LCC Competition in the U.S. and EU: Implications for the Effect of Entry by Foreign Carriers on Fares in U.S. Domestic Markets

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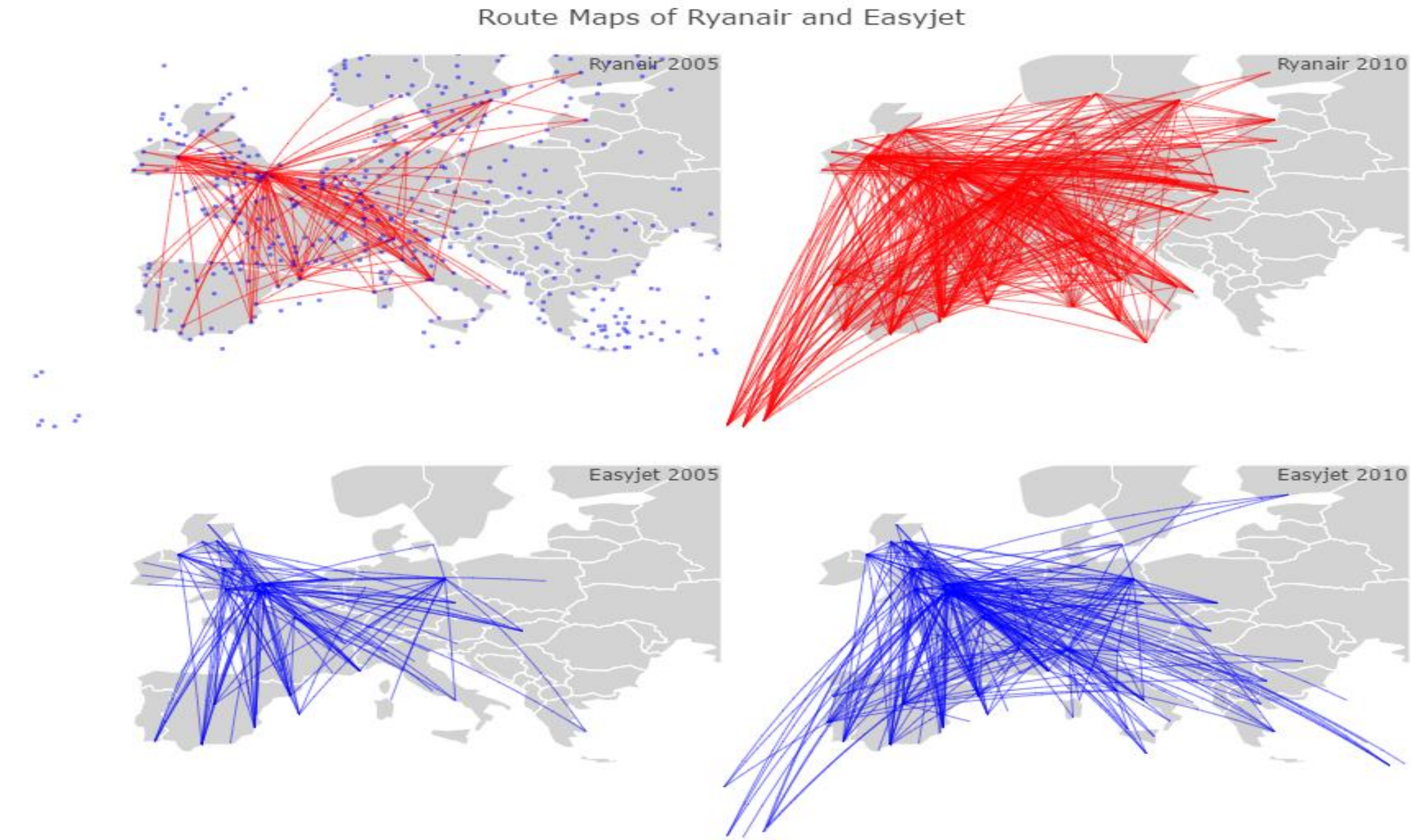
Motivation

- Concerns that airline mergers during the past decade could lead to higher fares and less route coverage.
  - US Airways-America West (2005)
  - Delta-Northwest (2008)
  - United-Continental (2010)
  - Southwest-AirTran (2011)
  - American-US Airways (2014)
  - Alaska-Virgin America (2016)
- Response: strengthen antitrust enforcement
- Our thoughts: more deregulation and open-skies, including cabotage—entry by foreign carriers

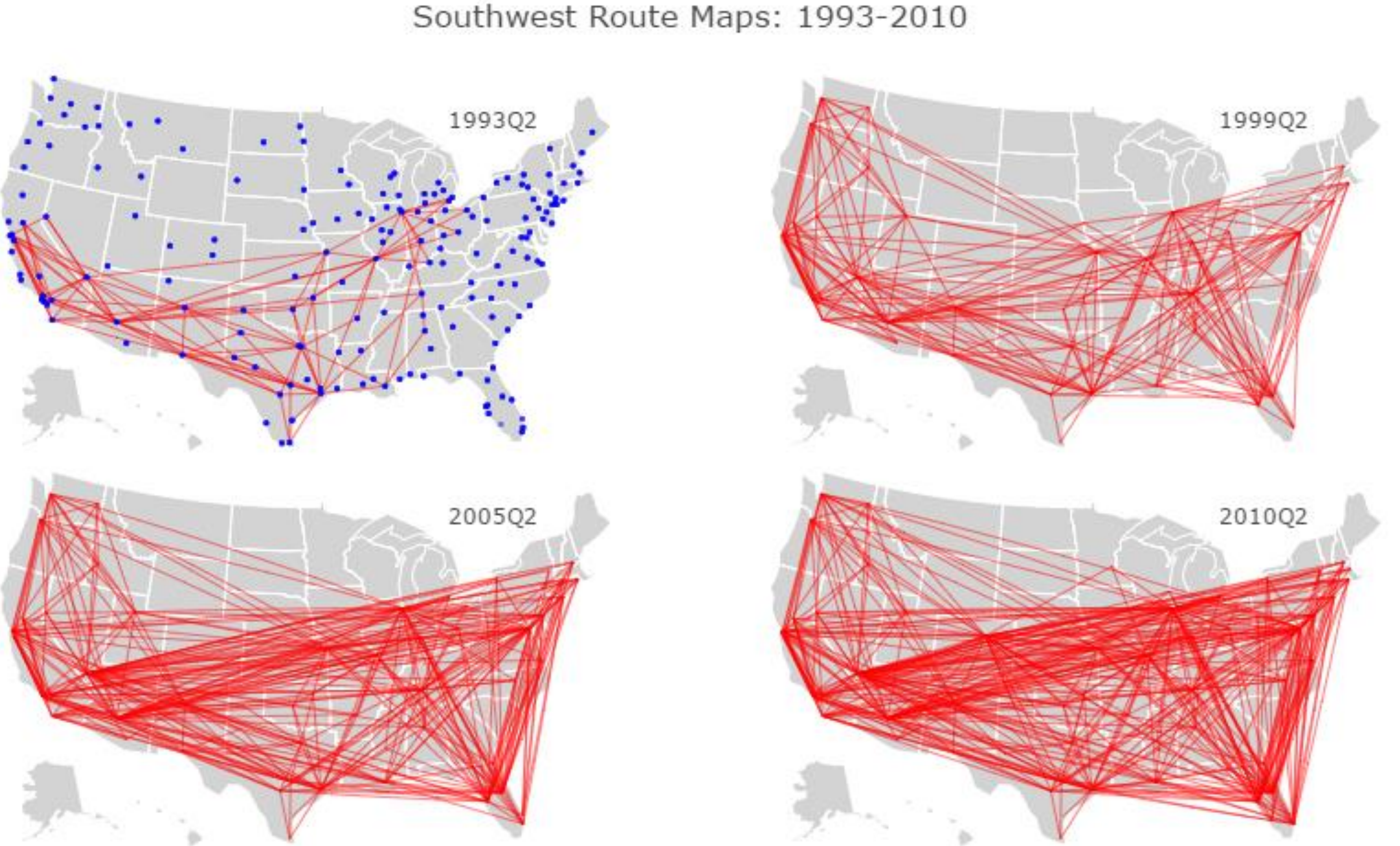
Why could such policies help?

