An Exploration of LCC Competition in U.S. and Europe

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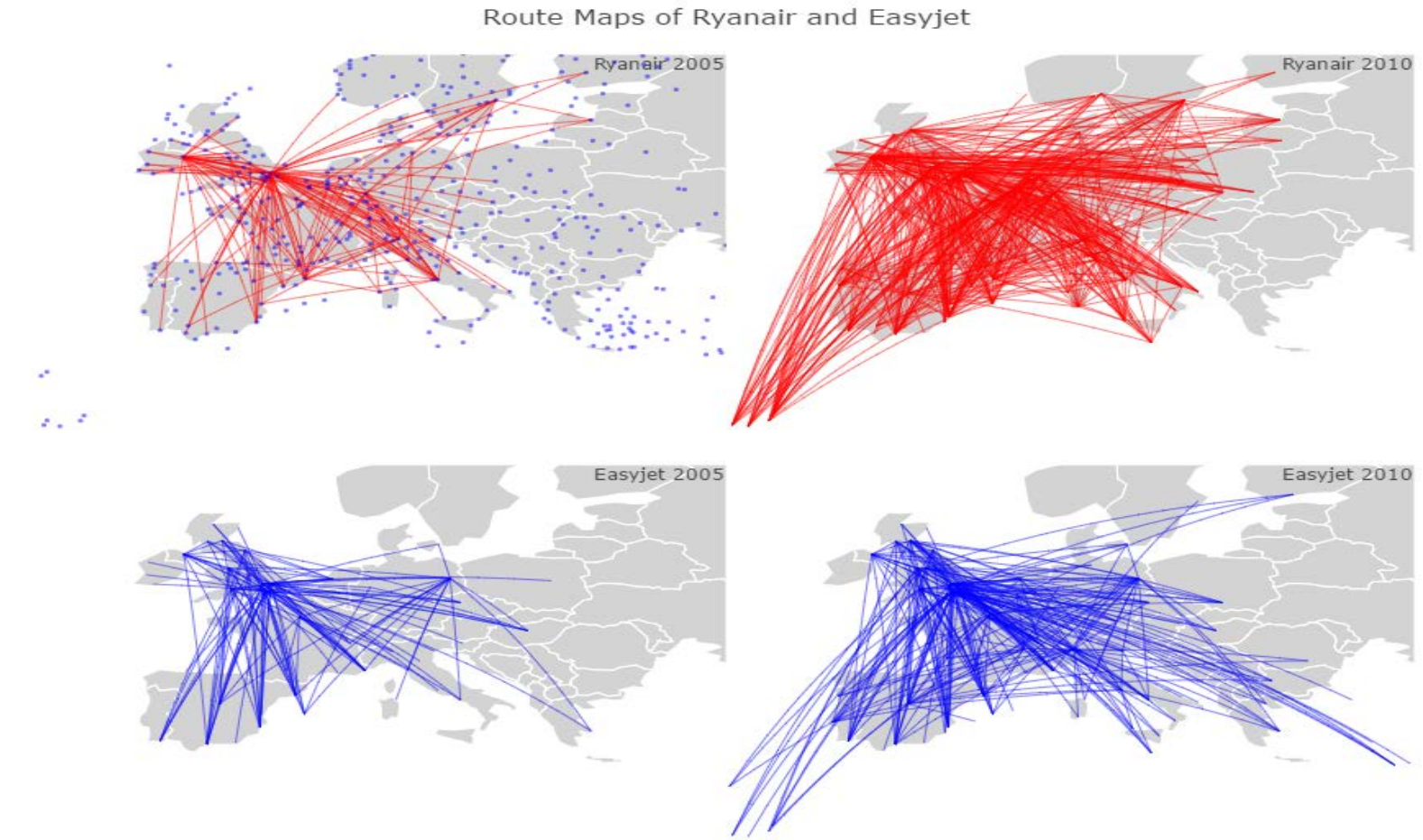
Motivation

- Consolidation of airlines could lead to higher fares and service cuts.
  - 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

