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Andrea Gualini, Gianmaria Martini and Flavio Porta

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The Effect of Low-Cost competition on Airfares in the European Skies

Andrea Gualini*†, Gianmaria Martini‡, Flavio Porta§

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Abstract

The main objective of this work is about the contribution to the existing literature regarding the effects on airfares resulting from Low-Cost Carriers (LCCs) in the gateway-to-gateway European market. To the best of our knowledge, this is the first paper describing the impact of LCCs' operations on ticket prices in Europe. Following a descriptive analysis, a panel data econometric model is developed. Data are mostly collected from the Official Aviation Guide (OAG) and consists of monthly based observations collected from carriers marketing and operating flights in Western and Eastern Europe between January 2016 and December 2019. Our results confirm a 17% airfare reduction when LCCs operate a route and a monotone negative trend as their market share increases. Finally, FSCs rise their fares when competing with LCCs: the average increase varies with the market share of the competitors and this time the function has a maximum: if LCCs' market share remains below 45%, FSCs' fares increase, otherwise their prices decrease as well. Our results provide updated insights to help reshaping the European airline scenario according to a genuine regime of competition and offers support and help to policy makers in their understanding of the effects of open sky liberalizations (LCCs) and competition that must be scrutinized carefully by antitrust authorities.

JEL classification: L93, L41, C36
Keywords: Airline price competition, European market, Low-Cost Carrier, Ryanair, EasyJet

*Corresponding author
†Università degli studi di Bergamo, Italy. E-mail address: andrea.gualini@unibg.it
‡Università degli studi di Bergamo, Italy. E-mail address: gianmaria.martini@unibg.it
§Università degli studi di Bergamo, Italy. E-mail address: flavio.porta@unibg.it

1 Introduction

Over the past decades, the European aviation industry has undergone major changes that have profoundly transformed the modern-day travel industry. The Single European Act (1986) paved the way for all commercial restrictions for European airlines operating within the EU to be removed.[1] The process of deregulation started in 1987 with the approval of the first liberalization package and completed in 1997 with the adoption of the third package. Since then all European airlines can operate national routes in all countries of the European Union.

One of the most notable consequence of the European market liberalization has been the rise of Low-Cost Carriers (LCCs) that strongly impacted the *status quo*. LCCs have generated additional demand by opening new routes Martini et al. (2013), and subtracted market shares from incumbent carriers when they compete on the same itineraries.

Key implications of the liberalization process therefore include the increase in the number of routes flown, the increase in the number and in the type of competitors and the natural selection of the most efficient operators only. However, after more than 20 years since the beginning of this process, the positive effects might have attenuated and the reasons why the liberalization took place might have faded away as LCCs consolidated their position in the market (according to ICAO they represent over the 40% of the supply side of the market (ICAO, 2015) [2] and might have changed their strategy, not aiming at proposing the cheapest fares anymore.

Making sure that the purposes why this process have been started still hold true is just enough to make the analysis of the impact of LCCs on airfares in the intra-European market a relevant and interesting topic to be scrutinized.

In general, the state of the art describes a reduction of airfares when LCCs operates a route, but this effect varies with the relative importance of LCCs on the route. To further analyze this aspect, our paper also investigates how FSCs behave while offering tickets for itineraries where they compete with LCCs looking exclusively at FSCs fares variation when facing LCCs competition.

To the best of our knowledge, this paper investigates for the first time the FSCs price behavior to Low-Cost competition and the impact of LCCs on airfares on direct flights in the European passenger aviation market and in general on medium/short-haul itineraries.

We develop a reduced form model based on a panel dataset of GDSs and online fares, hence enabling for a complete picture to be represented.

The paper is organized as follows. In the section 2, we provide a brief literature review of research

[1] Before deregulation long and established state-owned airlines–also called flag carriers–were dominating European skies and all routes were regulated by state-based bilateral agreements. There was no possibility of entry by airlines not included in the bilateral agreement.