- Open Skies have reduced fares and increased service.
    - 20%-30% price drop and increase in flight frequency from open-skies agreements that have been negotiated to date.
- A key ingredient to deregulation's success in the U.S. and EU: the expansion of LCCs.
- Suppose EU LCCs compete in the US?

Expansion of Ryanair and Easyjet



Expansion of Southwest



What are the welfare effects of LCC expansions abroad?

- Answer to the question is important to get a preliminary understanding of allowing cabotage to further deregulate aviation markets.

In this study we take the following steps to address this question:

- We review the patterns of LCC's expansions after deregulation in the EU and US. EU data are from IATA (European Union and UK); monthly data on airline operations and fares from 2005-2013. U.S. data are from DB1B and T100; quarterly data on airline operations and fares from 1994 – 2012.
- Routes are non-directional airport pairs; 3588 routes in EU and 13590 routes in U.S.
- We estimate the effect of LCC entry on the average fare of a route.
- We find that LCC entry caused about a 20% price drop in EU markets and a 30% price drop in U.S. markets.
- We compare our results with ones from traditional identification approach.
- Could EU LCCs significantly reduce fares in US markets?
- We outline initial effects and discuss likely longer run effects of allowing cabotage.

Challenges to identifying the effects of LCCs’ expansion

- LCC entry is not exogenous. We cannot simply compare fares in markets entered by LCCs with fares in markets that are not entered by an LCC.

- We cannot also compare pre- and post-entry periods in markets entered by an LCC because many other factors may also affect fares during the periods.

- The usual approach of implementing difference-in-differences (DID) may be inappropriate because LCC entry occurred over 10 years.
  - Entry occurred during different years with different market environments.
  - Unobserved factors affecting market outcomes are unlikely to be constant over a long time period.

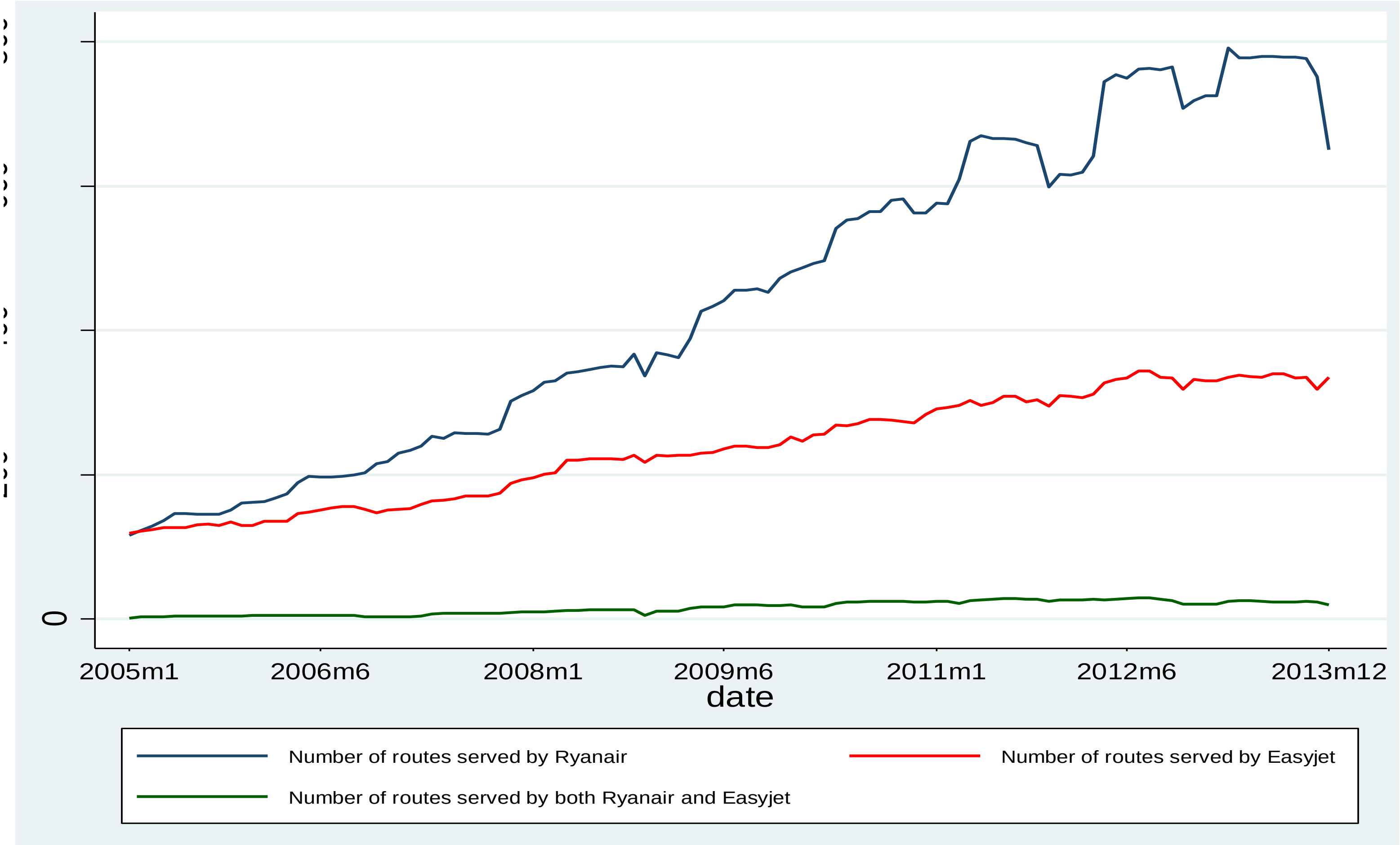
Our Approach

- We first explore the patterns of LCCs’ expansions in both EU and US markets.

