WOULD U.S. TRAVELERS BENEFIT FROM ENTRY BY FOREIGN AIRLINES?

SIMULATING THE EFFECT OF CABOTAGE BASED ON LOW-COST CARRIER COMPETITION IN U.S. AND EUROPEAN UNION MARKETS

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Abstract: We explore the potential benefits to U.S. travelers from granting foreign airlines cabotage rights. We design a new approach to obtain consistent estimates of the effect of Low-Cost Carrier (LCC) entry on fares in U.S. and EU markets, which addresses the endogeneity of entry. We then simulate the effect of allowing an EU LCC to serve U.S. markets and we find that U.S. travelers' initial welfare gains would be modest because airline competition is already intense. However, travelers' benefits are likely to grow significantly over time as all carriers develop their networks to offer seamless domestic and international travel.

Keywords: Airline Industry, LCC Entry, DID-Matching, Fare Effects

JEL: C51, D12, L11, L51, L93, L98

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1. Introduction

Some forty years after Congress deregulated the U.S. airline industry, controversy remains over whether the industry is sufficiently competitive and whether government should intervene to increase competition. The wave of airline mergers since 2005, which enabled the remaining large legacy carriers, American, United, and Delta, to solidify dominance of their hubs in large cities while they reduced service to smaller cities, has spurred recent concerns that fares will increase and service quality will decrease.[1]

At the same time, low-cost carriers (LCCs), such as Southwest and JetBlue Airlines, and ultra-low-cost carriers (ULCCs), which include Allegiant, Frontier, and Spirit Airlines (Bachwich and Wittman (2017)), have gained a greater share of the U.S. market and have offered new service in markets abandoned by legacy carriers. For example, Delta made significant cuts in service at Cincinnati Northern Kentucky Airport, but Allegiant, Frontier, and Southwest have provided new service. Similar changes are occurring at other former hubs, including Pittsburgh, Cleveland, Memphis, and St. Louis.

Although some larger carriers have exited through consolidation and some smaller low-cost carriers have expanded their networks, no evidence suggests that those competitive dynamics are likely to lead to notable long-run changes, on average, in fares and service quality. Yet, disquiet among the public and policymakers exists about the decline in the number of large carriers at the national level and the long-run financial strength of low-cost carriers because: (1) the airline industry has experienced major shocks

[1] Since 2005, the following mergers resulted in three major legacy carriers remaining in the industry: US Airways-America West (2005), Delta-Northwest (2008), United-Continental (2010), and American-US Airways (2014). In addition, Southwest acquired Air Tran in 2011 and Alaska acquired Virgin America in 2016. Luo (2014), Shen (2017), Carlton et al. (2018), and Zhang and Nozick (2018) have assessed the effects on fares of the mergers between the legacy carriers and have found that they vary significantly, depending on the carriers involved and the type of route.

since deregulation that have resulted in significant retrenchment by carriers, and (2) it has been difficult for new entrants to succeed, with JetBlue, which started in 2000, the last new large airline in the United States not to disappear through merger or bankruptcy. Recent research has added to those concerns by characterizing strategic behavior by airlines that could increase fares (for example, Aryal, Cilberto, and Leyden (2018), Sweeting, Roberts, and Gedge (2018)), and by pointing out that the largest investors in U.S. airlines own stock in multiple airlines and that common airline ownership raises fares (Azar, Schmalz, and Tecu (2018)).

The history of the U.S. transportation industry has shown that the most effective way for policymakers to protect and enhance consumer welfare is to stimulate competition by eliminating entry barriers; but history has also shown that policymakers have applied this lesson selectively (Winston (2013)). Thus, in the airline industry, policymakers benefited travelers within the United States by deregulating domestic markets (Morrison and Winston (1986, 1995)), and benefited international travelers by negotiating open skies agreements with some countries (Winston and Yan (2015)).[2] Nevertheless, policymakers have allowed public airports to establish exclusive use gates and slot controls that restrict air carrier entry and raise fares (Morrison and Winston (2000)), and, importantly, they have prevented foreign airlines from supplying additional competition in domestic markets by not giving them cabotage rights.[3]

Beginning with the growth of Southwest Airlines, competition provided by low-cost carriers (LCCs) has accounted for a large fraction of the fare savings from deregulating

[2] Open skies is an international policy concept that calls for liberalizing rules and regulations of international aviation to promote competition.
[3] In the aviation industry, a cabotage right is the right to operate within the domestic borders of another country.

entry into U.S. markets (Morrison and Winston (2000)). Subsequently, the growth of LCCs Ryanair and EasyJet contributed to the benefits of deregulating entry into European Union markets (Alderghi et al. (2012)), and the emergence of LCCs Norwegian Air and WOW Air, among others, is likely to increase the benefits of liberalizing entry into Transatlantic markets. Accordingly, allowing foreign LCCs into U.S. markets has the potential to increase travelers' welfare significantly.

Given that federal law prohibits foreign airlines from serving U.S. domestic travelers, we are not aware of previous research that has attempted to estimate the effects of allowing cabotage in the United States. Thus, in this paper, we develop a stylized analysis and assess the potential benefits of allowing an EU LCC to enter U.S. domestic routes. This is a credible and important entry scenario because U.S. and EU LCCs have adopted similar business models, shared similar cost characteristics, and been leading competitors in their respective markets.

The historical justifications for denying cabotage rights, (1) the U.S. military wanted immediate access to all aircraft during the time of war, and (2) airline labor would mount significant political opposition to any threats to its earnings, are largely irrelevant today. We therefore take a first step to shed light on the potential cost to travelers of U.S. policymakers' failure to grant cabotage rights.

Our approach is to: (1) provide an overview of the operations and entry patterns of Southwest, the leading U.S. LCC, and Ryanair and EasyJet, the leading EU LCCs; (2) obtain evidence about the effects of their actual, potential (Morrison and Winston (1987)), and adjacent (Morrison and Winston (2000)) entry on fares in their respective U.S. and EU markets; and (3) extrapolate from those findings to simulate the effect that the entry of an EU LCC would have on fares and travelers' welfare in U.S. markets.

In the process, we contribute to the literature on the effects of LCC competition on fares by developing a methodology, difference-in-differences (DID) matching with a regression adjustment, which addresses the endogeneity of an LCC's entry as either an actual, potential, or adjacent competitor. The standard DID approach used in previous research does not address fully the potential bias from endogenous entry. Our approach is also suitable for investigating the effects of firms' entry in other industries, such as banking, petroleum, and chain stores, where markets are geographically isolated and where firms' initial networks drives their expansion.

We find that Southwest Airlines reduces fares in U.S. markets by as much as 30% and that Ryanair and EasyJet reduce fares in EU markets by as much as 20%. We also find that the conventional DID approach tends to understate Southwest's effect on fares and to overstate the EU LCCs' effect on fares. We then simulate a stylized effect of cabotage by assuming that an EU LCC: (1) enters only U.S. markets that are not served by a U.S. LCC or ULCC, and (2) has an effect on fares that is comparable to its effect on fares in EU markets, but somewhat less than Southwest's effect on fares in U.S. markets. Given those assumptions, we find that travelers' would gain a modest $1.6 billion annually because some 80% of U.S. domestic passengers fly on routes that are served by at least one LCC or ULCC.

However, it is likely that those initial gains would expand greatly under a more comprehensive cabotage policy that allows entry by other foreign carriers, not just by an EU LCC. Competition in a more integrated global airline market would encourage both foreign and U.S, carriers to restructure their networks, which would result in greater entry on international routes and on domestic routes that feed those routes. The case for allowing cabotage therefore strengthens greatly as the framework evolves from the static network we considered here to a network restructured by new foreign entrants and domestic carriers that facilitates and encourages seamless international travel. Importantly, competition under cabotage would provide additional protection to U.S. travelers' welfare because excessive fares on domestic routes could discourage travel on international routes.

2. An Overview of LCC Expansions and Entry Patterns in the U.S. and EU

Before estimating the effects on fares of the LCCs of interest, Southwest in the United States and Ryanair and EasyJet in the European Union, we discuss how the LCCs developed their operations and networks to become major competitors in their respective markets. We then present descriptive evidence of patterns of LCC entry behavior, which motivate decomposing their effects on fares as actual entrants, potential entrants, and adjacent entrants.

Southwest's Expansion in the United States

Southwest Airlines began as an intrastate carrier in Texas and became an interstate carrier following deregulation in 1978, which allowed it to serve cities in other states. Southwest developed its business model as a low-cost carrier during the 1980s and captured national and even international attention. For decades, the key components of Southwest's model have been: (1) flying one type of aircraft, the Boeing 737, which reduces its maintenance and pilot training costs, and (2) strategically avoiding congested airports, or airports with high passenger facility charges, in favor of secondary, less crowded airports that have lower passenger facility charges and that enable Southwest to provide quick turnaround service and increase aircraft utilization (Boguslaski, Ito and Lee (2004)). Southwest's operating costs per available seat-mile have consistently been much lower than the other large U.S. airlines' operating costs per available seat-mile, with the exception of JetBlue, a more recent low-cost carrier.[4] Southwest's lower costs have enabled it to charge lower fares and put tremendous competitive pressure on other carriers.

