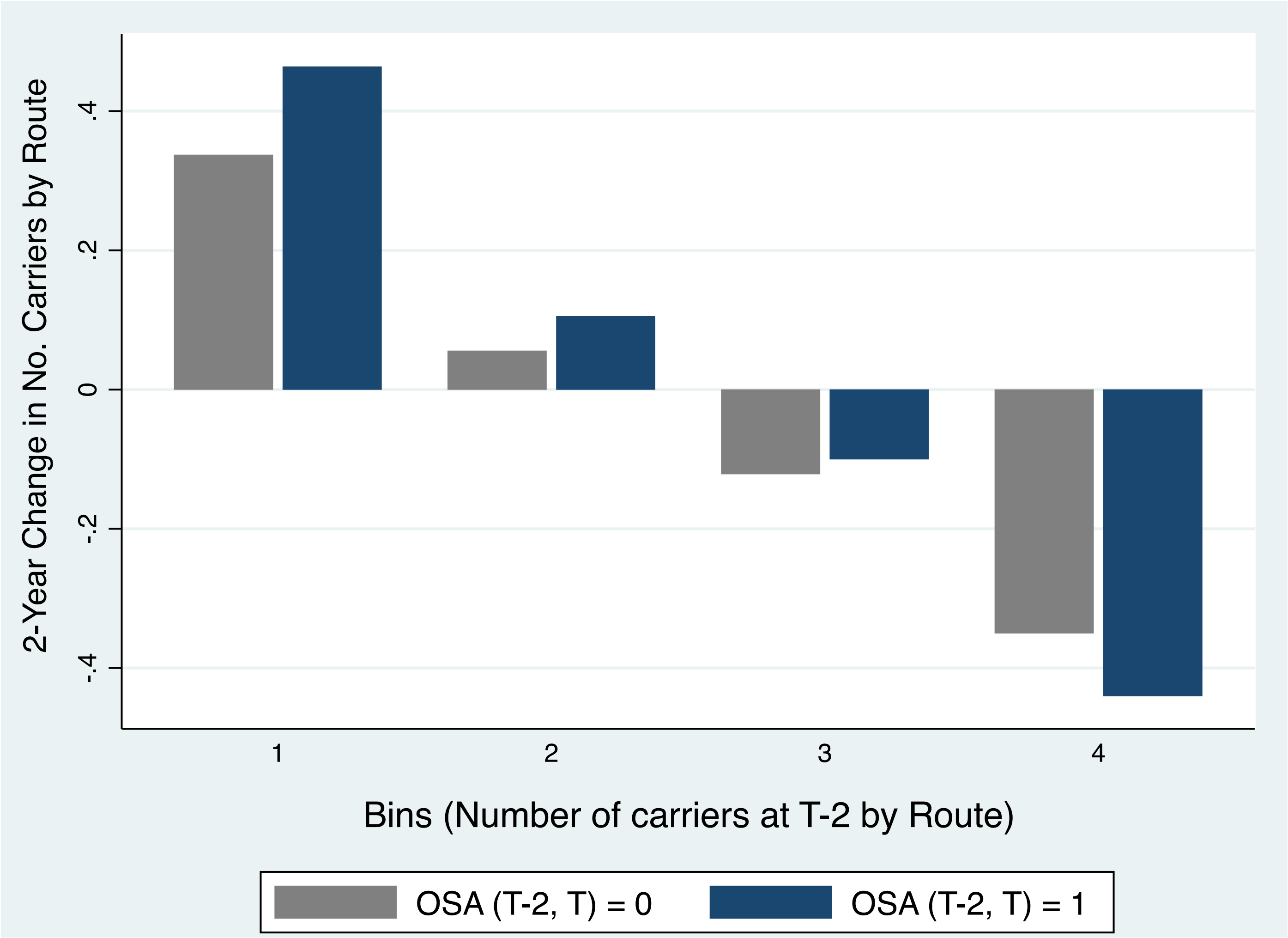
OSA Effect on Entry/Exit



OSA Effect on Route Prices, Quantities and Quality

- DID regressions at city-pair level (orig-dest):