[2] ICAO, 2015. https://www.icao.int/sustainability/pages/low-cost-carriers.aspx

connected to our paper, in Section 3 we discuss the estimation methods and our data, while in Section 4 we show the econometric results that we discuss in Section 5, that concludes our paper. In the Appendix, we report additional information about the dataset.

2 Literature review

Since a few years after the beginning of the deregulation process of the air transportation market and the rising of different business models (i.e., LCC) and new forms of cooperation (i.e., code-sharing, alliances, joint ventures), a literature about the effects and the consequences of such new features has born. The first studies were strongly theoretical due to the absence of empirical data. As detailed databases were made available, empirical studies took the scene. (i.e., Brueckner and Whalen (2000)). Since 1998 the U.S. DOT (Department of Transport) collected information about fares, traffic and departures between the United States and the rest of the world giving a valuable instrument to US American researchers that could start to exploit the nowadays well-known T-100 and DB1B databases. This paper is built on the stream of literature that analyses the impact of LCCs on airfares.

Shortly after the US deregulation in 1978, the pioneering LCC, Southwest Airlines, developed an aviation model that reduced costs and increased efficiencies, relying on a standardized aircraft fleet, simple point-to-point routes, fast turnaround times at gates, high aircraft utilization, and the use of secondary airports. Operations emphasized short-medium haul routes, where the low-cost model could readily be implemented. Other LCCs in North America, Europe, Asia and elsewhere followed suit. Research findings show that LCCs have operating costs 20-30% below network carriers (Zou et al. (2015); Wilken et al. (2016)), with fares 20% or more below competitors (Kwoka et al. (2016)). As the LCCs grew and saturated their markets, they searched for new operating strategies to gain market share. Some LCCs moved operations from secondary airports to more costly, primary airports to attract business travelers. Others diversified their fleets or established hubs to connect passengers. Finally, some LCCs began operating long-haul routes in addition to (or instead of) short-medium haul connections. Differently from many of the contributions regarding airfares and LCCs in Europe (among the others, Malighetti et al. (2009), Salanti et al. (2012), Bilotkach et al. (2015)) which focus on the analysis of the low-cost business model and the study of dynamic pricing techniques, this work takes a different perspective and considers prices as monthly averages ignoring the daily dynamism of this variable, but focusing on a broader picture. The objective of this study is in fact markedly different.

For this paper, we extend the work on LCCs by analyzing the fare effects from LCCs presence and intensity in the European market.

3 Model and Data

In the first part of this section, we present the econometric model adopted to study the impact of LCCs on prices in the intra-European market, as well as the related econometric challenges that we face, and the way our models accommodate these challenges. We introduce two models: the first investigates the impact of LCCs on airfares; the second analyses the different prices charged by FSCs as function of the presence/intensity of LCCs competition on a route. In both cases we estimated a panel data econometric model with fixed effects to control for the unobserved heterogeneity.[3] Time fixed effect have also been controlled for by including monthly and yearly dummy variables. Finally, standard errors are clustered at the city-pair level which is the cross identifier of our analysis and together with the time dimension defines each unique item of our dataset.

3.1 The econometric model

The baseline econometric specification is as follows:

$$\begin{aligned} log(FARE)_{jt} = \boldsymbol{\beta_1'} \cdot \boldsymbol{X_1} + \alpha_1 \cdot TOTCOMP_{jt} + \alpha_2 \cdot LCC_{jt} + \\ + \psi_j + m_t + y_t + v_{jt} \end{aligned} \tag{1}$$

In Eq. (1), the logarithm of the weighted average monthly fare in the European city-pair j in period t is function of a matrix $\mathbf{X_1}$ of exogenous explanatory control variables, and of a variable capturing the degree of competition ($TOTCOMP$), a variable capturing LCCs competition (LCC). [4] Since competition in aviation happens at the city pair level, we aggregated all the airports serving a specific local area.[5] $\boldsymbol{\beta_1}$ is a column vector of coefficients for the exogenous explanatory variables, α_1 is the coefficient for the effect of competition on airfares, α_2 identifies the impact of LCCs, α_3 the impact of alliances, ψ_j identifies the city-pair fixed effects which capture time invariant unobserved factors that may affect airfares on a route, while m_t and y_t are respectively monthly and yearly dummy variables. Finally, v_{jt} is the error term which it is assumed to be normally distributed with zero mean and constant variance σ_v^2.