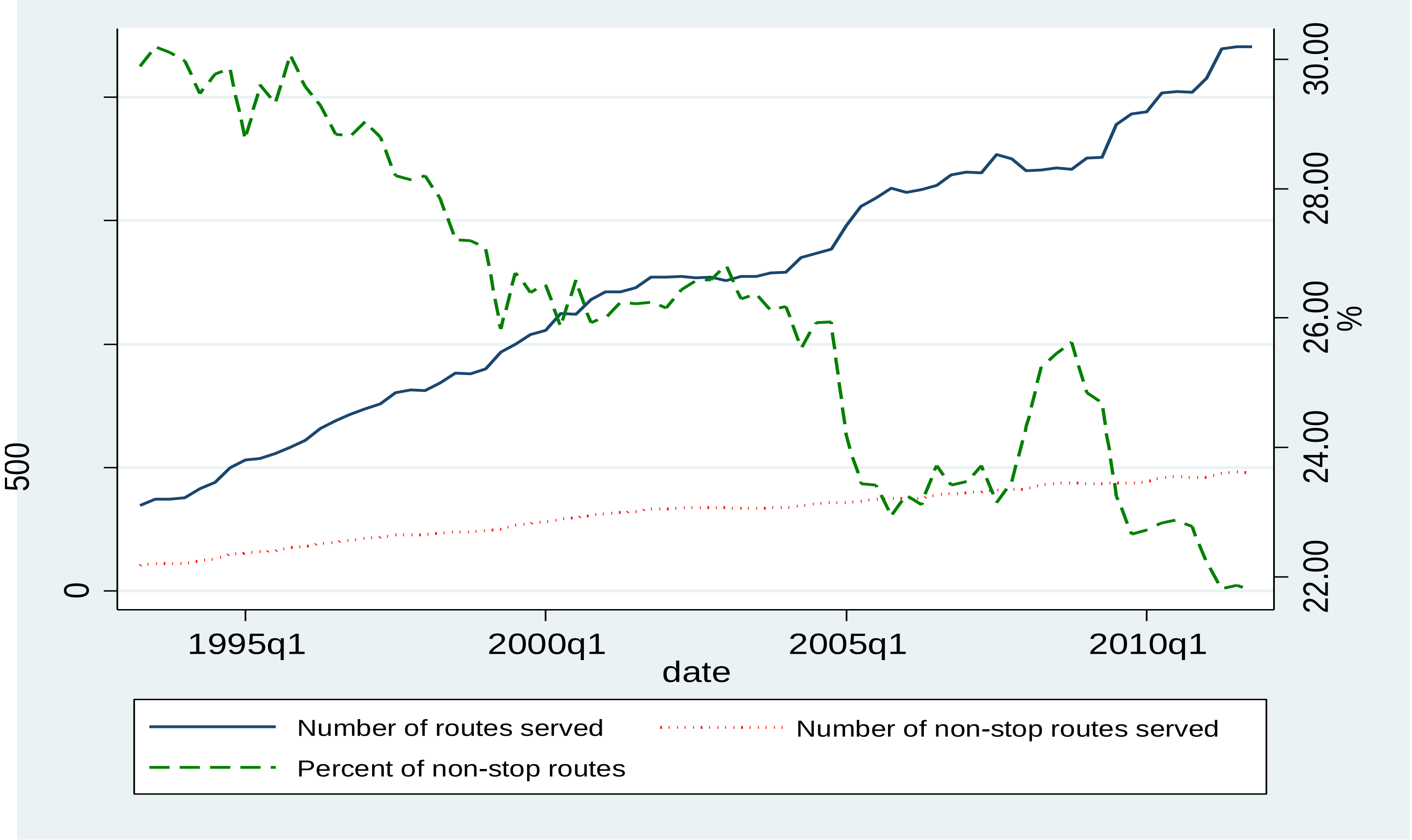
- Motivated by the patterns we find, we design a new quasi-experimental approach to estimate the effect of LCCs’ expansions on fares.
  - matching-based difference-in-differences identification
  - matching exploits the fact that LCCs entered routes sequentially.

- We compare the findings from our approach with those from a traditional identification approach.