In addition to its low fares, Southwest has grown far beyond its Texas roots (and routes) to serve markets throughout the United States. As shown in figure 1, Southwest expanded its network from 148 non-stop markets (501 markets with connections) in 1994 to 490 non-stop markets (2,228 markets with connections) in 2011. Most of those markets tend to consist of short and medium haul routes. Although Southwest has entered new routes over time, it has generally not exited many routes.

<u>Ryanair and EasyJet's Expansion in Europe</u>

Ryanair, an Irish airline established in 1984, followed Southwest's low-cost model and expanded its network when the European Union deregulated air transportation in 1997. Similarly, EasyJet, a British airline established in 1995, adopted a low-cost business model and expanded its operations following EU deregulation. Both LCCs are able to use Europe's (underused) secondary airports (Barrett (2004)), which is fortunate because the supply of slots at major European hub airports has been significantly restricted by grandfather rights given to other European carriers. Importantly, as in the case of Southwest, Ryanair and EasyJet encounter less congestion by using the secondary airports,

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[4] Data contained in U.S. SEC Filings: airlines' 10-K annual reports indicate that Southwest's operating costs per available seat-mile have fluctuated in real 2000 dollars around 8 cents from 1993-2011, while the operating costs per available seat-mile of the other large U.S. carriers have fluctuated around 10 cents.

thereby reducing their operating costs and enhancing their ability to compete effectively against other European carriers.

Within the EU, airlines can serve other member countries from their home country and can operate within other member countries; that is, they are granted cabotage rights. Figure 2 shows the number of routes served by Ryanair and EasyJet in the EU from January 2005 to December 2013. Because the two LCCs have expanded rapidly during this period, they have increased competition on many routes. At the same time, their networks do not overlap much because they tend to avoid competing with each other.

An Overview of LCCs' Entry Patterns

We investigate the entry patterns of the U.S. and EU LCCs to indicate their ability to affect fares through actual, potential, and adjacent entry. Our empirical overview is based on the U.S. Department of Transportation's (DB1B) Origin and Destination Survey and T-100 Domestic Segment Data from 1993 to 2011, and the International Air Transportation Association's (IATA) monthly data on airline operations and fares from 2005-2013.[5] The routes in our analysis are non-directional airport pairs.[6] In our sample, there are 13,590 such routes in the United States and 3,588 in the European Union. Appendix tables A1 and A2 present the means, standard deviations, minimum, and maximum values of the variables used in this and subsequent empirical analyses in the paper.

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[5] We are grateful to John Byerly and Douglas Lavin for helping us to obtain the IATA data. Because our sample ends in 2011, we do not confound our analysis with the structural effects of Southwest's merger with another LCC, AirTran Airways, in 2011. Our analysis of the European Union market includes the United Kingdom.

[6] Morrison (2001) points out that using airport pairs enables one to account for competition from adjacent airports and adjacent airport pairs; for example, the airport pair Baltimore-Washington International Airport to Oakland Airport provides adjacent competition for the airport pair Washington Dulles Airport to San Francisco Airport.

Actual entry (exit) occurs when an LCC served (did not serve) a route in a month (or quarter) but did not serve (served) that route in the previous month (or quarter).[7] Based on our data and assumptions, the EU LCCs tend to enter and exit routes frequently as Ryanair made 500 entries on 377 routes and 211 exits on 150 routes, and EasyJet made 438 entries on 323 routes and 231 exits on 134 routes. Figure 3 shows that both EU LCCs exhibit strong time patterns of entry and exit by adjusting their networks more in April and November than they do in other months of the year; about 60% of Ryanair's entries and exits and about 50% of EasyJet's entries and exits are made during those months.

In contrast, Southwest Airlines seldom exits an airport or a city-pair market. In our sample, Southwest ceased operations at only Detroit (1993), San Francisco (2001), and Houston Intercontinental (2005) airports. Because a city may have multiple airports, an airline's exit from an airport does not necessarily imply that it no longer serves the city. For example, after Southwest exited San Francisco airport, it continued to serve the San Francisco Bay Area by serving Oakland airport.

Potential entry occurs when an LCC serves one (Type 1 potential entry) or both (Type 2 potential entry) of the end-point airports but does not serve the airport pair. Adjacent entry occurs when an LCC enters an adjacent competitive route comprised of two adjacent airports. We define two airports as adjacent airports if the distance between them is less than 100 kilometers or 62.5 miles.[8] To avoid double counting, if an airline enters a

[7] More precisely, we assume an airline entered a route if it provided non-stop or one-stop connecting flights for at least for 6 quarters and offered at least one flight every two days; that is, 45 flights per quarter.

[8] Our assumption is midway between the 75-mile radius assumed by Morrison (2001) to construct adjacent competitive routes and the 50-mile radius assumed by Dresner, Lin, and Windle (1996) to construct adjacent competitive routes. Our results were not affected when we measured an airport's catchment area based on travel time instead of distance.

given route (actual entry) and then enters an adjacent route, we measure only the effect of actual entry on fares.

Patterns of Route Entry by LCCs

We estimate a probit model to suggest certain patterns that are associated with the U.S. and EU LCCs' entry. The conditional probability of an LCC entering a route is given by $\Pr\left(d_{ijt}=1\middle|X_{jt},Z_{it},Z_{i't}\right)$, where d_{ijt} is a binary indicator equal to 1 if LCC *i* entered route *j* for the first time in time t and 0 otherwise [9]; X_{jt} is a vector of market characteristics such as distance and market size; Z_{it} is a vector of variables measuring the LCC's network, and $Z_{i't}$ is a vector of variables measuring the competitors' *i'* networks at the time of entry.

The estimation results presented in table 1 suggest how the actual entry behavior of U.S. and EU LCCs' is associated with their potential and adjacent entry. The LCCs are more likely to enter a route when they already serve both end-point airports and, in the case of Ryanair and EasyJet, the likelihood increases as the number of routes connected to the end-point airports increase. Actual entry is also more likely to occur if the LCCs serve one of the end-point airports, but in the case of EasyJet, that effect is statistically significant only as the number of routes connected to the airport increases. Actual entry by the EU LCCs is less likely if they already provide adjacent competition, which may reflect the difficulty of entering certain routes connected to major EU hub airports. In contrast, actual entry by Southwest is more likely if Southwest already provides adjacent competition. Finally, consistent with the summary of their operations, an EU LCC is less likely to enter a route that the other LCC has entered.

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[9] In this exercise, we exclude re-entries of an LCC on a route because the re-entry decisions could be affected by the LCCs' previous entries and exits.

3. DID Regression of the Effect of LCC Entry on Fares

We begin our exploration of the effect of LCC entry on a route's average fare by using the difference-in-differences (DID) approach taken by many researchers.[10] The DID approach is a useful starting point because both the U.S. and EU samples include many instances of LCC entry and many routes that an LCC has never entered. However, we later discuss the concerns with the DID approach and we develop an improved approach. We perform the estimations using the DOT DB1B and IATA data sets.[11]

We define a route's product as the combination of a carrier, itinerary, and ticket class (first, business, economy full, economy discount and others).[12] We implement DID estimation of the average fare on a route for the following logarithmic specification:

$$
\begin{aligned}
\ln\left(y_{it}\right) = {} & \alpha_1 \text{LCCroute}_{it} + \alpha_2 \text{LCCadjacent}_{it} + \alpha_3 \text{LCConeairport}_{it} \times \text{LCCconnectivity}_{it} + \\
& \alpha_4 \text{LCCtwoairport}_{it} \times \text{LCCconnectivity}_{it} + \\
& \alpha_5 \text{LCConeairport}_{it} \times \text{LCCconnectivity}_{it} \times \text{noLCC}_i + \\
& \alpha_6 \text{LCCtwoairport}_{it} \times \text{LCCconnectivity}_{it} \times \text{noLCC}_i + \\
& \alpha_7 \ln\left(\text{Pax}_{it}\right) + \alpha_8 \ln\left(\text{Ncarriers}_{it}\right) + \mu_y + \mu_m + \mu_i + \varepsilon_{it}
\end{aligned}
\qquad (1)
$$

where,

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[10] Previous studies of the effects of Southwest's entry on fares in the U.S. markets include Windle and Dresner (1995), Dresner, Lin, and Windle (1996), Morrison and Winston (2000), Morrison (2001), and, more recently, Brueckner, Lee, and Singer (2013).

[11] Carriers have unbundled many services, such as checked luggage and ticket reservations by phone, which were included in the ticket price, and they have begun to charge additional fees for them. Thus, the fares in the DB1B data, which do not include ancillary charges, could understate the full costs to air travelers. However, Southwest does not charge travelers for services, such as checked luggage for the first and second bag, changing or cancelling reservations, and so on. In addition, Southwest's charges for oversized and overweight bags are generally lower than legacy carriers' charges. Thus, our analysis may understate Southwest's effect on the full costs to air travelers because it does not include its effect on the price of other optional services.