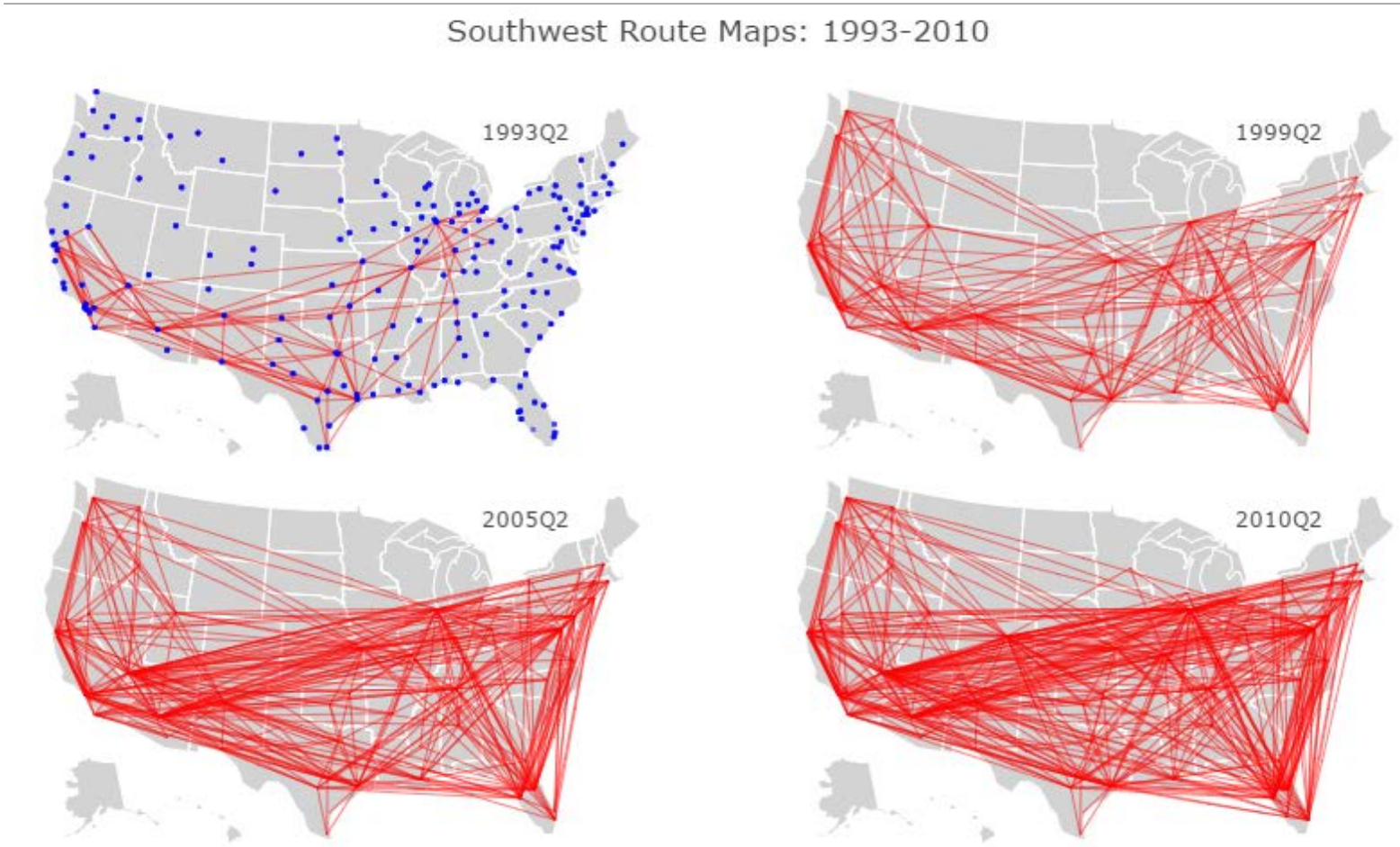
Why could such policies help?

- Open Skies have reduced fares and increased service.
  - 20%-30% price drop and 5%-10% increase in passenger volume 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?

- We review the patterns of LCC's expansions after deregulations in 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 reduce fares even further in US markets?
- We outline future work to address this question and to draw policy implications.

Challenges in identifying the effects of LCCs' expansion

- **Endogenous** LCC entries
- Unobserved time-varying market factors.
- LCC entries spanned over 10 years.
  - Entries occurred at different time points with different market environments.
  - Unobserved factors affecting market outcomes are unlikely to be constant over the long time period.