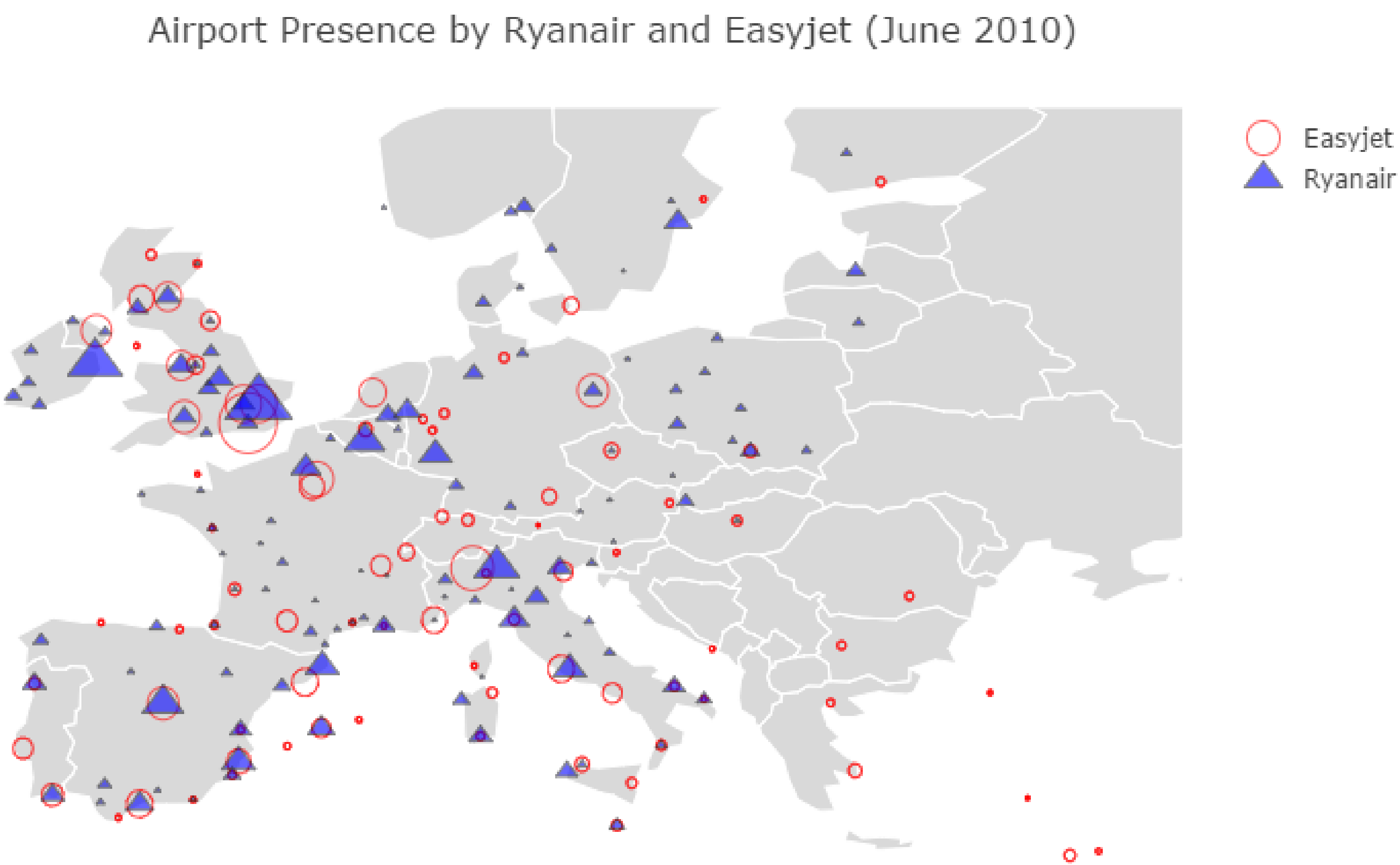
Visualizing Patterns of the expansions by Ryanair and Easyjet in EU



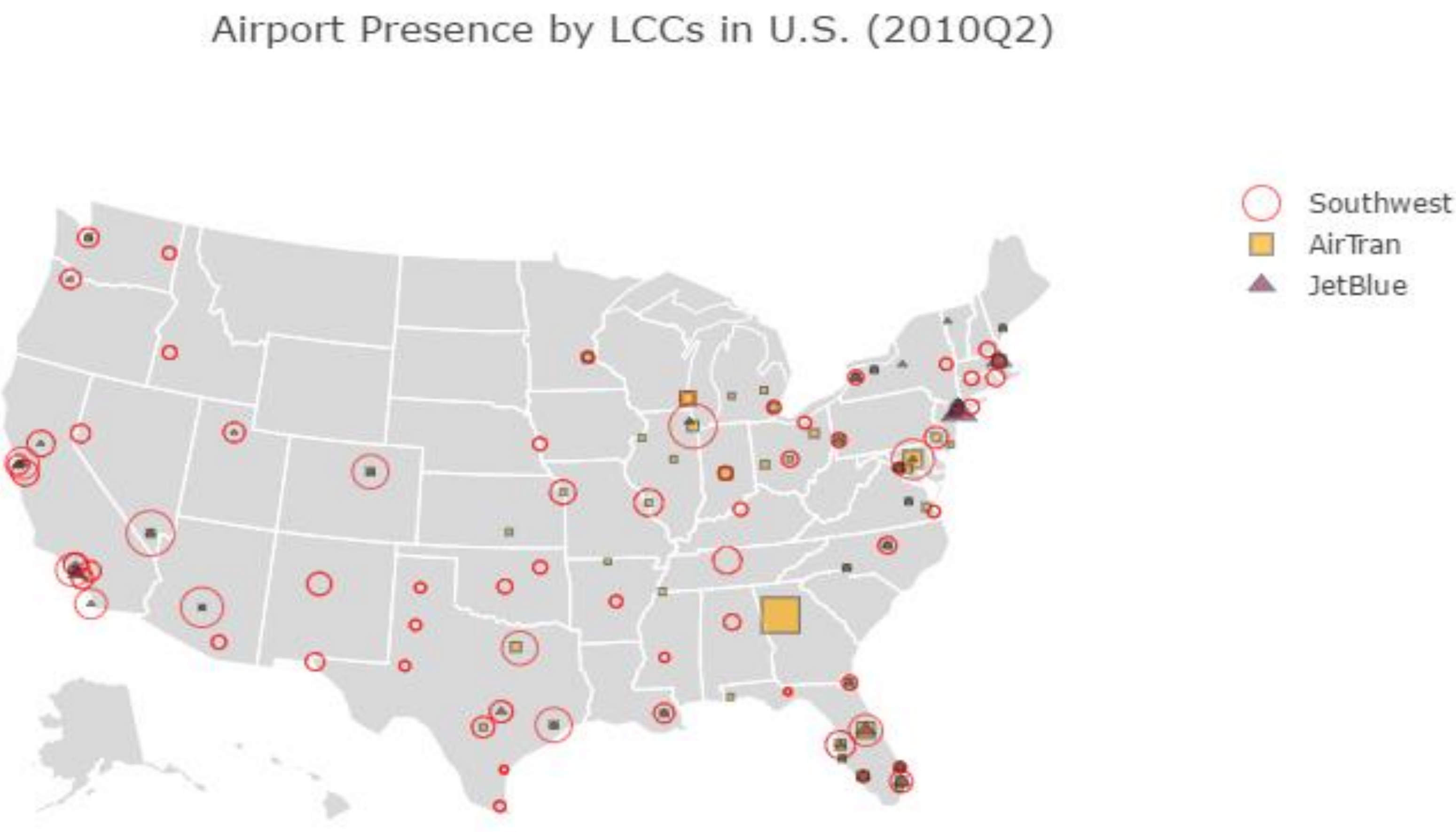
Visualizing patterns of Southwest's expansion in U.S.



Visualizing airport presence of Ryanair and Easyjet after rapid expansion



Visualizing airport presence of Southwest after rapid expansion



Exploring entry patterns based on Probit estimates

We run a Probit regression to estimate the conditional probability $\Pr(d_{ijt} = 1 | X_{jt}, Z_{it}, Z_{i't})$, where

d_{ijt} is a binary indicator which takes 1 if LCC i entered route j the first-time in month t;

X_{jt} is a vector of market characteristics such as distance and market size;

Z_{it} is the vector of variables measuring the LCC's network; and

$Z_{i't}$ is a vector of variables measuring the competitors' networks at the time of the entry.