$$lnP_{odt} = \alpha_{od} + \alpha_t + \beta_1 lnQ_{odt} + \beta_2 lnSeg_{odt} + \beta_3 OSA_{dt} + \beta_4 lnZ^P_{odt} + \beta_5 lnX_{odt} + \varepsilon_{odt}$$

$$lnQ_{odt} = \alpha_{od} + \alpha_t + \gamma_1 lnP_{odt} + \gamma_2 lnSeg_{odt} + \gamma_3 OSA_{dt} + \gamma_4 lnZ^Q_{odt} + \gamma_5 lnV_{odt} + \varepsilon_{odt}$$

$$lnSeg_{odt} = \alpha_{od} + \alpha_t + \delta_1 lnQ_{odt} + \delta_2 OSA_{dt} + \delta_3 \ln W_{odt} + \varepsilon_{odt}$$

- Estimate each equation by 2SLS to account for joint determination of P, Q, Segm.

Price Equation

$$lnP_{odt} = \alpha_{od} + \alpha_t + \beta_1 lnQ_{odt} + \beta_2 lnSeg_{odt} + \beta_3 OSA_{dt} + \\ + \beta_4 lnZ^P_{odt} + \beta_5 lnX_{odt} + \varepsilon_{odt}$$

- Key variables:
  - Passenger quantities (IV: population at origin, destination)
  - Number of segments flown (exogenous w.r.t. prices)
  - Measure of liberalization: OSA

- Controls
  - per-capita incomes at origin and destination
  - cost shocks:
    - aircraft insurance costs * world region dummies
    - jet fuel prices * distance (nonstop and excess distance, squared)
  - fixed effects for origin-destination, time
  - regional trends

Price Estimation

	Dependent variable: Ln Airfare		
	OSA Signatory countries		
	(4)	*(5)*	*(6)*
	Pooled	*By Type Gateways*	*By Type Gateways*
OSA	-0.028**	-0.025*	-0.029**
	[0.013]	[0.014]	[0.013]
OSA * Pre-OSA Gateway		0.010	0.014
		[0.010]	[0.009]
OSA * Large Hub		-0.021**	
		[0.010]	
OSA * Large Hub (T100)			-0.034***
			[0.012]
Ln Passengers	-0.107***	-0.103***	-0.106***
	[0.030]	[0.032]	[0.031]
Ln Flight Segments	-0.030	-0.025	-0.030
	[0.036]	[0.037]	[0.036]
First Stage Regression:			
Excluded instruments:			
Ln MSA Population	1.028***	0.985***	1.015***
	[0.049]	[0.049]	[0.048]
Ln Country Population	1.881***	1.852***	1.904***
	[0.309]	[0.310]	[0.308]
Partial R-squared	0.012	0.011	0.011
F-Test of IVs	240.300	225.600	248.700