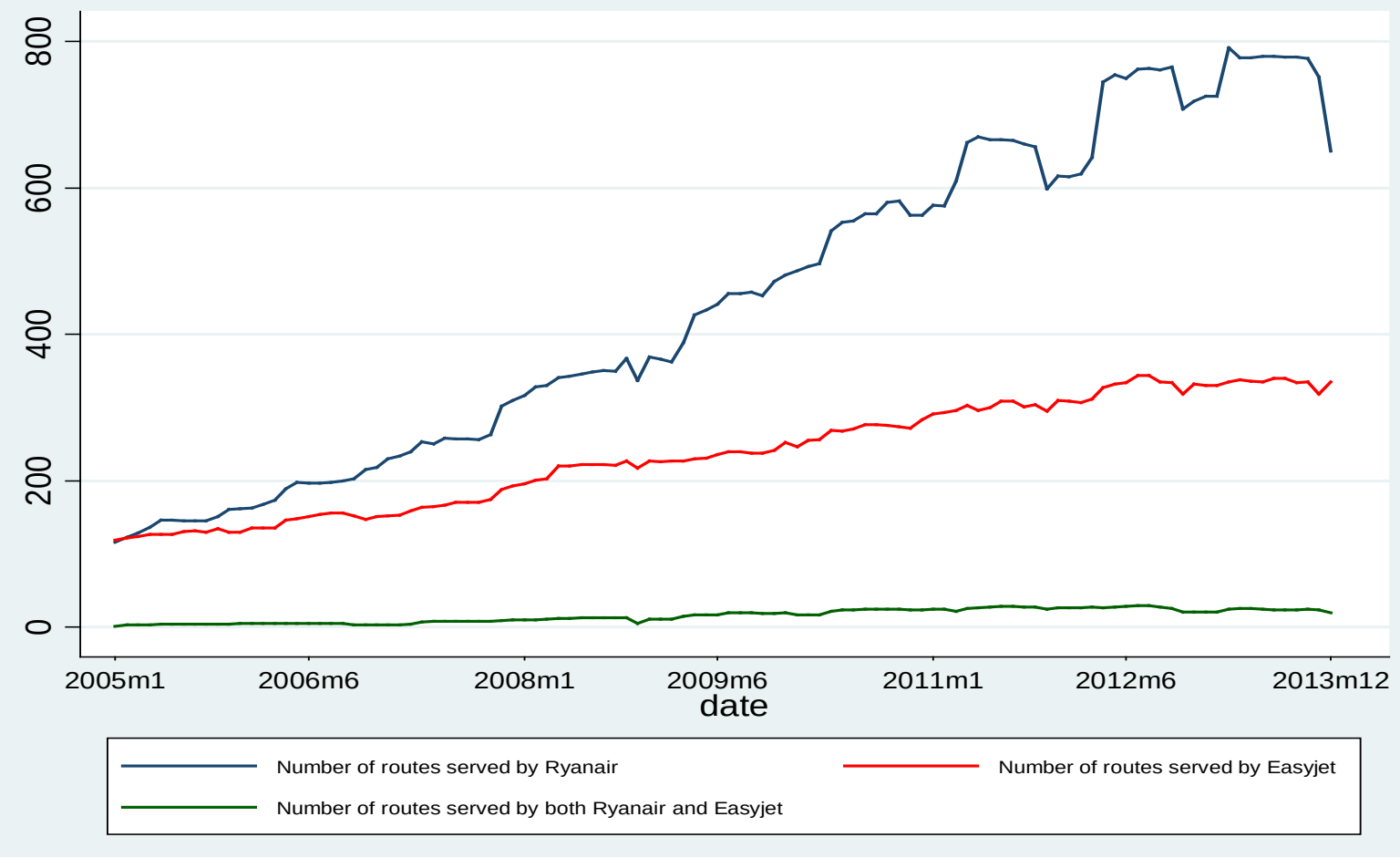
Our Approach

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

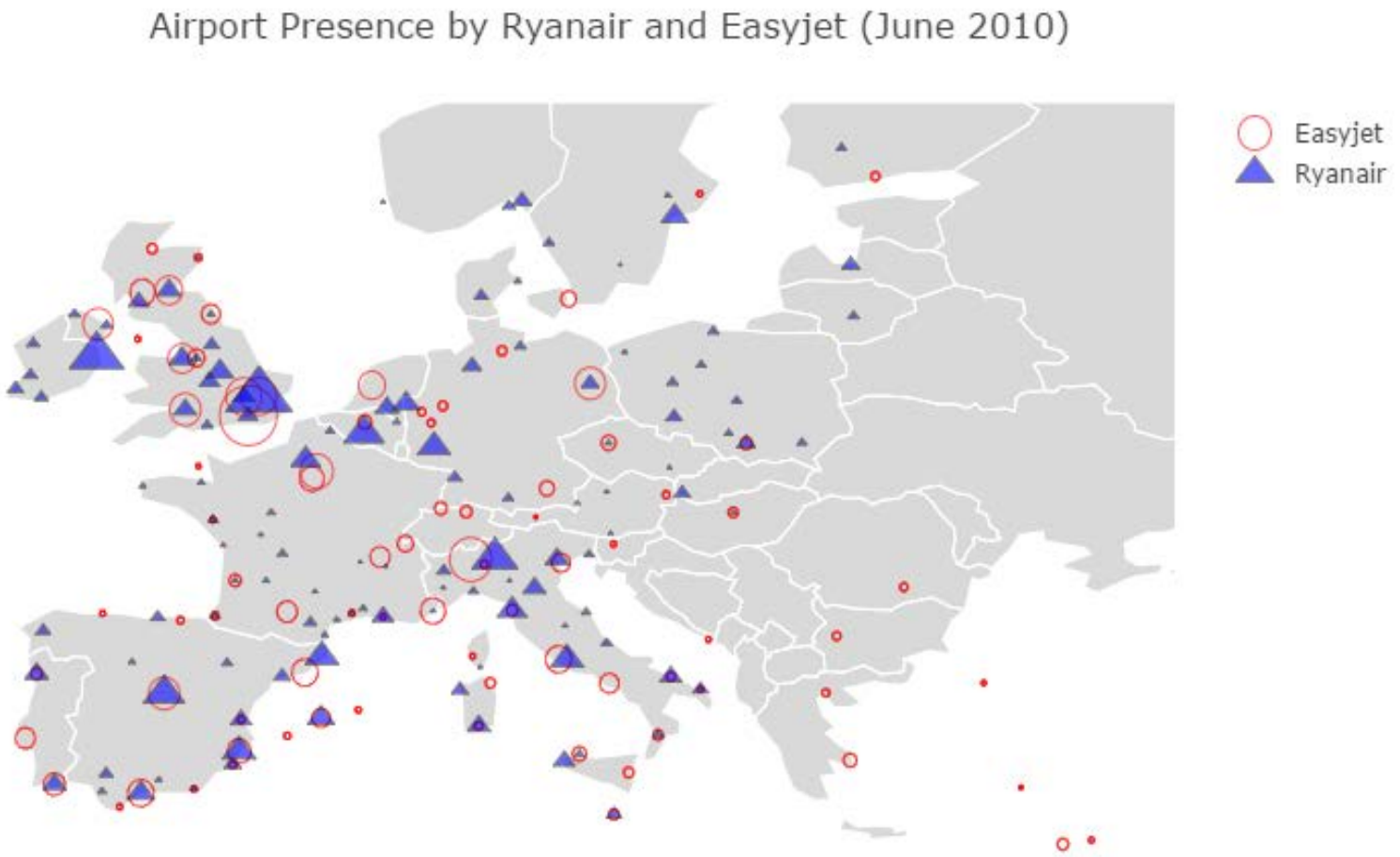
- Motivated by the patterns we find, we design a novel quasi-experiment approach to estimate the effects of LCCs' expansions on fares.
  - a matching-based difference-in-differences identification
  - matching exploits the fact that LCCs entered routes sequentially.