Findings from probit estimations

Common pattern in EU and U.S.

- Actual entry is positively associated with the LCC's airport presence.

Special patterns in EU

- Actual entry is positively associated with the number of routes that are connected to the airport.
- Actual entry is negatively associated with the LCC's adjacent route presence.

Special patterns in U.S.

- Actual entry is positively associated with the LCC's adjacent route presence.

Classification of entries motivated by entry patterns

- **Actual route entry (exit) made by an LCC** is defined as the case when the LCC served (did not serve) a route in a month but did not serve (served) the route in the previous month.

- **Adjacent routes** in our analysis are parallel routes connecting airports either from two cities or from two catchment areas. Two airports are considered to locate at the same catchment area if the distance between them is no more than 100km. **Adjacent entry** made by a LCC is route entry on adjacent routes.

- **Potential route entry of a LCC** in our analysis is defined as the case when a LCC started to operate in either one of (Type 1) or both of the end-point airports of a route (Type 2) but not the route itself in a month.

Decomposing the overall effect of LCC entry

Decomposing the overall effect of LCC entry on price:

- the effect of **actual** entry conditional on potential entry

- the effect of **potential** entry

  Type 1: present at only one airport

  Type 2: present at two airports

- the effect of **adjacent** entry

Adjacent routes connect airports either from two cities or from two catchment areas (within 100km).

Identification strategy: difference-in-differences (DID)

DID approach is believed to be appropriate because:

- We have routes entered by an LCC (treatment group) and routes not entered by an LCC (control group) during the sampling period.

- LCCs' entry encompassed the sampling period.

- The long panel allows us to compare fares before and after entries and between treated and control routes.

Benchmark identification: Fixed-effects regression implementation of DID Identification

The traditional approach of implementing DID identification is to run the regression on the price equation (*i* indexes route and t indexes month):

$$
\begin{aligned}
\ln(\mathrm{Fare}_{it}) = {} & \alpha_1 \mathrm{LCCroute}_{it} + \alpha_2 \mathrm{LCCadjacent}_{it} + \\
& \alpha_3 \mathrm{LCConeairport}_{it} \times \mathrm{LCCconnectivity}_{it} + \\
& \alpha_4 \mathrm{LCCtwoairport}_{it} \times \mathrm{LCCconnectivity}_{it} + \\
& \alpha_5 \mathrm{LCConeairport}_{it} \times \mathrm{LCCconnectivity}_{it} \times \mathrm{noLCC}_{\mathrm{i}} + \\
& \alpha_6 \mathrm{LCCtwoairport}_{it} \times \mathrm{LCCconnectivity}_{it} \times \mathrm{noLCC}_{\mathrm{i}} + \\
& \alpha_7 \ln(\mathrm{Pax}_{it}) + \alpha_8 \ln(\mathrm{Ncarriers}_{it}) + \mu_y + \mu_m + \mu_i + \varepsilon_{it}
\end{aligned}
$$

Identification assumptions of the regression approach

A1: LCC Entry (actual, potential and adjacent) and market structure are determined by time-invariant route-specific factors, which are controlled by route fixed effects.

A2: The geometric mean of population of end-point cities is used as the IV of the endogenous number of passengers.

Regression Results for EU

Variables	IV using geometric mean of population of end-point cities as the instrument for log passengers
LCC route presence	-0.3895 ***
LCC adjacent presence	-0.0330 ***
LCC one-airport presence × LCC connectivity	0.0089
LCC two-airport presence × LCC connectivity	-0.0491 ***
LCC one-airport presence × LCC connectivity × dummy of no LCC entry	-0.0018 ***
LCC two-airport presence × LCC connectivity × dummy of no LCC entry	-0.0062 ***
Log of number of passengers	0.1165 ***
Log of number of carriers	-0.0445 ***
Number of routes	3573
Number of observations	289,546

Regression Results for U.S.

Variables	IV using geometric mean of population of end-point cities as the instrument for log passengers
LCC route presence	-0.2607 ***
LCC adjacent presence	0.0199 ***
LCC one-airport presence × LCC connectivity	-0.0605***
LCC two-airport presence × LCC connectivity	-0.0672 ***
LCC one-airport presence × LCC connectivity × dummy of no LCC entry	-0.01549
LCC two-airport presence × LCC connectivity × dummy of no LCC entry	-0.0520
Log of number of passengers	0.0641 ***
Log of number of carriers	-0.0999 ***
Number of routes	13590
Number of observations	762,534

Summary of regression results

- On average, the actual entry of an LCC on a route causes the average fare on the route to drop 39% in EU markets and to drop 26% in US markets.

- LCCs' potential entry also cause fares to drop, with the effect larger in US markets than in EU markets.

- The adjacent entry of an LCC has different effects on fares in EU and US markets; route average fares tend to slightly rise in US markets and tend to drop in EU markets after an LCC makes an adjacent entry.

Concerns with the regression approach

- The assumption that unobserved route-specific factors affecting fare and entry are constant over time is questionable given the long sampling period.

- Because LCC entry did not occur at once , comparisons between treatment and control groups are based on different time windows.

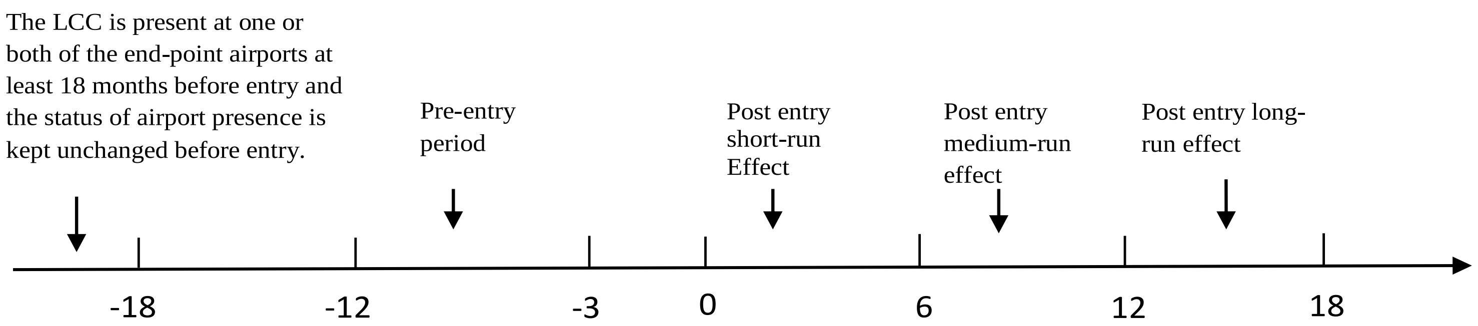
- It may be difficult to separate the effects of actual entry, potential entry, and adjacent presence on fares.