[12] We use the fare code information in the IATA data to determine the fare classification. However, we cannot use the fare code information in DB1B because each airline has its own definition of its fare codes. Thus, following common practice, we define the fare class based on the range of fares.

y_{it} : Average fare on route i at time t ;

LCCroute_{it} : A dummy indicating that route i is served by one of the LCCs at time t ;

LCCadjacent_{it} : A dummy indicating that one of route *i's* adjacent routes but not route i is served by an LCC at time t ;

$\text{LCConeairport}_{it}$: A dummy indicating that one of the end-point airports of route i but not route i is served by an LCC at time t ;

$\text{LCCtwoairport}_{it}$: A dummy indicating that both of the end-point airports of route i but not route i are served by an LCC in time t ;

$\text{LCCconnectivity}_{it}$: Number of routes that an LCC serves that are connected to the end-point airports of route i during period t . In the EU case, if both LCCs operate at the end-point airports, we use the larger number of routes that are served;

noLCC_{i} : A dummy indicating that an LCC has never entered route i during the sampling period;

Pax_{it} : Number of route passengers;

Ncarriers_{it} : Number of carriers serving the route at time t ;

μ_y, μ_m and μ_i : year, month/quarter, and route fixed effects;

ε_{it} : an error term.

We present the DID parameter estimates of the effects of LCC entry on average fares in table 2. We use the geometric mean of the population of the end-point cities as an instrumental variable for the number of passengers, which is endogenous. Note that population is correlated with passengers, but holding passengers constant, it is not correlated with fares. In addition, population varies across routes and over time. The first two columns of the table present OLS and IV estimates for the EU LCCs and the third and fourth columns present OLS and IV estimates for Southwest.[13]

The IV parameter estimates indicate that the LCCs' actual entry has (approximately) reduced fares, on average, by 39% in the EU markets and by 26% in the U.S. markets. The estimates also indicate that the EU LCCs reduce fares when they are adjacent competitors, but that Southwest slightly increases fares when it is an adjacent competitor. Finally, the LCCs have similar effects on fares when they are Type 2 potential competitors that serve both airports but not the route, but Southwest has a larger effect on fares than Ryanair and EasyJet have when the LCCs are Type 1 potential competitors that serve one airport comprising the route. In sum, the LCCs have marked impacts on fares in their respective markets, with the EU carriers reducing fares by more than Southwest reduces fares when we account for actual, potential, and adjacent entry.

At first blush, the findings are plausible and they are broadly consistent with previous estimates of Southwest's effects on fares. We are not aware of previous DID estimates of the effect of the EU LCCs on fares; thus, we cannot assess our comparative findings in the context of previous research. However, we have concerns about the conventional DID approach that raise doubts about the accuracy of the estimated effects of LCC entry.

Identification of the parameters relies on the assumption that the route and time dummy variables capture the unobserved route-specific factors and time effects that are correlated with the regressors. This assumption is questionable because both samples contain a large number of routes that capture entry at different points in time over several

[13] Although we present the average effects of Ryanair and EasyJet on fares in the table, their individual effects on fares were similar.

years in different market environments. Unobserved factors affecting market outcomes are unlikely to be captured by fixed route effects because they are unlikely to remain constant over time. In addition, the timing of an LCC's entry on different routes is affected mainly by the structure of its initial network; thus, we cannot simply compare the outcomes of markets entered by an LCC with the outcomes of markets not entered by an LCC across different years because many other factors also affect market outcomes. Finally, the DID approach does not separate the effects of actual entry, potential entry, and adjacent competition on fares because those actions may occur sequentially on a route. For example, an LCC's actual entry may occur only several months after its potential entry. If we have many routes where that occurs, identification of the actual and potential entry dummy variables would be contaminated.

4. An Improved Approach: DID Matching with a Regression Adjustment

We take advantage of our large panel data samples to design a new approach to address the identification problems with the standard DID approach. We use a DID matching approach to compare fares on treated routes (entered by an LCC) with fares on control routes (not entered by an LCC) in the same time window. The approach compares the difference in fares on routes entered by an LCC with the difference in fares on matched routes without LCC entry both before and after LCC entry on the treated routes. Importantly, we also separate the effects of LCC actual, potential, and adjacent entry on route fares by first quantifying the effect of actual entry conditional on potential entry and then quantifying the effect of potential entry, excluding the effect of an LCC's adjacent entry. Finally, we quantify the effect of adjacent entry, excluding the effects of an LCC's actual and potential entry.

We match a treated route to multiple control routes by satisfying a matching criterion that we explain in the next section. For a treated route i, y_i^{pre} and y_i^{post} denote the average fare before and after the LCC's entry.[14] For a matched route i', $y_{i'}^{pre}$ and $y_{i'}^{post}$ denote the average fare before and after the LCC's entry on the treated route. The non-parametric DID comparison on a matched pair is given by $\tau_{ii'}$, which measures the net change rate of the route average fare caused by an LCC's entry:

$$\tau_{ii'} = \underbrace{\left(\frac{y_i^{post} - y_i^{pre}}{y_i^{pre}}\right)}_{\substack{\text{change rate of the} \\ \text{average fare on a} \\ \text{treated route}}} - \underbrace{\left(\frac{y_{i'}^{post} - y_{i'}^{pre}}{y_{i'}^{pre}}\right)}_{\substack{\text{change rate of the} \\ \text{average fare on a} \\ \text{matched route}}}. \tag{2}$$

The first term on the right hand side is the change rate of the average fare on a treated route, and the second term is the change rate of the average fare on a matched route, which captures the time trend of the fare change in the counterfactual scenario where LCC entry does not occur.

It is, of course, possible that a treated route and the matched control routes have different characteristics that are correlated with the average route fare. We therefore construct variables, such as the number of carriers, number of passengers, and population and income at the end-point airports, to control for the difference between the treated and control routes.[15] Given our computation of the net change rate of the route average fare

[14] We average the route average fare over the quarters (or months) pre and post entry.

[15] Intercity rail competition is not an important issue in US markets. In European markets, our matching algorithm accounts for rail competition as long as the LCC entries followed similar decision rules over time.

caused by an LCC's entry in equation (2), we remove the effects of the control variables on the computed outcome.

Formally, we denote $\Delta X_{ii'} = \left(X_i^{post} - X_i^{pre} \right) - \left(X_{i'}^{post} - X_{i'}^{pre} \right)$ as the vector of the DID control variables on a treated route i and a controlled route i' and we run the following regression without a constant term:

$$\tau_{ii'} = \Delta X_{ii'} B + \varepsilon_{ii'} \quad , \tag{3}$$

where B is a vector of parameters and $\varepsilon_{ii'}$ is an error term. If the DID of the route average fare is completely determined by the DID of the control variables, then $\hat{\varepsilon}_{ii'} \equiv \tau_{ii'} - \hat{\tau}_{ii'}$, where $\hat{\tau}_{ii'}$ is the predicted value from the regression equation (3), would be expected to be close to zero. We therefore interpret a non-zero $\hat{\varepsilon}_{ii'}$ as the net effect of the LCC's entry on the route average fare.

In sum, we estimate the average treatment effect of an LCC's entry on a route's average fare, excluding the effects of observed market characteristics, by calculating:

$$\delta = N^{-1} \sum_{i \in \Psi} \left(M_i^{-1} \sum_{i' \in \Gamma_i} \hat{e}_{ii'} \right) , \tag{4}$$

where Γ_i is the set of matched routes to the treated route, M_i is the number of routes in the set, Ψ is the set of treated routes, and N is the total number of matched pairs. We use the bootstrap technique to construct the confidence interval of the estimator in equation (4) by randomly sampling the matched pairs (i, i') with replacement to obtain a bootstrapped sample with the same size as the original sample of matched pairs. We then compute δ using the bootstrapped sample and we repeat the process 100 times to obtain the empirical distribution of δ over the bootstrapped samples from which we construct the confidence interval of the estimator.

A final concern with our methodology is that unobserved market characteristics that are correlated with route fares may influence an LCC to enter a route. We address this concern by restricting the set of matched control routes for a treated route to those that the LCC entered at least two years later.[16] We therefore assume that the timing of an LCC's entry on different routes is driven mainly by the structure of its initial network and not by route characteristics. For example, the order that Uber has entered new markets is negatively related to their distance from Uber's headquarters in San Francisco and New York City. In our context, the assumption is plausible because: (1) The LCCs' networks have primarily evolved from their initial headquarters in Texas, England, and Ireland, and (2) As shown in table 1, an LCC tends to enter a route only when it already serves at least one of the end-point airports, and it is more likely to enter a route when it serves both end-point airports.