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

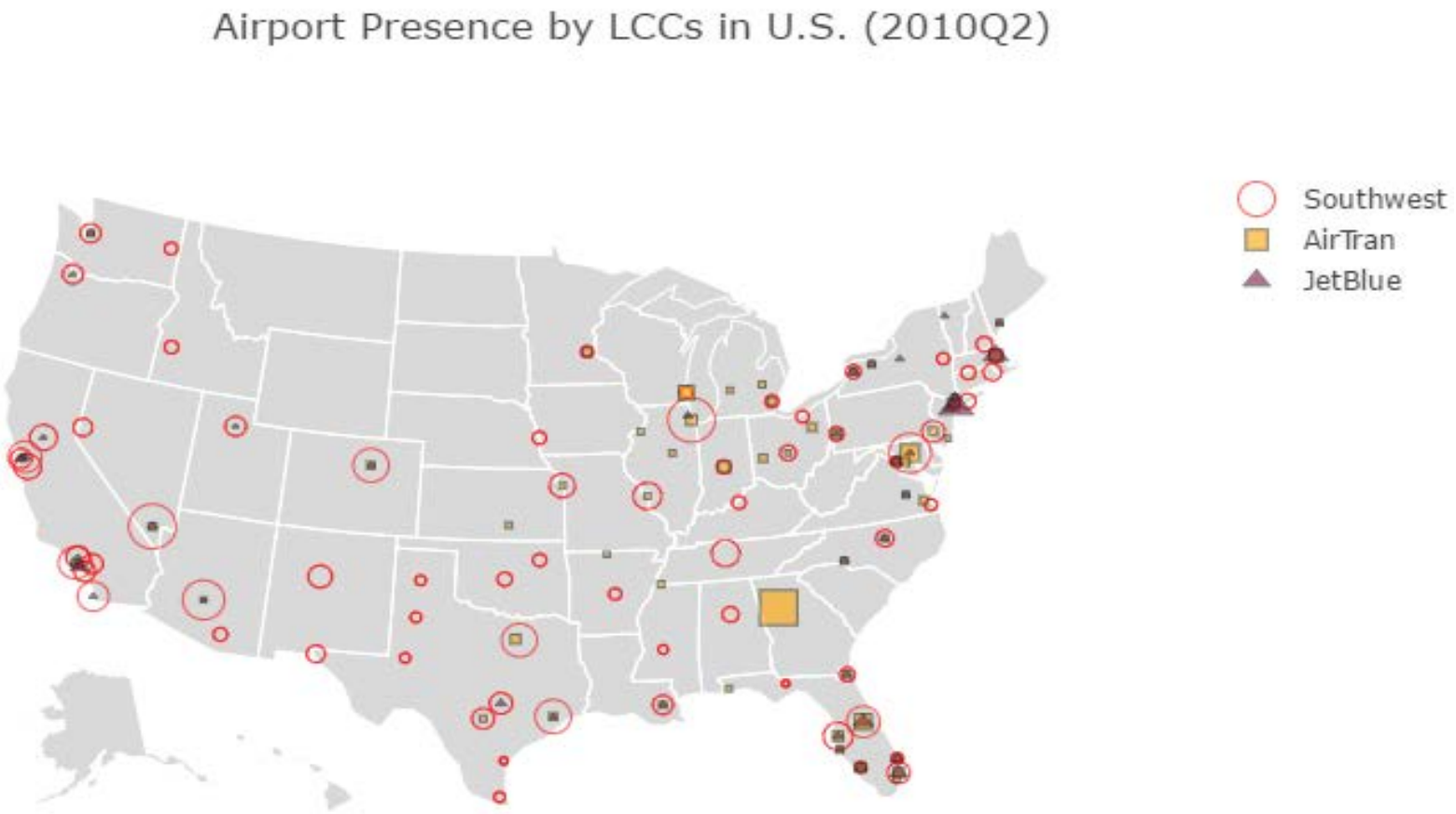
Visualizing Patterns of the expansions of Ryanair and Easyjet in EU



Visualizing airport presence of Ryanair and Easyjet after rapid expansion



Visualizing airport presence of Southwest after rapid expansion



Exploring entry patterns from Probit estimates

We run a Probit regression to estimate the conditional probability $\Pr\left(d_{ijt}=1 \middle| X_{jt}, Z_{it}, Z_{i't}\right)$, 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 affected by the LCC's airport presence.

Special patterns in EU

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

Special patterns in U.S.

- Actual entry is positively affected by the LCC's adjacent route presence.

Classification of entries motivated by entry patterns

- Actual route entry

- Adjacent entry

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- **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