[3] A Hausman test has also been run and confirms that a random effect specification was not a consistent alternative.

[4] Fares are directional (i.e., A-B and B-A are counted as separate routes) calculated in US dollars and do not include fees paid for allocating seats, baggage, or priority boarding. Nor do they include payments for onboard food and drinks, taxes, airports fees and surcharges. OAG Traffic Analyzer uses round-trip data (as well as one-way data) and divides the round-trip information into directional monthly bookings and fares, after considering revenue allocation procedures implemented by carriers. To limit for the inclusion of unrealistic data, we applied price and a frequency cutoffs: we constrained fares to be higher than 5$ and lower than 1000$ and we excluded flights reporting a frequency lower than 16 times a month (similarly to Brueckner and Singer (2019) where the frequency cutoff threshold is set to 48 departures per quarter).

[5] While in the U.S. airports are aggregated according to the Metropolitan Statistical Area (MSA), in Europe it is common to aggregate all airports within 90 minutes travel time distance or 100 kilometers. However we follow the OAG city-pair aggregation. For example, this means that Milan-Bergamo (BGY), Milan-Linate (LIN) and Milan-Malpensa (MXP) and Parma (PMF) are all aggregated to Milan city.

3.2 Econometric challenges

Working on such a model poses some econometric challenges like the potential endogeneity of $TOTCOMP$, and LCC.

We do not treat the possible endogeneity of LCC because most of the Low-Cost Carriers operating in our sample are experienced and consolidated players, present in the majority of the entire European network.

The reverse causality between price and competition is therefore the only econometric concern we treat as previous studies shown the importance for this correction (Bilotkach and Hüschelrath (2013), Gayle and Brown (2014), Bilotkach and Hüschelrath (2019), Dresner et al. (2021) among others).[6] As anticipated the method chosen to correct for that problem is the development of a standard 2SLS procedure where a couple of instrumental variables ($HUBDEST$ and $L1HHI$) are proposed to attenuate this econometric concern. $HUBDEST$ is defined as a dummy variable equal to 1 if the city-pair connects the origin to a destination where many cities can be reached: in particular if the destination city belongs to the top 10 percentile of the route distribution measured in terms of available destinations in the European market.

MODIFICARE (lo spirito è un po quello di BJ 2010)

Available seats on a flight are the output of a long-run decision, planned by an airline prior to the observed month (i.e., flight schedules are usually fixed for a season and disclosed at least one season in advance). As in Berry and Jia (2010), this instrument is used because the 75th quantile is a nonlinear function of exogenous route characteristics. It is clearly related to the number of competitors on a route, but its relationship with airfares is ambiguous. On the one hand, on the most important routes, competition might be severe and, therefore, fares could be low. On the other hand, given the high level of demand on these routes, fares might be higher than average. The second instrument $L1HHI$ is the market concentration index, one month before the observed fare and, given the fact that the structure of the market cannot vary too much within a season, it should reflect the number of competitor at the current time t, while it should be unrelated to the price. A similar instrumental variable was proposed in Bilotkach and Hüschelrath (2013) and Bilotkach and Hüschelrath (2019). To serve as valid instruments, the two variables need to be relevant and exogenous, and must respect the exclusion. Such conditions