Price Estimation

	Dependent variable: Ln Airfare		
	OSA Signatory countries		
	(4)	*(5)*	*(6)*
	Pooled	*By Type Gateways*	*By Type Gateways*
OSA	-0.028**	-0.025*	-0.029**
	[0.013]	[0.014]	[0.013]
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	[0.030]	[0.032]	[0.031]
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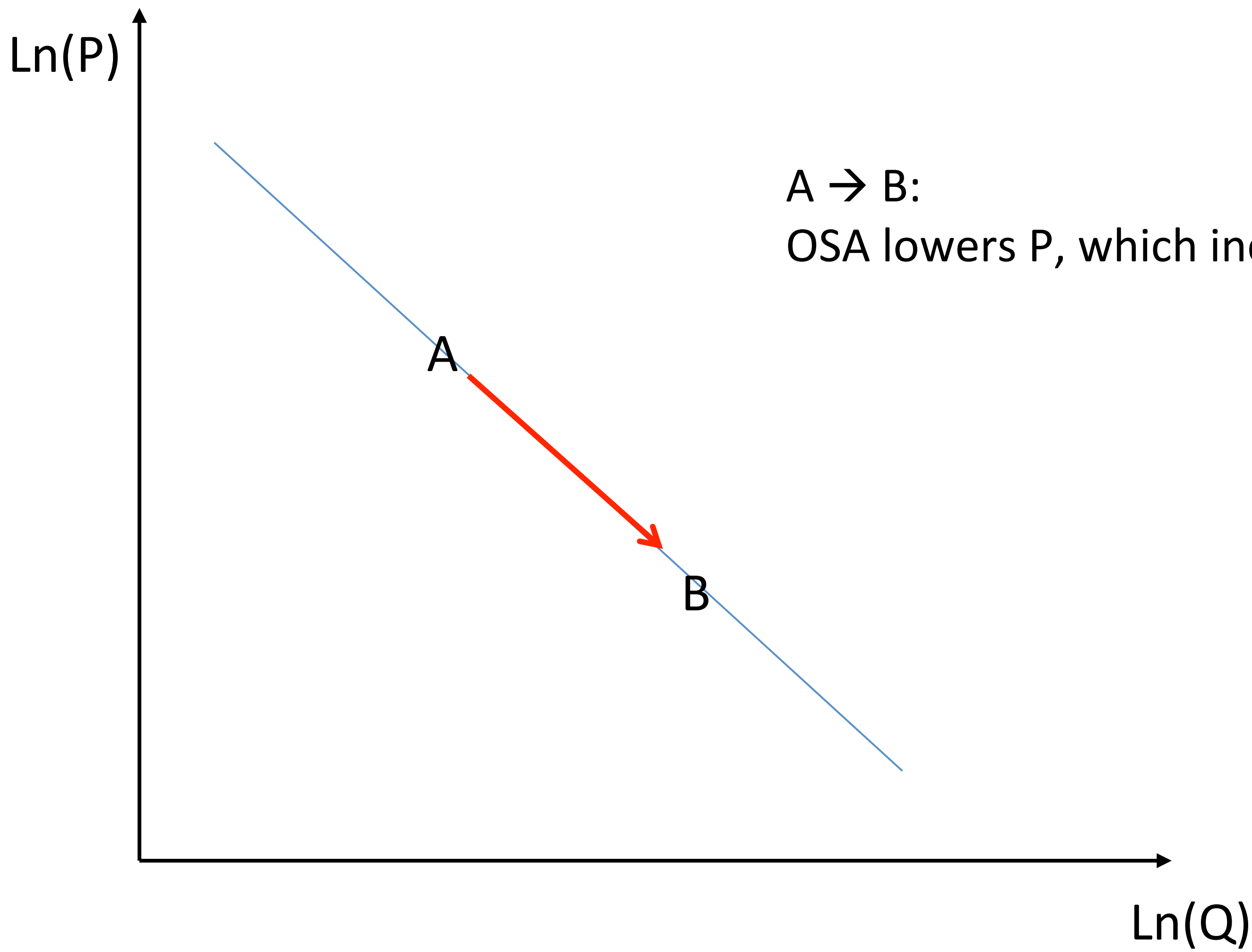
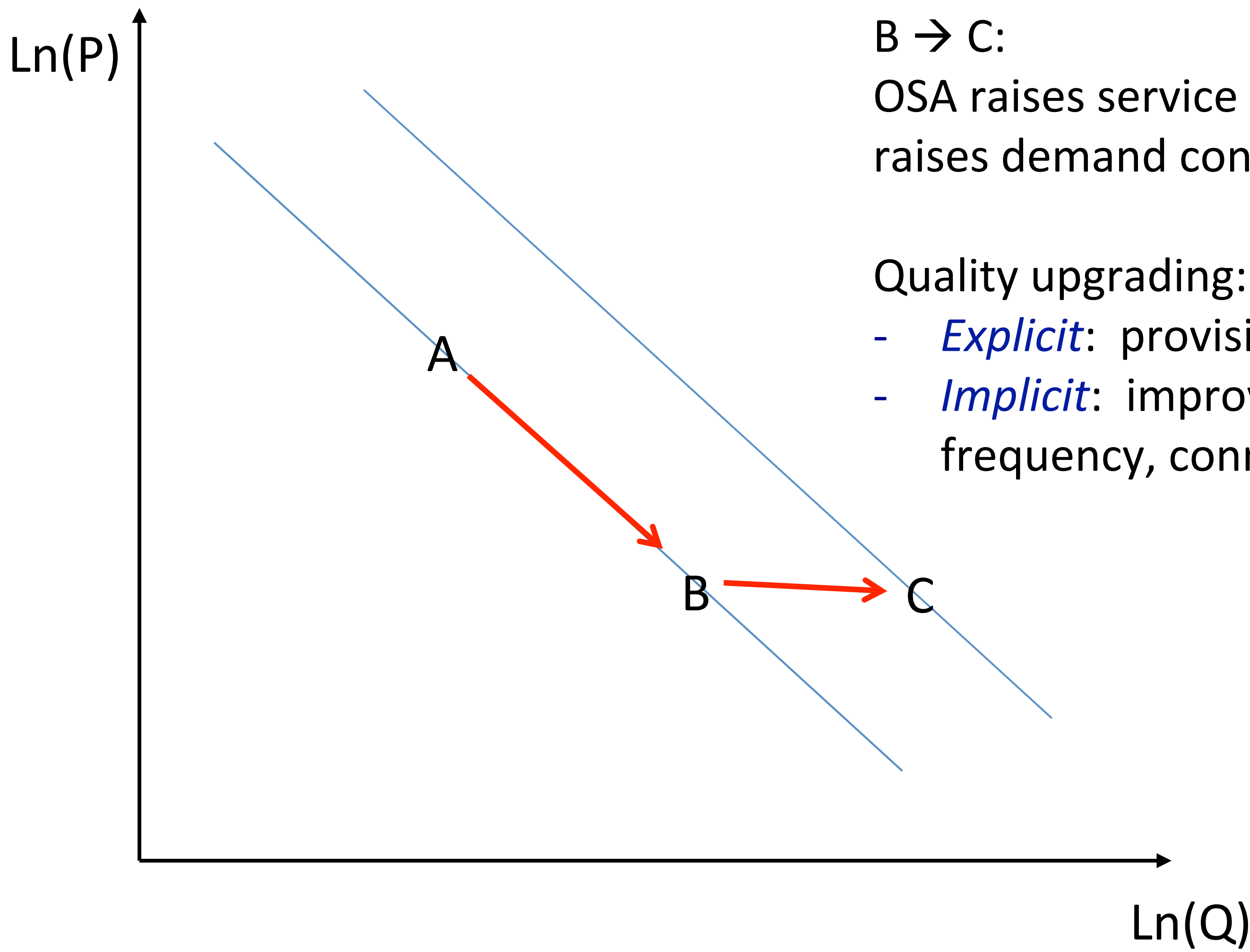
OSA effects on quantities