- Identification is based on the chosen linear functional form.

A Quasi-Experimental Approach: DID matching with a regression adjustment

1. We conduct the estimations of different types of LCC entry separately: actual entry conditional on potential entry, type 2 potential entry conditional on type 1, type 1 potential entry and adjacent entry.
2. For each type of entry, we select treated routes to exclude the contamination of other types of entry.
3. *For a treated route, we match it to a set of control routes that were entered (with the same type of entry) by the same LCC in later years.
4. We exclude also the contamination of other types of entry on the matched controlled routes.
5. For a matched pair, we conduct a DID comparison non-parametrically and the comparison is based on the same time window.
6. We remove further the possible impacts of other time-varying factors on the DID results via a regression adjustment.

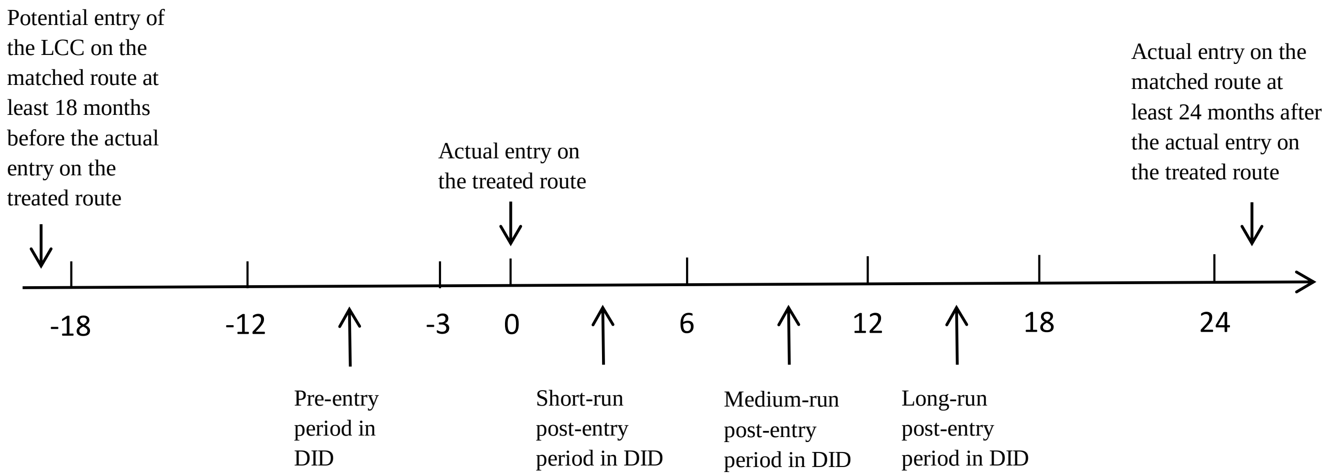
Time line for defining treated routes of actual entry



Timeline (in month) defining a treated route of a LCC's actual entry

Time Line of defining control routes of actual entry

For a given treated route, matching within the treated group by defining the control group as those routes entered by the LCC in later years



Timeline (in month) defining a matched route to a treated one from the routes entered by the same LCC

Non-parametric DID Comparison on a matched pair

Net change rate of route average fare caused by LCC entry

$$\tau_{ii'} = \underbrace{\left(\frac{y_i^{post} - y_i^{pre}}{y_i^{pre}}\right)}_{\substack{\text{change rate of} \\ \text{average fare in a} \\ \text{treated route}}} - \underbrace{\left(\frac{y_{i'}^{post} - y_{i'}^{pre}}{y_{i'}^{pre}}\right)}_{\substack{\text{change rate of} \\ \text{average fare in a} \\ \text{matched route}}}$$

where y_i, $y_{i'}$ are average fare on the treated and controlled routes respectively; *post*, *pre* denote post- and pre-treatment, respectively.

Removing the influences of changing market characteristics

- Conduct DID computations for time-varying characteristics including number of carriers, HHI index of regional markets connecting two catchment areas, population and GDP per capita:
$$\Delta \mathbf{x}_{ii'} = \left(\mathbf{x}_i^{post} - \mathbf{x}_i^{pre}\right) - \left(\mathbf{x}_{i'}^{post} - \mathbf{x}_{i'}^{pre}\right)$$

- Run regression $\tau_{ii'} = \Delta \mathbf{x}_{ii'} \mathbf{B} + e_{ii'}$

- The estimator of the average treatment effects is constructed from the regression residuals: $\delta = N^{-1} \sum_{i \in \Psi} \left(M_i^{-1} \sum_{i' \in \Gamma_i} \hat{e}_{ii'} \right)$

Additional remarks on the empirical approach

- The confidence interval of the estimator is constructed by the bootstrap.

- We conduct similar computations and estimations for potential and adjacent entry.

- We conduct sensitivity checks on the time lines for defining the treated and controlled routes. The results are robust.

Comparing key identification assumptions of the DID matching approach with the ones of the regression approach

- In the regression approach, DID comparison is done between routes entered by a LCC and routes not entered by a LCC in the sampling period. The two types of routes are homogeneous after controlling for fixed-effects and other control variables.

- In the DID matching approach, the DID comparison is between routes entered by LCC earlier and routes entered by the same LCC later. Compared with the regression approach, homogeneity between treated and controlled routes is higher.

- *The embedded key identification assumption of the DID matching approach is that the order of LCC entry is not driven by unobserved factors. This assumption is plausible because the LCCs started to expand from their initial network, which is pre-determined before deregulation by regulations on entry and exit. Uber has entered markets over time in accordance with their distance from SF and NYC.

Test identification assumptions of the DID matching approach

- We conducted a balance test on the similarity of key market variables that matter for our analysis. Only two variables – number of carriers and HHI, which are directly affected by entry, are significantly different between treated and control routes. However, the regression adjustment in our empirical approach can control for the impacts of such differences on our results.

- We also compared the time patterns of route average fare before entry between treated and control routes, and the time patterns on the matched sample are quite similar.