[6] Brueckner and Singer (2019) do not address this issue as they believe the correction has little effect on the final estimates

can be verified with economic intuition and by empirical tests. However, while the relevance requirement can be tested, no empirical test can assure about the non violation of the exclusion restriction. Concerning the former requirement, a relevance test is a F-test on the instruments' parameters estimated in the first stage of the 2SLS. The p-value (equal to 0) suggests that our instruments are relevant (the hypothesis H0 that the instruments are irrelevant is in fact rejected). Furthermore, the very high F statistics (ranging from 71.33 to 88.49) guarantee that our instruments are not weak (Staiger and Stock (1997)). In order to empirically check for the second requirement (uncorrelation between the IVs and the error term), no trustable test is available. However, to check for underidentifying and overidentifying restrictions we run the Kleibergen–Paap and the Hansen J tests without a significant confirmation of the validity of the overall procedure. Nevertheless, we still believe that we are reducing the bias.
With such premises, the 2SLS model can be written as:

$$log(FARE)_{jt} = \boldsymbol{\beta_1'} \cdot \boldsymbol{X_1} + \alpha_1 \cdot TOT\hat{C}OMP_{jt} + \alpha_2 \cdot LCC_{jt} + \psi_j + m_t + y_t + v_{jt} \tag{2}$$

$$TOTCOMP_{jt} = \boldsymbol{\beta_2'} \cdot \mathbf{X_2} + \boldsymbol{\gamma_1} \cdot \mathbf{Z}_1 + e_{jt} \tag{3}$$

Eq. (3) represents the first stage of the 2SLS standard procedure and expresses the endogenous variable ($TOTCOMP$) as a function of a vector of exogenous variables $\mathbf{X_2}$ (where $\boldsymbol{\beta_2'}$ is a vector of coefficients), the two instrumental variables included in the vector $\mathbf{Z_1}$ and the error term e_{jt}, with 0 mean and variance σ_e^2. To capture the LCCs fare effects, two models have been implemented. The first specification approximates the main variable of interest with intensive attributes ($LCCPRES$) that do not account for the size of the phenomenon.The second variant proxies LCCs competition by capturing the respective intensity of the phenomenon ($LCCINT$) based on the seats share of the carriers serving the city-pair j at time t. To Account for non-linear relationships between fares and the intensity of LCCs and alliances operations, we included squared terms in the second specification of the model. Eqs. (4) and (5) present the extended formulation of the two models:

$$log(FARE)_{jt} = \boldsymbol{\beta_1'} \cdot \boldsymbol{X_1} + \gamma_1 \cdot TOT\hat{C}OMP_{jt} + \gamma_2 \cdot LCCPRES_{jt} + \psi_j + m_t + y_t + v_{jt} \tag{4}$$

$$log(FARE)_{jt} = \boldsymbol{\beta_1'} \cdot \boldsymbol{X_1} + \delta_1 \cdot TOT\hat{C}OMP_{jt} + \delta_2 \cdot LCCINT_{jt} + \\ + \delta_3 \cdot LCCINT_{jt}^2 + \psi_j + m_t + y_t + v_{jt} \tag{5}$$

where $TOT\hat{C}OMP_{jt}$ is obtained from the first stage in Eq. (3).

Results are presented in Table 2 in Section 5, and show the coefficients obtained through: the ols panel models (columns (2) and (4)) and the 2SLS models (columns (3) and (5)).
The second part of the analysis is based on a subset of data. The purpose is to identify the FSCs behavior in terms of fares while competing with LCCs. To achieve so, only those routes with at least one LCC have been analyzed, and without LCCs fares contributing to the computation of average monthly fares in each route. In this second fashion, the dependent variable represents the average of the FSCs fares only. Results for the subsample are presented in Table 3, and show the coefficients obtained through: the panel OLS models (columns (2) and (4)) and the 2SLS models (columns (3) and (5)).