A → B:
OSA lowers P, which increases Q demand

OSA effects on quantities



B → C:
OSA raises service quality, which raises demand conditional on prices

Quality upgrading:

- *Explicit*: provision of direct flights
- *Implicit*: improvement in flight frequency, connectivity, aircraft

Quantity equation

$$lnQ_{odt} = \alpha_{od} + \alpha_t + \gamma_1 lnP_{odt} + \gamma_2 lnSeg_{odt} + \gamma_3 OSA_{dt} +$$

$$+ \gamma_4 lnZ^{Q}_{odt} + \gamma_5 lnV_{odt} + \varepsilon_{odt}$$

- Key variables:
  - Airfare & number of segments (explicit quality)
    - IV: jet fuel prices * distance (nonstop & excess distance, squared)
  - Measures of liberalization: OSA

- Controls:
  - Population & incomes at origin and destination; bilateral exports
  - fixed effects for origin-destination, time
  - region trends

- OSA variable measures *implicit* quality:
  - increase in passengers conditional on prices and on flight segments

Quantity Estimation

	Dependent variable: Ln Passengers		
	OSA Signatory countries		
	(4) Pooled	(5) By Type Gateways	(6) By Type Gateways
OSA	-0.012	-0.036	-0.018
	[0.039]	[0.040]	[0.039]
OSA * Pre-OSA Gateway		0.100**	0.083*
		[0.045]	[0.044]
OSA * Large Hub		0.091**	
		[0.037]	
OSA * Large Hub (T100)			0.023
			[0.055]
Ln Airfare	-1.892***	-1.839***	-1.967***
	[0.474]	[0.484]	[0.479]
Ln Flight Segments	-1.003	-1.067*	-1.019
	[0.625]	[0.641]	[0.635]
First Stage Regressions:			
Dependent variable:	*Ln Airfare*		
Partial R-squared	0.006	0.006	0.006
F-Test of IVs	12.760	12.520	12.780
Dependent variable:	*Ln Flight Segments*		
Partial R-squared	0.005	0.005	0.005
F-Test of IVs	37.110	36.880	36.850

Quantity Estimation

	Dependent variable: Ln Passengers		
	OSA Signatory countries		
	(4) Pooled	(5) By Type Gateways	(6) By Type Gateways
OSA	-0.012	-0.036	-0.018
	[0.039]	[0.040]	[0.039]
OSA * Pre-OSA Gateway		0.100**	0.083*
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OSA * Large Hub (T100)			0.023
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Ln Airfare	-1.892***	-1.839***	-1.967***
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Dependent variable:	*Ln Airfare*		
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	OSA Signatory countries		
	(4)	*(5)*	*(6)*
	Pooled	*By Type Gateways*	*By Type Gateways*
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Partial R-squared	0.005	0.005	0.005
F-Test of IVs	37.110	36.880	36.850

Number of Flight Segments Per Route

$$lnSeg_{odt} = \alpha_{od} + \alpha_t + \delta_1 lnQ_{odt} + \delta_2 OSA_{dt} + \delta_3 \ln W_{odt} + \varepsilon_{odt}$$

- Key variables:
  - Passenger quantities (IV: population at origin and destination)
  - Measures of liberalization: OSA
- Controls
  - per-capita incomes at origin & destination
  - fixed effects for origin-destination, time
  - Regional trends

No. Segment Estimation

	Dependent variable: Ln Flight Segments		
	OSA Signatory countries		
	(4) Pooled	(5) By Type Gateways	(6) By Type Gateways
OSA	-0.015**	-0.027***	-0.017***
	[0.006]	[0.007]	[0.006]
OSA * Pre-OSA Gateway		0.045***	0.036***
		[0.007]	[0.007]
OSA * Large Hub		0.046***	
		[0.005]	
OSA * Large Hub (T100)			-0.021*
			[0.011]
Ln Passengers	-0.099***	-0.105***	-0.094***
	[0.011]	[0.011]	[0.011]
Ln MSA Income	0.089***	0.081***	0.084***
	[0.012]	[0.012]	[0.012]
Ln PcGDP	0.014	0.015	0.013
	[0.027]	[0.028]	[0.027]
First Stage Regression:			
Dependent variable:	*Ln Passengers*		
Partial R-squared	0.011	0.010	0.011
F-Test of IVs	240.000	235.700	245.300

No. Segment Estimation

	Dependent variable: Ln Flight Segments		
	OSA Signatory countries		
	(4) Pooled	(5) By Type Gateways	(6) By Type Gateways
OSA	-0.015**	-0.027***	-0.017***
	[0.006]	[0.007]	[0.006]
OSA * Pre-OSA Gateway		0.045***	0.036***
		[0.007]	[0.007]
OSA * Large Hub		0.046***	
		[0.005]	
OSA * Large Hub (T100)			-0.021*
			[0.011]
Ln Passengers	-0.099***	-0.105***	-0.094***
	[0.011]	[0.011]	[0.011]
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	[0.012]	[0.012]	[0.012]
Ln PcGDP	0.014	0.015	0.013
	[0.027]	[0.028]	[0.027]
First Stage Regression:			
Dependent variable:		*Ln Passengers*	
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F-Test of IVs	240.000	235.700	245.300