5. Criteria for Matching Control Routes to Treated Routes

We structure our analysis to characterize the pre-entry and post-entry periods and to distinguish between the different types of LCC entry. We define the pre-entry period as 4 to 12 months before actual route entry and we define the post-entry period as 18 months after actual entry. Within the post-entry period, we define 0-6 months after entry as the short-run, 7-12 months as the medium-run, and 13-18 months as the long run. We summarize the timeline for a treated route in exhibit 1. Because potential entry occurs at

[16] Our basic findings were not affected when we conducted sensitivity analysis on the two-year threshold.

least 18 months before actual entry, it is likely to be unrelated to the eventual market fare when actual entry occurs. We exclude the 3-month period before actual entry because a time lag may exist between an LCC's announcement that it plans to serve a route and when it does serve the route.[17]

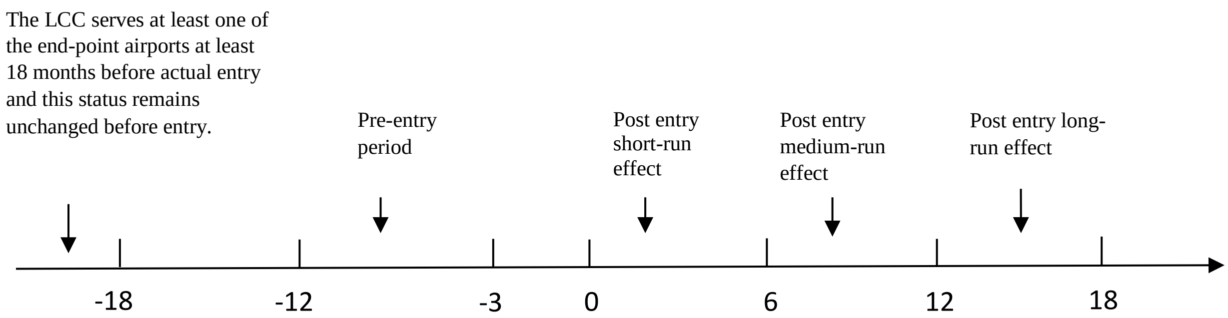

Exhibit 1. Timeline (in months) of an LCC's actual entry on a treated route.

Exhibit 2 shows the timeline for determining the set of control routes that match the treated route. The LCC serves at least one of the end-point airports on a control route at least 18 months before actual entry on the treated route. However, its actual entry on a control route occurs at least 24 months after its actual entry on the treated route, thereby avoiding any effect its entry on a control route may have on its long-run effect on the treated route.

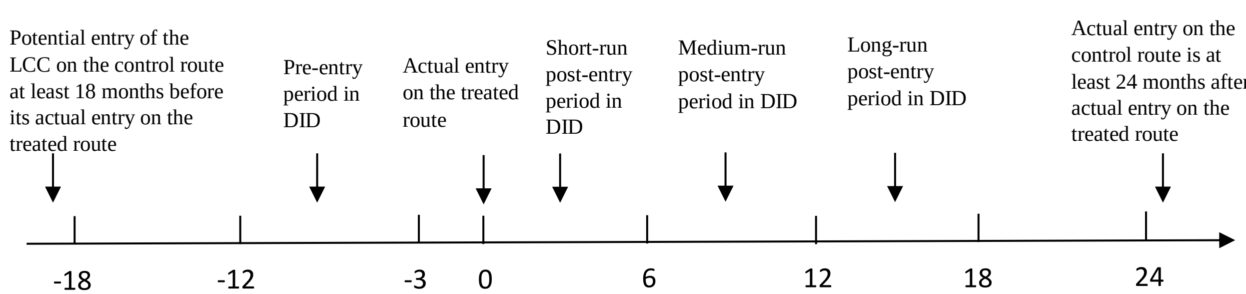

Exhibit 2. Timeline (in months) for defining a control route and a treated route for routes entered by a given LCC.

[17] We observed that the time gap between an entry announcement and actual entry was, on average, more than one quarter. Thus, in the U.S. case, we excluded 2 quarters before Southwest's actual entry in a market.

Selection of the Sample of Routes

We now summarize our assumptions to select treated routes and control routes to estimate the distinct effects of the LCC's actual, potential, and adjacent entry on average fares. We construct four modules: (1) the effect of Southwest's actual entry without potential entry, excluding the effect of its adjacent entry—this module is specific to Southwest Airlines because it arises in its U.S. domestic route network; (2) the effect of an LCC's actual entry conditional on both types of an LCC's potential entry, excluding the effect of an LCC's adjacent entry; (3) the effect of both types of an LCC's potential entry, excluding the effects of its actual and adjacent entry; and (4) the effect of an LCC's adjacent entry, excluding the effect of its actual and potential entry.

In table 3, we list the conditions that a route must satisfy to be a treated route and that it must satisfy to be a control route in a given module. The conditions are aligned with the timelines that we presented in exhibits 1 and 2. We also indicate certain robustness checks that we conducted.

Balancing Test

The preceding conditions to define treated and control routes are based on the assumption that the timing of an LCC's entry into different routes is exogenous. We test this assumption formally with a balance test proposed by Rosenbaum and Rubin (1985); that is, we test whether routes entered by an LCC in earlier years are similar to those entered by the LCC in later years.

The test statistic, $B(X)$, is based on the standardized difference:

$$B(X) = 100.\frac{\bar{X}_F - \bar{X}_M}{\sqrt{\frac{S_F^2(X) + S_M^2(X)}{2}}}, \qquad (5)$$

where for each covariate, $\bar{X}_F$ and $\bar{X}_M$ are the sample means for the full affected routes (i.e., all the treated routes in our sample) and the matched treated routes (i.e., the routes entered later by an LCC that are compared with each treated route), and $S_F^2(X)$ and $S_M^2(X)$ are the corresponding sample variances. Intuitively, $B(X)$ measures the difference in the means of a conditioning variable, scaled by the square root of the variances in the samples. Rosenbaum and Rubin (1985) define imbalance for a covariate as exceeding 20 in absolute value.

We found that the standardized differences in both the U.S. and EU samples of the routes' average fares, distances, endpoint populations, and endpoint incomes per capita have absolute values less than 20, which indicates that those route characteristics pass the balancing test. Other route characteristics, namely the number of carriers and HHI of the city-pair market, had standardized differences that exceeded 20 in some modules. However, we can use our regression adjustment to remove the effect of that imbalance on the results.

6. Estimation Results

We have developed an approach to identify the distinct effects of LCCs' actual, potential, and adjacent entry on average fares in the short, medium, and long run; thus, we report the estimation results for each type of entry in separate tables. As noted, Southwest entered some routes without prior potential entry, but our data did not indicate that the EU

LCCs entered routes without prior potential entry. As shown in table 4, Southwest's entry for this case reduces fares, on average, roughly 10% in the short run and nearly 14% in the long run. The second column of the table shows that the regression adjustment is important because we would have significantly over-estimated the effect of Southwest's entry on fares without it. Hereafter, we report results only with the regression adjustment. The third and fourth columns of the table report findings for entry on connecting routes only and show that they are very similar to the findings for entry on all routes.

Both Southwest and the EU LCCs entered routes conditional on potential entry and, as shown in table 5, their entry has different effects on fares, which suggests that the EU and U.S. airlines respond differently to an LCC's actual entry. Entry by an EU LCC, conditional on its potential entry at one or both end-point airports, reduces fares roughly 15% in the short and medium run and 10% in the long run, possibly because an LCC cuts prices substantially in the short and medium run to capture market share, but gradually adjusts prices after the initial entry shock. In contrast, the last two columns of the table show that Southwest's entry, conditional on it being a potential competition at one end-point airport, reduces fares by nearly 18% in the short run and by nearly 19% in the long run.[18] However, its effect on fares is much less, roughly 4%, when it is a potential competitor at both end-point airports and therefore likely to have already had a strong effect on fares before it actually enters a market.

As expected, we find in table 6 that when an LCC is a potential competitor, it reduces fares more if it serves both endpoint airports (Type 2) than if it serves one of the

[18] We found that the fare effect of Southwest's actual entry conditional on being a Type I potential competitor was somewhat greater when it entered routes that were more concentrated and when it entered hub routes.

endpoint airports. Generally, Southwest has a much larger effect for this type of entry than the EU LCCs have. In fact, Southwest's effect as a Type 1 potential competitor (column 3) is somewhat greater than the EU LCC's effect as a Type 2 potential competitor.

We previously speculated that Southwest's effect as an actual competitor is less when it is a Type 2 potential competitor than when it is a Type 1 potential competitor because it already has a strong effect on fares when it provides Type 2 potential competition. Column 4 of table 6 is consistent with this speculation because we find that when Southwest is a Type 2 potential competitor, it reduces fares by roughly 8% to nearly 10% in the short and medium run and by more than 7% in the long run. Finally, we tested whether Southwest's effect as a potential competitor is consistent with its behavior, noted previously, of primarily entering short and medium haul markets. We found that Southwest reduced fares as a Type I potential competitor by 8% on routes less than 500 miles and that this effect declined with distance, becoming negligible on routes greater than 1500 miles because incumbent carriers were presumably less concerned that Southwest would eventually enter those routes.

Southwest also has a larger effect on fares as an adjacent competitor than the EU LCCs have, especially in the long run. We show in table 7 that adjacent competition provided by all of the LCCs reduces fares roughly 3% in the short and medium run; however, in the long run, Southwest reduces fares 5% and the EU LCCs reduce fares by slightly more than 1%.

In sum, we have developed a methodological approach, DID matching with a regression adjustment, which, compared with the conventional DID approach, enables us to provide more detailed and more accurate estimates of the effect of LCC competition on fares. Importantly, we are able to identify distinct effects of actual, potential, and adjacent competition on fares and to show variations in those effects for Southwest and the EU LCCs. Our major findings include:

● Depending on the type of potential entry that an LCC provides, Southwest's actual entry in a market reduces fares more than when an EU LCC enters a market.

● When Southwest is a potential or adjacent competitor, it reduces fares notably more than when an EU LCC is a potential or adjacent competitor.