3.3 Data

Our dataset is a panel with 4 years and 7,537 routes and is built as follows: we consider all intra European gateway-to-gateway round-trip routes marketed between January 2016 and December 2019 on a monthly base. Data on all flights are aggregated up to the city-pair level by grouping airports in the same metropolitan area following multi-airport designations in the Official Aviation Guide (OAG). Our sample counts 234,241 observations where each item is identified by the unique route-month combination over the 48 months of the time span considered.
Fares are obtained from the OAG Traffic Analyzer. The OAG provides fares charged by airlines on flights on routes worldwide. The OAG Traffic Analyzer data consist primarily of Marketing Information Data Transfer (MIDT) data obtained through MIDT's arrangement with the Travelport Global Distribution System (GDS) and adjusted with additional data from other GDS's. Bookings are divided into first class, business class, premium economy, full economy and discount economy tickets. Since one of our main purposes is to determine the impact of LCC operations on route fares and since LCCs sell predominantly discount economy tickets, we only include discount economy bookings. Fares are directional (i.e., A-B and B-A are counted as separate routes) calculated in US dollars and do not include fees paid for allocating seats, baggage, or priority boarding. Nor do they include payments for onboard food and drinks, taxes, airports fees and surcharges. OAG Traffic Analyzer uses round-trip data (as well as one-way data) and divides the round-trip information into directional monthly bookings and fares, after considering

revenue allocation procedures implemented by carriers.

Our dataset includes booking information mainly from European airlines serving the European market.[7] The dataset differentiates our contribution from the existing literature as it includes data from all airlines serving the market and all nonstop intra-European routes. Among others, our dataset includes EasyJet and Ryanair, the two largest Low-Cost Carriers in Europe.[8] The Schedule Analyzer gives access to schedule database allowing to collect essential information to identify trends and monitor competitors. In particular, the information about the frequency of a certain routes in the chosen time period helps to evaluate the relevance of a certain carrier on the route itself. Through that is possible to select only the carriers that make sense to consider as competitors and/or to weight observations and to built variables as $LCCINT$ which is based on seats (an information only available through the OAG SA module).

3.4 Variables

As we moved from an airline specific dataset to the route level, the variable representing the number of tickets sold at given price was chosen as weight to compute the average fares. To generate $LCCPRES$ dummy variable, we set a threshold equal to a market share of 5%. Observations with market shares below this cutoff point were not considered as signaling the presence of LCCs. Table 1 below presents descriptive statistics for the variables included in the econometric models.

Variable	Mean	Std. Dev.	Min	Max	Description
FARE	99.23	55.01	5	834	Average fare in discount economy class[9] (US $)
TOTCOMP	1.85	1.09	1	10	Number of operating carriers on a route
LCCPRES	0.51	0.49	0	1	Low-Cost carriers presence on the route
LCCINT	0.32	0.40	0	1	Low-Cost carriers intensity on the route
DIST	1,023	671.76	21	4,738	Weighted average route distance
POP	13,100	16,100	33.60	185,000	Product of the two endpoints' population[9] (bil)
GDP	1,980	2,660	1,660	2,830	Product of the two endpoints' income per capita[9] (mil US $)

Table 1: Summary statistics for the variables included in the models

The average price for the economy class is close to $100 with a pretty high standard deviation and a range going from $5 to $834. The number of competitors on a specific route goes from 1 to 10 with a mean value of 1.85 indicating a moderately competitive environment. About half of the

[7] The list of of all the European countries included in the analysis can be found in Table 5 in the Appendix

[8] The list of airlines included in the dataset is reported in Table 6 in the Appendix

routes sees the presence of a LCC as $LCCPRES$ takes value 1 in 51% of the cases. $LCCINT$ must have a lower mean than $LCCPRES$ (the same value would describe a situation where LCCs are always monopolist where they operate, hence a higher value would be impossible). The value 0.32 is not extremely far from 0.51 letting us think that the routes where LCCs are monopolists are not just a few (as it can be noticed from comparing Figure 1 and Figure 6 LCCs monopolist routes account for about one third of the monopoly category.

The average product of the two endpoints' population (POP) is about 13 trillion while the average product of per capita income (GDP) is almost \$2 billion.