No. Segment Estimation

	Dependent variable: Ln Flight Segments		
	OSA Signatory countries		
	(4)	*(5)*	*(6)*
	Pooled	*By Type Gateways*	*By Type Gateways*
OSA	-0.015**	-0.027***	-0.017***
	[0.006]	[0.007]	[0.006]
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Combining the OSA Effects into a Consumer Welfare Measure

- Changes in *P, Q, Segments* depend on OSA *and* on each other

- Need to calculate *total derivative* of P and Q w.r.t. OSA

Consumer Welfare

	Consumer Welfare Effects of OSA				
	Pooled	*Pre-OSA Gateway*	*Large Hub (All)*	*Large Hub (T100)*	*Spoke Cities*
PANEL B – OSA SIGNATORY COUNTRIES					
1. *Cumulative Demand Effects:*	*0.078*	*0.104*	*0.171*	*0.227*	*0.053*
Of which:					
2. Direct Effect:	-0.012	0.064	0.055	0.005	-0.036
3. Indirect Effect via Prices:	0.068	0.048	0.117	0.162	0.055
4. Indirect Effect via Connectivity:	0.023	-0.008	-0.001	0.060	0.035
5. *Price Equiv. of Demand Effects:*	*-0.006*	*-0.031*	*-0.029*	*-0.034*	*0.001*
6. *Cumulative Cost Effects:*	*-0.036*	*-0.026*	*-0.064*	*-0.085*	*-0.030*
Of which:					
7. Direct Effect:	-0.028	-0.015	-0.046	-0.063	-0.025
8. Indirect Effect via Quantity:	-0.008	-0.011	-0.018	-0.024	-0.005
9. Indirect Effect via Connectivity:	0.001	0.000	0.000	0.002	0.001
11. ***Total price effect of OSA:***	***-0.041***	***-0.057***	***-0.093***	***-0.120***	***-0.029***

Consumer Welfare

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Consumer Welfare

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Consumer Welfare

	Consumer Welfare Effects of OSA				
	Pooled	*Pre-OSA Gateway*	*Large Hub (All)*	*Large Hub (T100)*	*Spoke Cities*
PANEL B – OSA SIGNATORY COUNTRIES					
1. *Cumulative Demand Effects:*	*0.078*	*0.104*	*0.171*	*0.227*	*0.053*
Of which:					
2. Direct Effect:	-0.012	0.064	0.055	0.005	-0.036
3. Indirect Effect via Prices:	0.068	0.048	0.117	0.162	0.055
4. Indirect Effect via Connectivity:	0.023	-0.008	-0.001	0.060	0.035
5. *Price Equiv. of Demand Effects:*	*-0.006*	*-0.031*	*-0.029*	*-0.034*	*0.001*
6. *Cumulative Cost Effects:*	*-0.036*	*-0.026*	*-0.064*	*-0.085*	*-0.030*
Of which:					
7. Direct Effect:	-0.028	-0.015	-0.046	-0.063	-0.025
8. Indirect Effect via Quantity:	-0.008	-0.011	-0.018	-0.024	-0.005
9. Indirect Effect via Connectivity:	0.001	0.000	0.000	0.002	0.001
11. ***Total price effect of OSA:***	***-0.041***	***-0.057***	***-0.093***	***-0.120***	***-0.029***

Summary and Conclusions

- Regulation of aviation markets constrain capacity, routes, entry.
- We study the resulting market distortions and the channels through which the market responds after liberalization.
- We build a model of capacity constrained price competition with uncertain demand and consumer heterogeneity
  - comparative statics that map tightly into empirical objects
- We use a diff-in-diff estimation strategy to find that OSAs lead to:
  - new route offerings
  - capacity allocation towards constrained routes
  - lower prices, higher quantities, more direct services (higher quality)

  Benefits are largest for most constrained cities.

Summary and Conclusions

- Policy implications of aviation liberalization go beyond the immediate industry benefits:
  - travel affects the rate of innovation and economic growth
  - travel affects trade and FDI
  - possible channel for the observed complementarity between manufacturing and services trade

Thank You!