Results: Actual entry conditional on potential entry

	EU	US
Short-run effect (0-6 months after entry)	-14% [-16%, -12%]	-10.5% [-11.2%, -9.4%]
Medium-run effect (6-12 months after entry)	-15% [-17%, -12%]	-11.2% [-11.7%, -10.2%]
Long-run effect (12-18 months after entry)	-10% [-13%, -8%]	-11.5% [-12.5%, -10.0%]
Number of treated routes	120	136
Number of observations	477	1800

Results: Type 1 potential entry (presence at one airport)

	EU	US
Short-run effect (0-6 months after entry)	-0.1%	-2.3%
	[-0.02%, -0.016%]	[-2.9%, -1.9%]
Medium-run effect (6-12 months after entry)	-0.3%	-3.3%
	[-0.08, -0.44%]	[-3.9%, -2.9%]
Long-run effect (12-18 months after entry)	0.6%	-3.2%
	[-0.1%, 1.1%]	[-3.8%, -2.7%]
Number of treated routes	180	2287
Number of observations	4025	73889

Note: we report median along with [5%-ile, 95%-ile] for each of the effects. The confidence interval is calculated using the bootstrap technique.

Results: Type 2 potential entry (presence at two airports) conditional on type 1 potential entry

	EU	US
Short-run effect (0-6 months after entry)	-1.3% [-2.8%, -0.1%]	-8.3% [-8.7%, -7.9%]
Medium-run effect (6-12 months after entry)	-2.2% [-3.6%, -0.6%]	-9.7% [-10%, -9.1%]
Long-run effect (12-18 months after entry)	-0.3% [-1.3%, 0.8%]	-7.2% [-7.7% -6.8%]
Number of treated routes	82	224
Number of observations	1198	7944

Results: Adjacent entry

	EU	US
Short-run effect (0-6 months after entry)	-2.8% [-4.4%, -1.2%]	-3.0% [-3.4%, -2.6%]
Medium-run effect (6-12 months after entry)	-3.5% [-5.2%, -1.9%]	-3.9% [-4.3%, -3.5%]
Long-run effect (12-18 months after entry)	-1.3% [-2.7%, 0.01%]	-5.1% [-5.5%, -4.6%]
Number of treated routes	77	441
Number of observations	823	7348

Summary of Estimation Results

- We find substantial fare reductions caused by LCC expansions: 20% in EU markets and 30% in US markets (aggregating the reductions from actual, potential, adjacent entry).

- Differences between EU and US:
  - In EU markets, fare reductions are mainly caused by LCCs' actual entry.
  - In US markets, potential entry can cause a big price drop.

Comparing findings from DID matching and regression approach

Compared with the findings from DID matching approach, the regression approach

- Overestimates the effect of actual LCC entry and the overall effect of LCC entry on route fare;

- Underestimates the effects of potential and adjacent LCC entries on fare, especially in US markets.

Explaining the different findings in EU and US markets

EU markets are less competitive than US markets because of

- more airport slot constraints
- more airport gate constraints
- subsidized national carriers, which are weak competitors

Quantifying Travelers' Gain from LCC Entry in the US and EU

We assume a constant elasticity demand function

$$Q = aP^e$$

Elasticities are calculated as in Smyth and Pearce (2008) based on DB1B database from 1994:Q1 to 2005:Q4 for the top 1000 city pair routes (by traffic) in the U.S. domestic markets and IATA's PaxIS database since 2005 for the intra Europe markets. Route level elasticities are -1.4 for the North America market and -2.0 for the Europe market.

a is derived as the mean of $Q / P^{\hat{e}}$ for each route.

Quantifying Travelers' Gain from LCC Entry (Continued)

We then calculate consumer surplus using the following formula:

$$\Delta CS = -\sum_t \Delta CS_t = -\sum_t \sum_r \int_{p_c}^{p_0} \hat{a}_r p_{rt}^{\hat{e}} dp$$

where p_c is the counterfactual price post entry in category c (actual, potential, or adjacent), and p_0 is the observed average price before entry. r is the route affected by the LCC.

The counterfactual is that an LCC enters a route as an actual, potential, or adjacent competitor.

Flow-chart of Calculating Consumer Welfare from Different Categories of LCC Entry

Presence at only one endpoint airport

$P_0(1-\delta_s^{ptl1}) \rightarrow P_0(1-\delta_m^{ptl1}) \rightarrow P_1 \equiv P_0(1-\delta_l^{ptl1})$

Presence at two endpoint airports

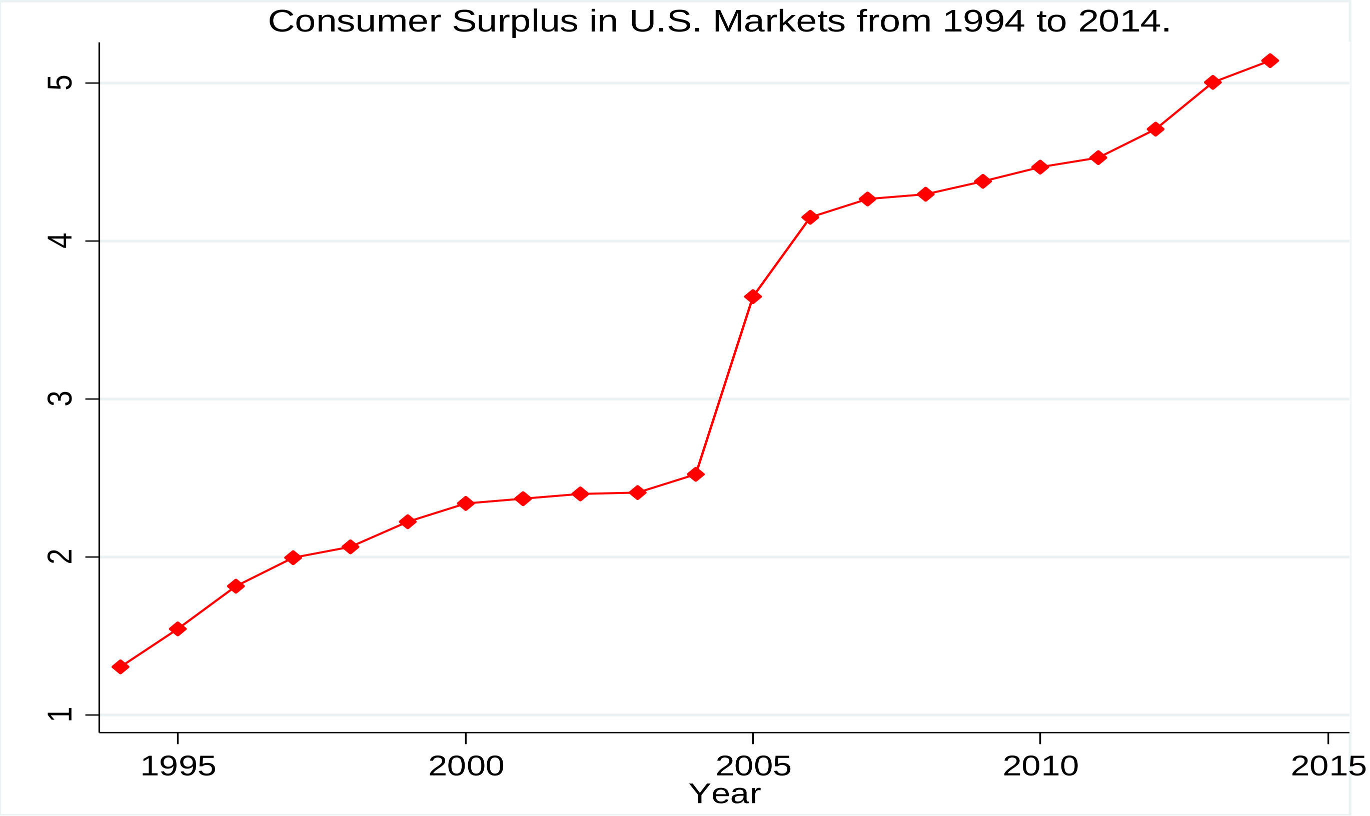
$P_1(1-\delta_s^{ptl2}) \rightarrow P_1(1-\delta_m^{ptl2}) \rightarrow P_2 \equiv P_1(1-\delta_l^{ptl2})$