In order to better understand the nature of our dataset we provide some descriptive evidence regarding interesting characteristics of our market. At first we focus on describing the market structures typical of our sample, then we provide descriptive insights on the average price of some clusters of interest. As shown in Figure 1, European routes exhibit high monthly variability in market structure. The plurality of routes are monopolies, with about 2,000 monopoly routes operating during the winter period and more than 2,700 during the peak demand period in the summer. The remaining routes are split about evenly between duopolies and routes with 3 or more operating carriers (there are additional airlines that market tickets on the routes and code share with operating carriers). There are about 1,100 routes in each of these categories during the winter period and 1,400 during the summer.[10]

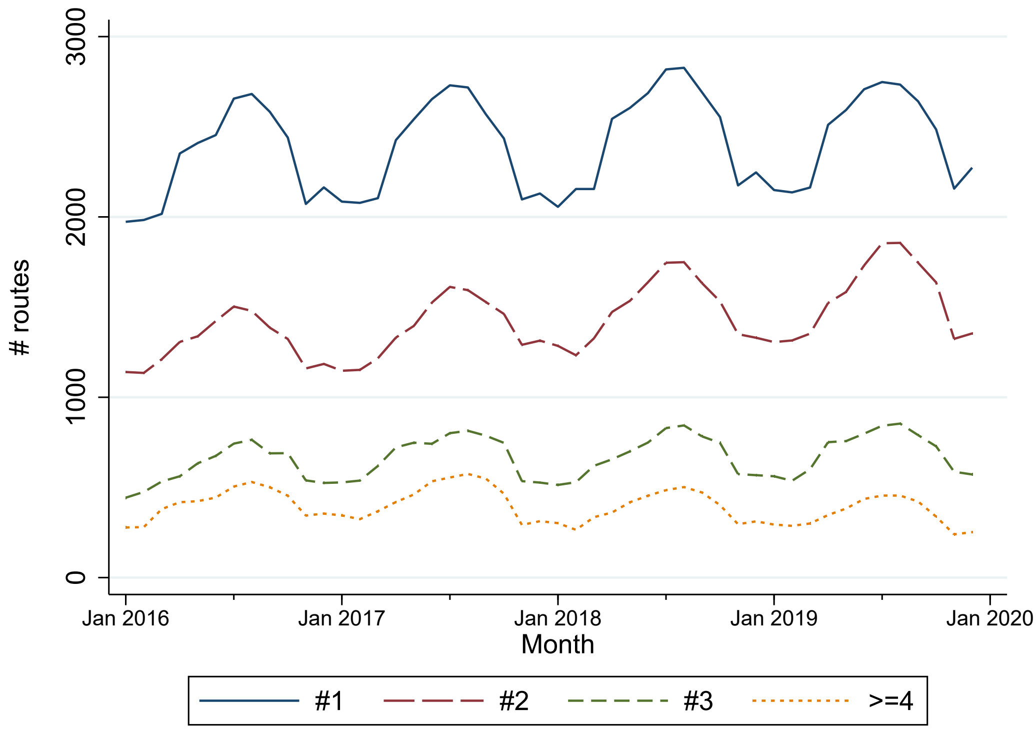

Figure 1: European routes by # of airlines and month

Figure 2 presents descriptive evidence on the impact of number of competitors on North Atlantic fares. The figure shows monthly fare per kilometer flown on monopoly routes (#1), duopoly routes (#2), triopoly routes (#3) and on routes where 4 or more airlines operate (#>=4). It is evident that average monthly fares are higher on monopoly routes than on routes with at least two competitors. Interesting and well visible is also the seasonality, with the highest peaks in July and August.