● Considering the effect of all types of entry, Southwest reduces fares, on average, by as much as 30%, with potential and adjacent entry accounting for a non-trivial amount of the decline in fares.

● Considering all types of entry, an EU LCC reduces fares, on average, by as much as 20%, with actual entry accounting for most of the decline in fares.

● Competition provided by an LCC appears to be more intense in U.S. markets than in EU markets, in all likelihood because entry into U.S. airports is less constrained by slot controls and the limited availability of gates.[19]

● Compared with our findings, the estimates that we obtained using the traditional DID approach overestimate the full effect of EU LCCs on fares and underestimate the full effect of Southwest on fares, which indicates that the methodological improvements in our approach are important in practice.

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[19] For example, in 2016, of the 180 slot-controlled airports in the world, 93 were in the EU and 2 in the U.S. http://www.europarl.europa.eu/RegData/etudes/IDAN/2016/585873/IPOL_IDA(2016)585873_EN.pdf
In the EU, slots are allocated based on the "grandfather rights" rule, which tends to benefit incumbent, mainly national, airlines by restricting the slots available to potential new entrants (Barrett (2004)).

7. Additional Robustness Checks

Besides Southwest, other LCCs and ULCCs serve U.S. markets, including Allegiant Air, Frontier Airlines, JetBlue, Spirit Airlines, Sun Country Airlines, and Virgin America, which could affect fares and potentially bias our estimates of Southwest's effect on fares if they provide service on the control routes. As a robustness check, we performed calculations where we considered only those routes where the preceding airlines did not serve the treated or the control routes for at least 8 quarters after Southwest actually entered the treated routes. We present the results in table 8.[20] As expected, we find that without the presence of other LCCs and ULCCs as actual competitors, the effect of Southwest's entry on average fares under alternative states of potential entry is greater, but the quantitative effect is not much greater than the effect in the base case, which can be interpreted a lower bound.

Ryanair and EasyJet account for most of the traffic carried by LCCs in the European Union during our sample. Given that Southwest's effect on fares was modestly affected when we controlled for other LCCs and ULCCs in the U.S., Ryanair's and EasyJet's effect on fares is likely to be even less affected if we controlled for other LCCs on EU routes.

Because LCCs are growing, the number of routes that connect to their end-point airports varies over time. Importantly, greater connectivity increases the probability that an LCC will enter a route. In response, incumbent carriers may employ different pricing strategies as the probability of an LCC's entry changes with its connectivity. As a robustness check, we reevaluated the effect of Southwest's potential entry controlling for

[20] Because it is difficult to exclude all routes where other LCCs and ULCCs were potential competitors, we focused on the effect of Southwest's actual entry.

the number of routes that it served from its endpoint airports; however, we found that Southwest's effect on fares as a potential competitor increased only slightly.

8. **Travelers' Potential Gains from Cabotage**

We have found that Southwest's actual, potential, and adjacent entry has reduced fares, on average, 30% in U.S. markets. Although Southwest does not serve every U.S. route, especially long-haul routes with highly congested airports as endpoints, it does serve short-haul and medium-haul routes. Without Southwest's entry, those routes are more likely than long-haul routes to have elevated fares because they are more likely to be underserved.

Southwest's entry has also generated significant gains in consumer surplus. To quantify those gains, we assume a simple constant elasticity demand function:

$$Q = aP^e \quad , \tag{6}$$

where Q is the demand for air travel, a is a positive constant, P is the average fare, and e is the constant elasticity of demand. We assume a route elasticity of demand of -1.4 based on Smyth and Pearce's (2008) analysis of U.S. city pair routes and we derive a as the mean of $Q/P^{\hat{e}}$ for each route.[21] We then calculate consumer surplus using the following expression:

$$\Delta CS = -\sum_t \Delta CS_t = -\sum_t \sum_r \int_{p_c}^{p_0} \hat{a}_r p_{rt}^{\hat{e}} dp \quad , \tag{7}$$

[21] We do not distinguish between short-haul and long-haul markets here because Smyth and Pearce (2008) obtained very similar elasticity estimates for both types of markets.

where p_c is the counterfactual average fare following Southwest's entry in category c (actual, potential, or adjacent), p_0 is the average fare before Southwest's entry, and r is the route affected by Southwest's entry. We appropriately account for the sequential pattern of Southwest's entry as an actual, potential, and adjacent competitor, and we find that travelers gained roughly $5 billion from Southwest's entry in U.S. markets during the last year of our sample, 2014, and gained $67.6 billion (2000 dollars) from its entry during the entire sample period, 1994-2014.

The recent motivation for a policy that grants cabotage rights to foreign airlines has arisen from concerns that the reduction in the number of airlines at the national level following several mergers has reduced competition. Given our findings about the large effects of Southwest, an LLC, on fares and travelers' welfare, the entry of another effective LCC would be desirable to address those concerns.

We assume that allowing cabotage enables an EU LCC, Ryanair or EasyJet, to enter markets and we simulate the effect that such entry could have on fares. This simulation is of particular interest because: (1) the EU LCCs' business plan was modeled after Southwest's business plan; thus, they primarily serve short-haul to medium-haul markets and tend to avoid highly congested airports; (2) similar to Southwest, their costs per seat-mile are notably lower than their competitors' costs per seat mile, and (3) their entry on EU routes has significantly reduced fares, 20%, despite airport entry barriers, which have limited their competitiveness.

Because the EU LCCs, as well as any other foreign carrier, do not serve U.S. domestic routes, we make some plausible assumptions to execute the simulation. First, we assume that an EU LCC only would enter routes that Southwest or another U.S. LCC or

ULCC do not currently serve. This assumption is consistent with Ryanair and EasyJet's tendency to avoid competing with each other on the same routes. Second, we assume that an EU LCC's entry on U.S. routes would not reduce fares by as much as Southwest's entry has reduced fares, but we assume its entry would reduce fares more than its entry in EU markets has reduced fares because it would be less constrained by airport entry barriers. Thus, we assume that an EU LCC's entry would reduce fares, on average, in U.S. markets 25%.

Under those assumptions, we find that an EU LCC's entry in U.S. markets would generate a modest, but non-trivial, $1.6 billion annual gain to travelers. Our qualitative finding would not change if we assumed that an EU LCC's entry reduced fares by, say 5%, more or less than 25%. Importantly, this new entrant would address a potential gap in competition by entering city-pair markets that in our sample have, on average, fewer competitors, 2.58 carriers, than the city-pair markets that LCC carriers currently serve, which have, on average, 3.94 carriers. At the same time, the welfare gain is modest because Southwest and the other LCCs and ULCCs serve routes that account for 80% of U.S. domestic passengers. In other words, competition on U.S. routes is generally very intense, which should be somewhat reassuring to policymakers who are concerned about the state of airline competition, but it should not divert them from the possibility that travelers could still benefit significantly if they allowed cabotage.

Cabotage would usher in a new era of airline competition, which would affect domestic and international markets, because airlines would focus on providing seamless service in a global market. For example, companies such as Google and airlines such as Emirates, are envisioning seamless travel/lifestyle experiences, which rely on one airline to transport passengers from their domestic origins, possibly in low-density markets, to their foreign destinations, also possibly in low-density markets, with customized amenities. Generally, all carriers would have the incentive and ability to restructure their domestic and international networks for global competition. As in the case of domestic deregulation and open skies, travelers would then accrue gains from lower fares and improved service on international routes and on domestic routes of all hub classifications that could help feed those routes. Policymakers' concerns about competition would also be addressed because the airlines that comprise the deregulated global air transportation industry would be unlikely to" leave any domestic route behind."[22]

9. Conclusions

Given the absence of foreign airlines that serve U.S. domestic routes, we have argued that LCC competition in the U.S. and EU is a useful starting point to explore the potential effects of cabotage because the LCCs have adopted a similar business model, shared similar cost characteristics, and been leading competitors in their respective markets. After estimating the fare effects of actual, potential, and adjacent entry by Southwest, the leading U.S. LCC, and by Ryanair and EasyJet, the leading EU LCCs, we have extrapolated from those estimates to simulate the effect of entry by an EU LCC in U.S. markets.

We designed a new methodological approach, DID-Matching with a regression adjustment, to estimate the fare effects of LCC entry, which addresses the bias from

[22] We noted that Azar, Schmalz, and Tecu (2018) have argued that the largest investors in U.S. airlines own stock in multiple airlines and that common ownership raises fares. If so, entry by foreign airlines may also reduce fares by diluting the extent of common ownership of competing carriers. Currently, U.S. law prevents foreign companies and individuals from owning more than 25% of a U.S. airline, but policymakers have not considered ownership restrictions on companies and individuals investing in a foreign airline operating in the United States. Thus, if cabotage rights were granted, it is not clear whether the largest investors in U.S. airlines could or would also attempt to own foreign airlines.

endogenous entry that is not addressed by the conventional DID approach used in previous research to estimate the fare effects of Southwest's entry. The potential bias is important because we found that the conventional DID approach underestimates the fare effect of Southwest's entry and overestimates the fare effect of the EU LCCs' entry. In general, our methodology could overcome the bias from using the conventional DID approach to analyze the effects of entry in other industries, which are characterized by markets that are geographically isolated and firms with an initial network that drives their expansion.