Enter the route

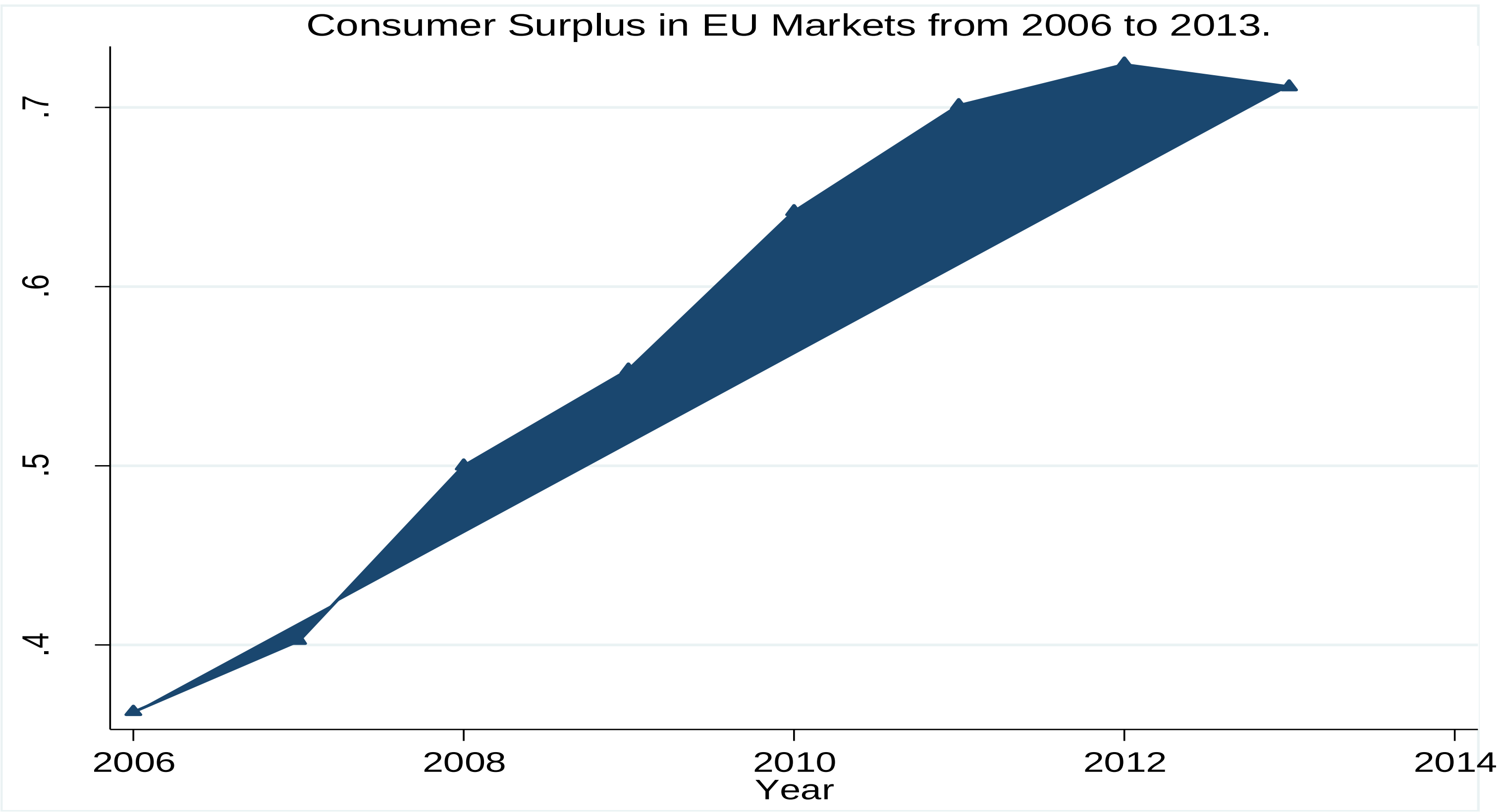
$P_2(1-\delta_s^{actual}) \rightarrow P_2(1-\delta_m^{actual}) \rightarrow P_2(1-\delta_l^{actual})$

Note: P_0 is the average airfare before entry; subscripts s,m,l stand for short-run, medium-run and long-run effect, respectively.

Travelers’ Cumulative Gain in US Markets from LCC Entry



Travelers' Cumulative Gain in EU Markets



The Initial Welfare Gain from EU LCC Entry Into US Markets: Cabotage

In the last year of our sample, Southwest and the other LCCs in the US offered service on routes that accounted for 80% of transported passengers.

The routes that accounted for the remaining 20% of passengers included short spoke routes and had other features that apparently were not attractive to Southwest.

Assume: (1) An EU LCC would enter routes in the US that do not have a US LCC, and (2) The EU LCC would reduce fares 25%, same as the effect of Southwest's actual entry in the US and close to the overall effect of EU LCC entry in the EU.

Then, as an upper bound, consumers would gain $1.6 billion annually from allowing an EU LCC cabotage rights.

Policy Conclusions

The U.S. domestic airline market is very competitive, in large part because of LCCs.

Thus, the initial gains from allowing cabotage rights in the US appear to be quite modest.

But, allowing cabotage would generate additional long-run benefits as all carriers restructure their networks for global competition. Gains would increase from entry on international routes and on domestic routes that feed those routes.