[10]Figure 6 in the Appendix shows the same plot but limited to LCCs routes

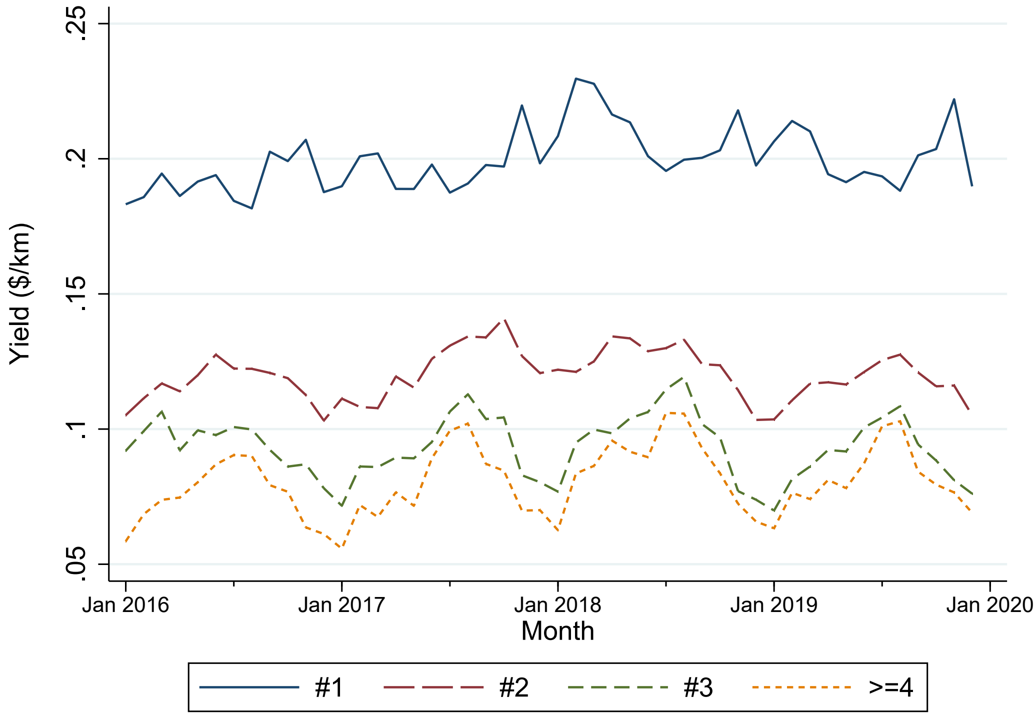

Figure 2: European routes average monthly price per kilometer, by competitive level

Figure 3 below shows descriptive evidence of the average yield offered by the top 5 carriers operating in the European market. It is evident that we can distinguish two groups: the LCCs (Ryanair (FR), EasyJet (U2)) and the major European flag carriers (British Airways (BA), Lufthansa (LF) and Air France (AF)). As expected, Figure 3 allows to infer how the former group operates at lower yields compared to the latter one. Ryanair proposes the cheapest fares per kilometer followed by EasyJet, with both carriers characterized by remarkable summer peaks. Among the top three national carriers, British Airways seems to set the lower yields, followed by Lufthansa and Air France. The national carriers' yields are about twice the LCCs'. Figures 1 to 4 pave the way for understanding the main treats of the European competitive landscape. However, to shed some light upon the descriptive clues just provided, a proper econometric model must be estimated to account for other factors that may be influencing fares. Results are reported in the next section.