We found that Southwest's entry reduces fares 30% in U.S. markets, with potential and adjacent entry having important effects, and that the EU LCCs reduce fares 20% in EU markets, with actual entry accounting for most of the effect. To the best of our knowledge, the latter is the first estimate of the effect of the EU LCCs' entry on fares. We then found from our simulation that an EU LCC's entry in U.S. markets would generate a modest $1.6 billion annual welfare gain to travelers.

We qualified our finding because it captures the effect of only one carrier's entry in U.S. markets and does not account for the change in the global airline network, including competition from other carriers on domestic and international routes. We argued that changes in the global network would be the largest source of gains from cabotage because carriers would seek to provide seamless air travel throughout the world. We therefore conclude that the potential gains from allowing cabotage are likely to be substantial and that the influx of new entry should finally assuage policymakers' fears of insufficient airline competition in U.S. markets. At the same time, the arguments against cabotage are irrelevant today. We hope that this paper is the beginning of a strong empirical case for cabotage, which policymakers would have to consider seriously.

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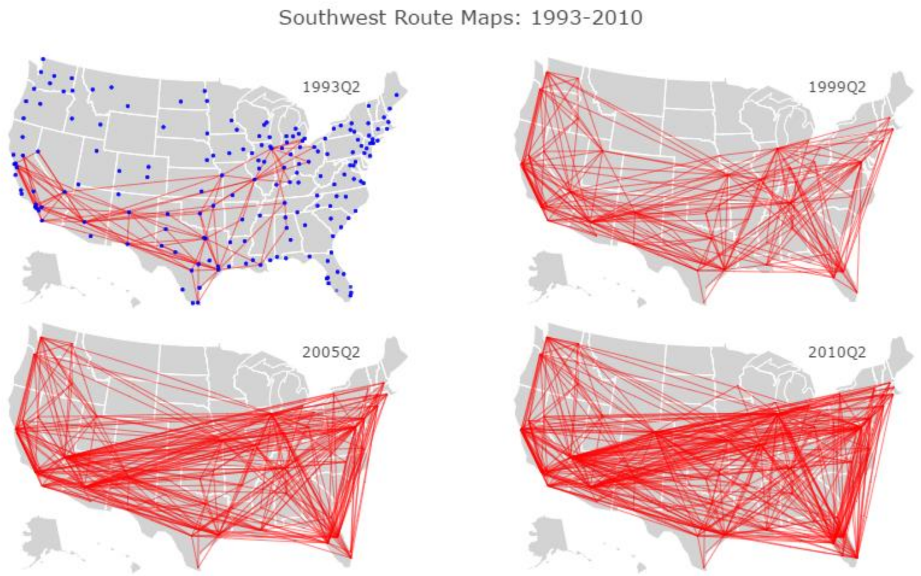
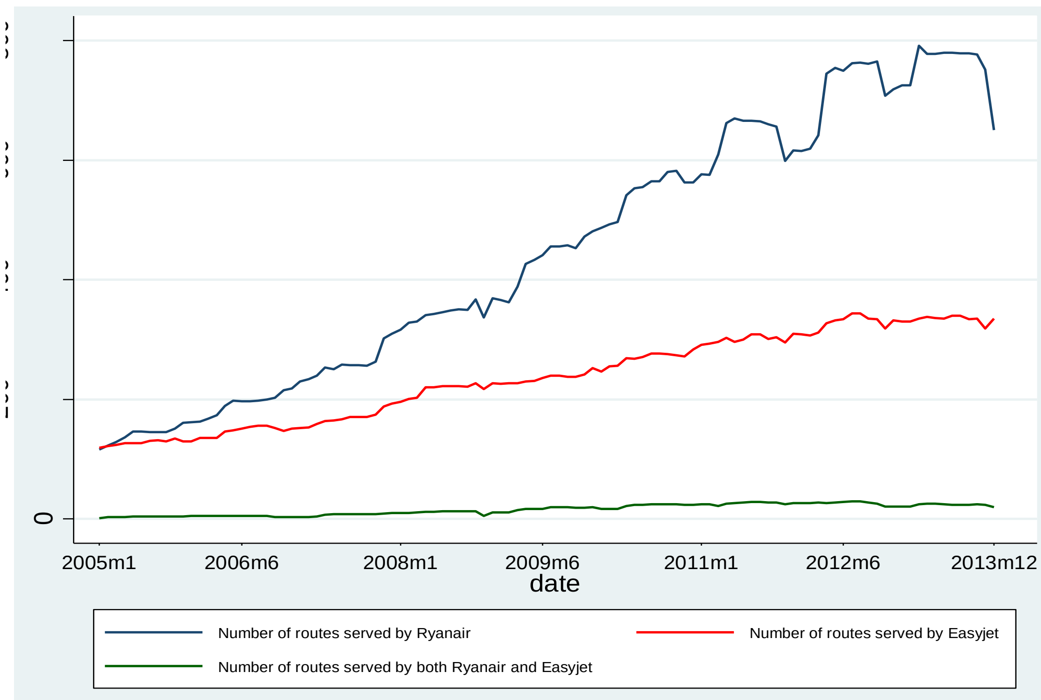
Figure 1: Southwest's Expansion in the United States



Note: Blue dots and red lines denote airports and non-stop routes, respectively. Data Sources are the Origin and Destination Survey (DB1B) and the T-100 Domestic Segment Data (T100) from 1993 to 2011.

Figure 2: Expansion of Ryanair and Easyjet from January 2005 to December 2013



Data source is the International Air Transportation Association (IATA), monthly data on airline operations and fares from 2005-2013

Figure 3: Monthly Entries and Exits by Ryanair and EasyJet, 2005-2013

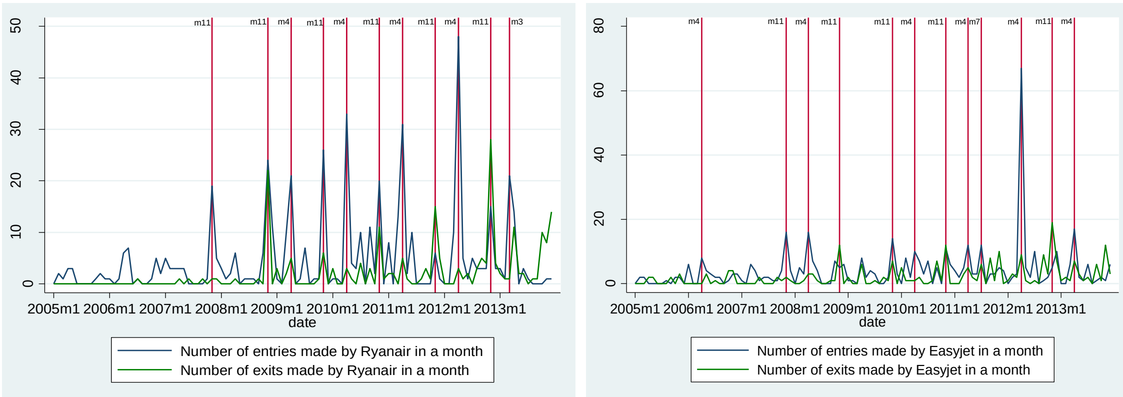


Table 1: Spatial entry patterns of LCCs from Probit regressions (Dependent variable: the dummy of the first-time route entry)