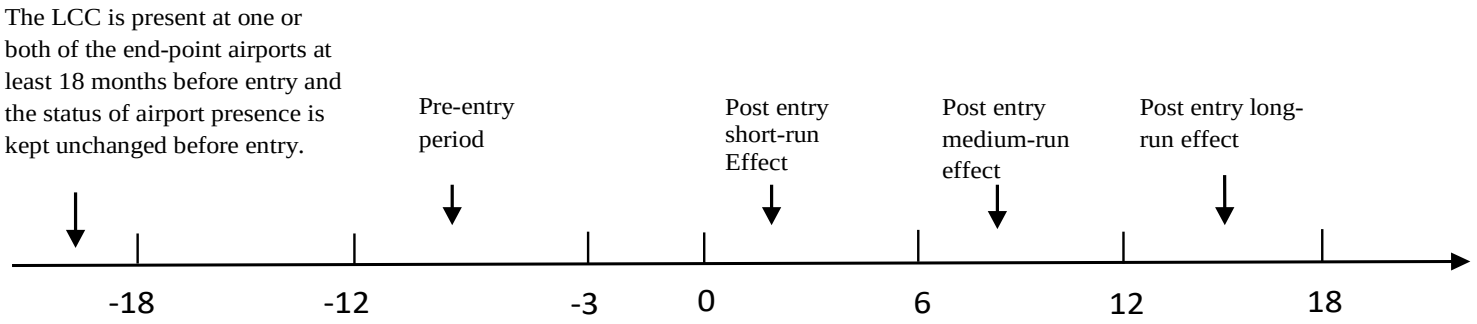
- the effect of **adjacent** entry

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

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

1. We conduct the estimations for different types of LCC entries 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 controlled 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 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.

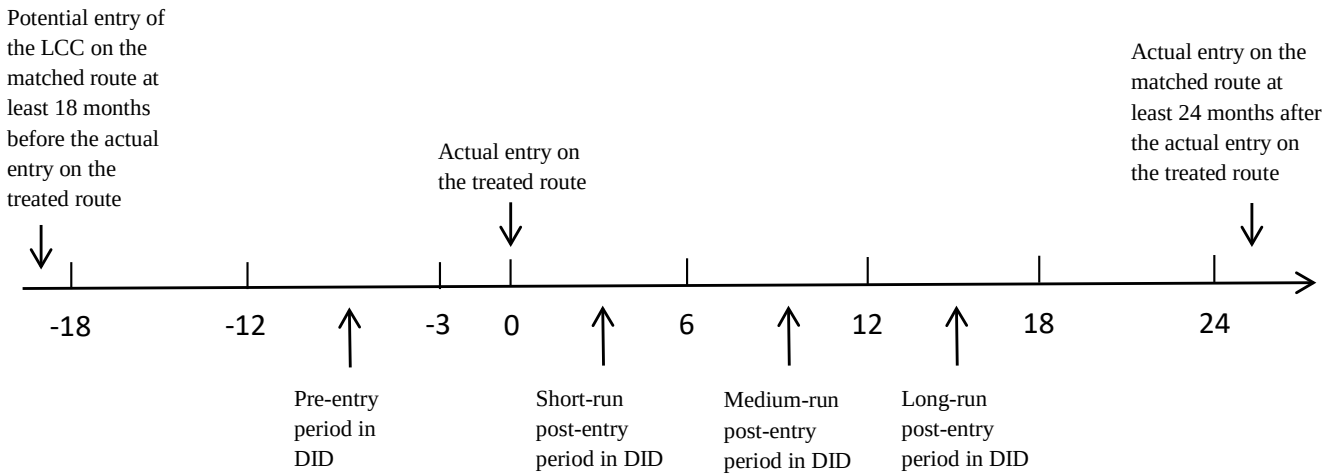
Time line for defining treated routes of actual entry



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

Time Line of defining controlled 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 a LCCentry

$$\tau_{ii'} = \underbrace{\left(\frac{y_i^{post} - y_i^{pre}}{y_i^{pre}}\right)}_{\text{change rate of average fare in a treated route}} - \underbrace{\left(\frac{y_{i'}^{post} - y_{i'}^{pre}}{y_{i'}^{pre}}\right)}_{\text{change rate of average fare in a matched route, capturing the time trend of fare change in the counterfactual scenario without a LCC entry}}$$

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 timing of a 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.

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 Findings

- We find substantial fare reductions caused by LCC expansions: 20% - 30% drop in both US and EU markets.

- Differences between EU and US:
  - In EU markets, fare reductions are mainly caused by LCCs' actual entries.
  - In US markets, potential entries can cause 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

Further work and possible policy implications

- LCCs are likely to expand if international aviation markets are fully deregulated and if cabotage is allowed.
- Travelers can benefit from LCCs expansions.
- We expect to show this by:

- Policy implications: concerns about market consolidation can be addressed by allowing foreign competition in domestic markets.