Variables	Note	Ryanair (1)	Easyjet (2)	Southwest (3)
Constant		-3.2791 (0.2175)	-3.9192 (0.2147)	-4.8442 (0.1435)
Geometric mean of population of end-point catchment areas	The value of current period	-0.0228 (0.0150)	0.0129 (0.0132)	-0.0067 (0.0088)
Geometric mean of income-per-capita of end-point catchment areas	The value of current period	-0.0817 (0.0245)	0.0481 (0.0248)	0.0095 (0.0030)
Route distance		0.0910 (0.2886)	0.0337 (0.0346)	-0.0115 (0.0163)
Percentage of first and business passengers in the regional market	The average value in previous year	0.0117 (0.0928)	-0.0599 (0.0187)	--
Dummy of airport presence at one of the end-point airports	The status of previous period	0.6136 (0.1801)	0.1450 (0.1625)	1.1388 (0.1027)
Dummy of airport presence at one of the end-point airports × Number of served routes connecting the airport	The value of previous period	0.0198 (0.0015)	0.0259 (0.0023)	-0.0015 (0.0009)
Dummy of airport presence at both end-point airports	The status of previous period	1.6303 (0.1760)	0.7785 (0.1558)	2.1022 (0.1078)
Dummy of airport presence at both end-point airports × Number of served routes connecting the two airports	The value of previous period	0.0032 (0.0013)	0.0149 (0.0019)	-0.0136 (0.0009)
Dummy of adjacent route presence	The status of previous period.	-0.7568 (0.0596)	-0.8550 (0.0879)	0.3298 (0.0238)
Dummy of route presence of the other LCC	The status of previous period	-0.1129 (0.1035)	-0.3585 (0.1738)	--
Dummy of adjacent route presence of the other LCC	The status of previous period	-0.0113 (0.0804)	-0.2159 (0.0848)	--
Dummy of airport presence of the other LCC at one of the end-point airports	The status of previous period	0.2355 (0.0747)	0.1774 (0.0631)	--
Dummy of airport presence of the other LCC at one of the end-point airports × Number of served routes connecting the airport by the other LCC	The value of previous period	-0.0061 (0.0041)	-0.0141 (0.0038)	--
Dummy of airport presence of the other LCC at both end-point airports	The status of previous period	0.2619 (0.0873)	0.1973 (0.1034)	--
Dummy of airport presence of the other LCC at both end-point airports × Number of served routes connecting the two airports by the other LCC	The value of previous period	-0.0029 (0.0030)	-0.0073 (0.0038)	--
Average flights-to-runway ratio at end-point airports	The average value in previous year	-0.2421 (0.2543)	0.0512 (0.2444)	--
Maximal flights-to-runway ratio at end-point airports	The average value in previous year	-0.1233 (0.1656)	-0.0680 (0.1682)	--
Number of seats in regional market	The average value in previous year	0.0265 (0.0045)	0.0112 (0.0042)	--
Number of flights in the regional market	The average value in previous year	-0.0043 (0.0007)	-0.0012 (0.0005)	-0.0034 (0.0022)
Number of carriers in the regional market	The average value in previous year	-0.0053 (0.0062)	0.0054 (0.0060)	0.0106 (0.0078)
HHI of the regional market	The average value in previous year.	-0.5900 (0.0967)	-0.2046 (0.1047)	0.0332 (0.0649)
Number of legacy carriers in the regional market	The average value in previous year	--	--	0.1246 (0.0108)
Vacation dummy	1 if at least one of the two airports is located in Florida or Nevada	--	--	0.0585 (0.0238)
Hub route dummy	1 if only one airport is the hub of some major full service airlines	--	--	-0.0300 (0.0208)
Double hub route dummy	1 if both the two airports are hubs of some major full service airlines	--	--	-0.0431 (0.0386)
Pseudo R^2		0.18	0.16	0.14
Number of routes		3,573	3,573	13,569
Number of Observations		258,322	258,322	666,371

Notes: period = month for Ryanair and Easyjet, and = quarter for Southwest respectively; Adjacent routes are the nearby parallel routes to the one under consideration. The end-point airports of an adjacent route are located within 100km of the end-point airports of the route under consideration; The HHI is calculated based on the seats (passengers in Southwest case) of carriers in a market.

Table 2: DID Parameter Estimates of the Effects of the LCCs on Average Fares.

Variables	Ryanair and Easyjet		Southwest	
	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)
LCC route presence	-0.2976	-0.3895	-0.2080	-0.2607
	(0.0035)	(0.0066)	(0.0028)	(0.0033)
LCC adjacent presence	-0.0308	-0.0330	0.0183	0.0199
	(0.0030)	(0.0032)	(0.0035)	(0.0038)
LCC one-airport presence × LCC connectivity	0.0052	0.0089	0.0500	-0.0605
	(0.0126)	(0.0134)	(0.0081)	(0.0093)
LCC two-airport presence × LCC connectivity	-0.0435	-0.0491	0.0242	-0.0672
	(0.0109)	(0.0116)	(0.0047)	(0.0056)
LCC one-airport presence × LCC connectivity × dummy of no LCC entry in the sample period	0.0011	-0.0018	-0.2159	-0.1549
	(0.0004)	(0.0004)	(0.0083)	(0.0092)
LCC two-airport presence × LCC connectivity × dummy of no LCC entry in the sample period	-0.0001	-0.0062	-0.1344	-0.0520
	(0.0003)	(0.0005)	(0.0101)	(0.0111)
Log of number of passengers	-0.0539	0.1165	-0.0807	0.0641
	(0.0009)	(0.0101)	(0.0004)	(0.0041)
Log of number of carriers	0.0078	-0.0445	0.00004	-0.0999
	(0.0016)	(0.0035)	(0.0008)	(0.0029)
Year dummies included?	YES	YES	YES	YES
Month (Quarter) dummies included?	YES	YES	YES	YES
Route dummies included?	YES	YES	YES	YES
Number of routes	3,573	3,573	13,590	13,590
Number of observations	289,546	289,546	762,534	762,534
R^2				
within	0.15	0.03	0.20	0.07
between	0.47	0.17	0.16	0.02
overall	0.35	0.13	0.19	0.01

Note: In the IV estimations, we use geometric mean of population of end-point cities as the instrument for log passengers.

Table 3. Conditions that a Treated Route and a Control Route Must Satisfy

Conditions of a treated route	Conditions of a control route
Module 1 (on US markets only): The effect of Southwest's actual entry without potential entry, excluding the effect of its adjacent entry.	
1. Southwest entered a route after 1993 and served the route for at least 8 quarters. *2.* Southwest was not a potential competitor on the route before its actual entry. *3.* Southwest did not serve an adjacent route before its actual entry.	1. It is not adjacent to the treated route. 2. Southwest did not serve the route and the route's adjacent routes for at least 8 quarters after it actually entered the treated route. 3. Southwest was not a potential competitor on the route before and at least 8 quarters after it actually entered the treated route. 4. Southwest eventually entered the control route in later years without potential entry before the actual entry.
Module 2 (on both US and EU markets): The effect of an LCC's actual entry conditional on both types of an LCC's potential entry, excluding the effect of an LCC's adjacent entry.	
<u>EU markets</u> 1. The LCC entered the route in a month after July 2006 and continued to provide service. 2. The LCC was a potential competitor on the route for at least 18 months before actual entry. 3. The LCC did not serve an adjacent route before the actual entry. 4. After the LCC entered the route, the other LCC did not enter the route and an adjacent route for at least 24 months. 5. Before the LCC entered the route, the other LCC was not a potential competitor on the route. <u>US markets</u> 1. Southwest entered the route after the second quarter of 1994 and continued to serve the route for at least 8 quarters. 2. Southwest was a potential competitor on the route for at least	<u>EU markets</u> 1. It is not adjacent to the treated route. 2. An LCC did not serve the route and the route's adjacent routes for at least 24 months after the actual entry on the treated route. 3. It was potentially entered by an LCC at least 18 months before the actual entry on the treated route. 4. The same LCC that entered the treated route entered the route in at least 24 months after the actual entry on the treated route. <u>US markets</u> 1. It is not adjacent to the treated route. 2. Southwest did not serve the route and the route's adjacent routes for at least 8 quarters after the actual entry on the treated route.

<table>
<tr><td>6 quarters before the actual entry. route.
3. Southwest did not serve an adjacent route before actual entry.</td><td>3. It was potentially entered by Southwest at least 6 quarters before the actual entry on the treated route.
4. Southwest eventually entered the route at least 8 quarters after the actual entry on the treated route.</td></tr>
<tr><td colspan="2">Module 3 (on both US and EU markets): The effect of an LCC’s potential entry, excluding the effects of its actual and adjacent entry.</td></tr>
<tr><td><u>EU markets</u>
1. An LCC started to operate continually at one or both end-point airports, but not the route itself after July 2006.
2. Following the potential entry, an LCC did not actually enter the route for at least 24 months.
3. Before the potential entry, an LCC did not serve the end-point airports of an adjacent route.

<u>US markets</u>
1. Southwest became a potential competitor after the second quarter of 1994 and continued to serve the endpoint airport or airports.
2. If Southwest served both end-point airports, the time between entering them sequentially was not less than 8 quarters.
3. After it became a potential competitor, Southwest did not enter the route for at least 8 quarters.
4. Before it became a potential competitor, Southwest did not enter an adjacent route.
5. After it became a potential competitor, Southwest did not serve an adjacent route.</td><td><u>EU markets</u>
1. It is not adjacent to the treated route.
2. It was free of actual, potential and adjacent entry before the potential entry on the treated route.
3. The same LCC potentially entered the treated route potentially entered the route at least 24 months after the potential entry on the treated route.

<u>US markets</u>
1. It is not adjacent to the treated route.
2. After Southwest became a potential entrant on the treated route, it did not serve the control route and the adjacent routes for at least 8 quarters.
3. After Southwest became a potential entrant on the treated route, it did not become a potential entrant on the control route for at least 8 quarters.
4. The distance of the control route was similar to the distance of the treated route. Because there are so many routes for potential entry, we use distance as an additional criteria to control for the number of controlled routes and for heterogeneity.</td></tr>
<tr><td colspan="2">Module 4 (on both US and EU markets): The effect of an LCC’s adjacent entry, excluding the effect of its actual and potential entry.</td></tr>
</table>

<u>EU markets</u> 1. An LCC operated on one of the adjacent routes after July 2006 for at least 24 months. 2. After adjacent entry, the LCC was not a potential competitor for at least 24 months. 3. The other LCC was not an actual or adjacent competitor of the route. <u>US markets</u> 1. Southwest served at least one of the adjacent routes after the second quarter of 1994 for at least 8 quarters 2. After Southwest's adjacent entry, it was not a potential competitor for at least 8 quarters.	<u>EU markets</u> 1. it is not adjacent to the treated route. 2. An LCC did not serve the route and its adjacent routes for at least 24 months after actual entry on the treated route. 3. An LCC was a potential competitor on the route at least 18 months before entry on the treated route. <u>US markets</u> 1. It is not adjacent to the treated route. 2. After Southwest's adjacent entry on the treated route, it did not serve the control route and its adjacent routes for at least 8 quarters 3. After Southwest's adjacent entry on the treated route, it was not a potential competitor on the control route for at least 8 quarters 4. The distance of the control route was similar to the distance of the treated route.

Table 4: DID matching results on the effect of Southwest's actual entry without prior potential entry on route average fare.

	All routes entered		Connecting routes entered only	
	Excluding the effects of observed market characteristics (1)	Without excluding the effects of observed market characteristics (2)	Excluding the effects of observed market characteristics (3)	Without excluding the effects of observed market characteristics (4)
Short-run effect (1-2 quarters after entry)	-10.2% [-10.5%, -9.8%]	-23.8% [-24.2%, -23.4%]	-11.3% [-11.6%, -10.9%]	-20.4% [-20.8%, -20.0%]
Medium-run effect (3-4 quarters after entry)	-13.2% [-13.6%, -12.7%]	-24.3% [-24.8%, -23.8%]	-13.1% [-13.5%, -12.5%]	-21.0% [-21.6%, -20.5%]
Long-run effect (5-6 quarters after entry)	-13.7% [-14.1%, -13.2%]	-24.6% [-25.1%, -24.2%]	-13.4% [-14.0%, -13.0%]	-20.8% [-21.4%, -20.4%]
Number of treated routes	227	227	161	161
Number of observations	9,093	9,093	5,204	5,204

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

Table 5: DID matching results on the effect of a LCC's actual entry with potential entry on route average fare.

	EU Conditional on both types of potential entry (1)	US conditional on Type 1 potential entry[a] (2)	US conditional on Type 2 potential entry[a] (3)
Short-run effect (0-6 months after entry)	-14% [-16%, -12%]	-17.7% [-18.7%, -16.9%]	-4.0% [-4.6%, -3.4%]
Medium-run effect (6-12 months after entry)	-15% [-17%, -12%]	-17.5% [-18.2%, -16.8%]	-5.0% [-5.7%, -4.4%]
Long-run effect (12-18 months after entry)	-10% [-13%, -8%]	-18.8% [-19.9%, -17.8%]	-3.8% [-4.5%, -3.0%]
Number of treated routes	120	159	136
Number of observations	477	2,925	1,800

[a] Southwest did not potentially enter the controlled route up to 8 quarters after the actual entry on the treated route.
Note: Type 1 potential entry = present at only one end-point airport; Type 2 potential entry = present at both end-point airports. The effects of observed market characteristics are excluded in all results. We report median along with [5%-ile, 95%-ile] for each of the effects. The confidence interval is calculated using the bootstrap technique.

Table 6: DID matching results on the effect of a LCC's potential entry on route average fare.

	EU		US	
	Type 1 (1)	Type 2 (2)	Type 1 (3)	Type 2[a] (4)
Short-run effect (0-6 months after entry)	-0.1% [-0.02%, -0.016%]	-1.3% [-2.8%, -0.1%]	-2.3% [-2.9%, -1.9%]	-8.3% [-8.7%, -7.9%]
Medium-run effect (6-12 months after entry)	-0.3% [-0.08, -0.44%]	-2.2% [-3.6%, -0.6%]	-3.3% [-3.9%, -2.9%]	-9.7% [-10.0%, -9.1%]
Long-run effect (12-18 months after entry)	0.6% [-0.1%, 1.1%]	-0.3% [-1.3%, 0.8%]	-3.2% [-3.8%, -2.7%]	-7.2% [-7.7%, -6.8%]
Number of treated routes	180	82	2,287	224
Number of observations	4025	1198	73,889	7,944

[a] The time interval between entering the two airports is not less than 6 quarters.
Note: Type 1 potential entry = present at only one end-point airport; Type 2 potential entry = present at both end-point airports. The effects of observed market characteristics are excluded in all results. We report median along with [5%-ile, 95%-ile] for each of the effects. The confidence interval is calculated using the bootstrap technique.

Table 7: DID matching results on the effect of a LCC's adjacent entry on route average fare.

	EU (1)	US (2)
Short-run effect (0-6 months after entry)	-2.8%	-3.0%
	[-4.4%, -1.2%]	[-3.4%, -2.6%]
Medium-run effect (6-12 months after entry)	-3.5%	-3.9%
	[-5.2%, -1.9%]	[-4.3%, -3.5%]
Long-run effect (12-18 months after entry)	-1.3%	-5.1%
	[-2.7%, 0.01%]	[-5.5%, -4.6%]
Number of treated routes	77	441
Number of observations	823	7,348

Note: The effects of observed market characteristics are excluded in all results. We report median along with [5%-ile, 95%-ile] for each of the effects. The confidence interval is calculated using the bootstrap technique.

Table 8: DID matching results on the route average fare effect of Southwest's actual entry on routes without other LCCs' entry

	Direct entry without potential entry (1)	Southwest operated at only one of the end-point airports before entry (2)	Southwest operated at both the end-point airports before entry (3)
Short-run effect (1-2 quarters after entry)	-10.8%	-20.0%	-4.9%
	[-11.4%, -10.3%]	[-21.4%, -18.8%]	[-5.7%, -3.9%]
Medium-run effect (3-4 quarters after entry)	-13.7%	-20.7%	-6.2%
	[-14.4%, -13.0%]	[-22.5%, -19.1%]	[-7.3%, -4.9%]
Long-run effect (5-6 quarters after entry)	-14.8%	-23.0%	-5.3%
	[-15.4%, -14.1%]	[-24.6%, -21.0%]	[-6.7%, -4.2%]
Number of treated routes	146	133	89
Number of observations	3,617	811	736

Note: No other LCCs served either the treated or the controlled routes up to 8 quarters after the actual entry of Southwest on the treated route. The effects of observed market characteristics are excluded in all results. We report median along with [5%-ile, 95%-ile] for each of the effects. The confidence interval is calculated using the bootstrap technique.

Appendix

Table A1: Summary Statistics of U.S. Data

Variable	Mean	Std.Dev.	Min	Max
Dummy of route presence of Southwest	0.113	0.317	0	1
Dummy of presence at the origin airport of Southwest	0.352	0.478	0	1
Dummy of presence at the destination airport of Southwest	0.424	0.494	0	1
Number of Low-cost carriers on the route	0.172	0.464	0	5
Number of legacy carriers on the route	2.545	1.715	0	8
Number of carriers in the city market	3.941	2.917	1	18
Number of legacy carriers in the city market	3.002	1.923	0	8
Number of route passengers (1,000)	0.701	2.25	1	50.54
Route average fare ($)[a]	215.1	76.89	16.55	1,501
Number of passengers in the city market (1,000)	2.6	10.8	1	243.4
HHI of the city market	0.610	0.279	0.111	1
Number of flights in the city market (1,000)	3.21	6.41	45	67.13
Number of served routes by Southwest connecting the origin airport	10.17	16.22	0	64
Number of served routes by Southwest connecting the destination airport	12.46	17.44	0	63
Origin hub dummy	0.211	0.408	0	1
Destination hub dummy	0.194	0.395	0	1
Geometric mean of population of end-point cities (Millions)	1.622	1.855	0.068	16
Geometric mean of income-per-capita of end-point cities (1,000 $)	30.21	3.87	14.83	54.35
Route distance (1,000 miles)	1.045	0.648	0.025	4.004
Number of observations	762,534			

[a] We do not include taxes in the fares because the tax does not vary across domestic markets.

Table A2: Summary Statistics of EU Data

Variable	Mean	Std.Dev.	Min	Max
Route average fare (Euros)[a]	141.8	70.28	26	4,430
Route distance (1,000 km)	1.141	0.796	0.1	4.996
Number of carriers in the regional market	7.002	5.862	1	48
Dummy of the route presence of Ryanair	0.167	0.373	0	1
Dummy of the route presence of EasyJet	0.088	0.283	0	1
Number of passengers in the regional market (1,000)	11.48	20.45	1	227.9
Percentage of first class passengers in the regional market	0.016	0.051	0	1
Percentage of business class passengers in the regional market	0.037	0.074	0	1
Number of served routes by Ryanair connecting the origin airport	7.026	13.790	0	99
Dummy of presence at the origin airport of Ryanair	0.406	0.491	0	1
Number of served routes by Ryanair connecting the destination airport	7.132	16.29	0	99
Dummy of presence at the destination airport of Ryanair	0.431	0.495	0	1
Number of served routes by EasyJet connecting the origin airport	5.084	8.574	0	69
Dummy of presence at the origin airport of EasyJet	0.563	0.496	0	1
Number of served routes by EasyJet connecting the destination airport	4.687	8.750	0	69
Dummy of presence at the destination airport of EasyJet	0.506	0.500	0	1
Number of flights in the regional market	146.9	236.4	1	2,832
Number of seats in the regional market (1,000)	19.28	33.33	19	388.3
HHI of the regional market	0.639	0.308	0.070	1
Geometric mean of population of end-point catchment areas (Millions)	2.581	1.926	0	13.95
Geometric mean of income-per-capita of end-point catchment areas (1,000 Euros)	35.26	11.39	3.79	97.04
Number of observations	289,546			

[a] We obtained tax information in the European data, but consistent with the U.S. data we did not include taxes in the fares.