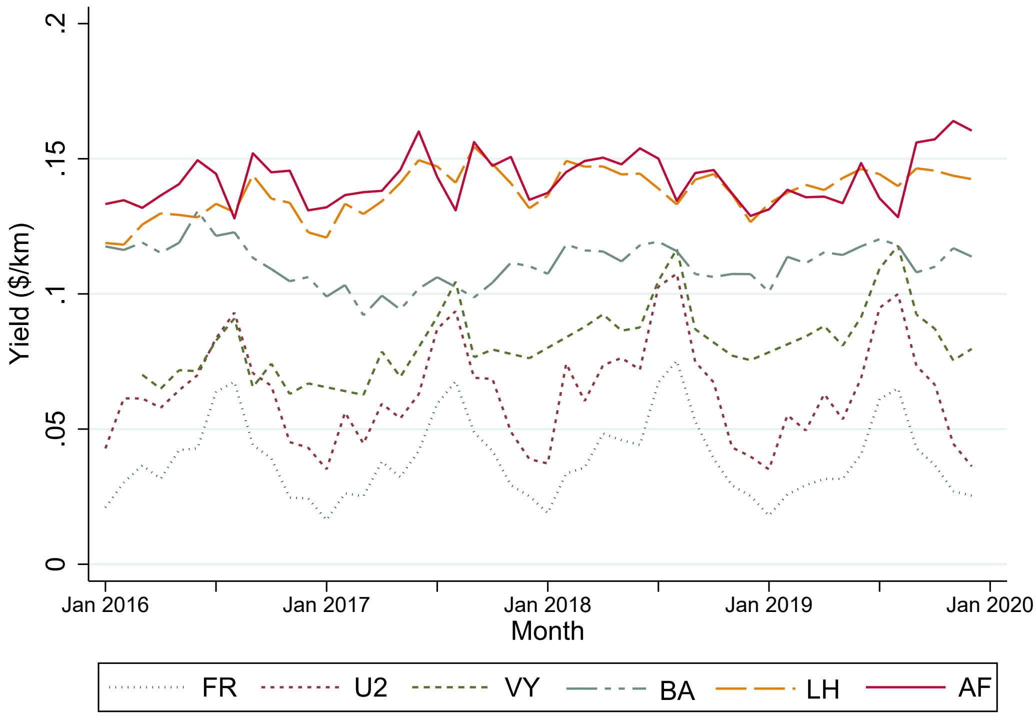

Figure 3: European routes' average monthly price per kilometer, of the top 6 airlines (by seats)

4 Results

In this section, we present the empirical results of our econometric models to estimate the impact of LCCs in intra-European markets. In Table 2, we show the full sample results.

dependent variable: *LFARE*				
	(2)	(3)	(4)	(5)
	OLS	2SLS	OLS	2SLS
TOTCOMP	-0.0407***	-0.141***	-0.0510***	-0.178***
	(-9.04)	(-31.18)	(-11.85)	(-35.52)
LCC	-0.176***	-0.143***		
	(-13.11)	(-29.10)		
LCCINT			-0.879***	-0.691***
			(-14.16)	(-26.64)
LCCINTSQ			0.516***	0.298***
			(10.72)	(12.74)
DIST	0.607	0.923***	0.331	0.760***
	(0.97)	(3.89)	(0.54)	(3.32)
POP	-1.316***	-1.314***	-1.233***	-1.236***
	(-9.10)	(-17.19)	(-8.65)	(-16.13)
GDP	-0.333***	-0.262***	-0.371***	-0.284***
	(-4.57)	(-6.82)	(-5.15)	(-7.44)
Time Fixed Effects	Yes	Yes	Yes	Yes
Route Fixed Effects	Yes	Yes	Yes	Yes
Observations	217,847	201,244	217,847	201,244
adj. R-sq	0.14	0.10	0.15	0.10
Robust t statistics in parentheses				
Legend: + = p 0.1; * = p 0.05; ** = p 0.01; *** = p 0.001				

Table 2: Fare estimates from different specifications - full sample

Columns (2) and (4) report the coefficients of the OLS regression model, while columns (3) and (5) the 2SLS estimates. The first two columns only capture the presence of LCCs with dummy variables. In particular column (3) shows that each additional competitor causes airfares to decrease by 6.1%, the presence of LCCs is associated with 17.4% lower fares. The $TOCOMP$ coefficient from column (3) is higher than the OLS estimate. This is due to the endogeneity correction of $TOTCOMP$. When we ignore this issue and we treat $TOTCOMP$ as exogenous, we believe that the coefficient from column (2) is downward biased as it contains individual characteristics that cause $TOTCOMP$ to produce an increase of fares, hence attenuating its true downward effect. Columns (4) and (5) report the estimates from intensity-based model. In column (5), similarly to the former results, we can note that each additional competitor reduces airfares by 12.7%. The coefficient of $LCCINT$ is negative (and significant) while the estimated coefficient of $LCCINTSQ$ is positive (and significant) indicating a U-shaped relation that we comment below with the help of Figure 4. Unfortunately, from column (5) we cannot infer much on the causal effect of alliance intensity of operations on airfares. Monthly, yearly and city-pair dummies are also included in the model, but not reported due to space considerations.

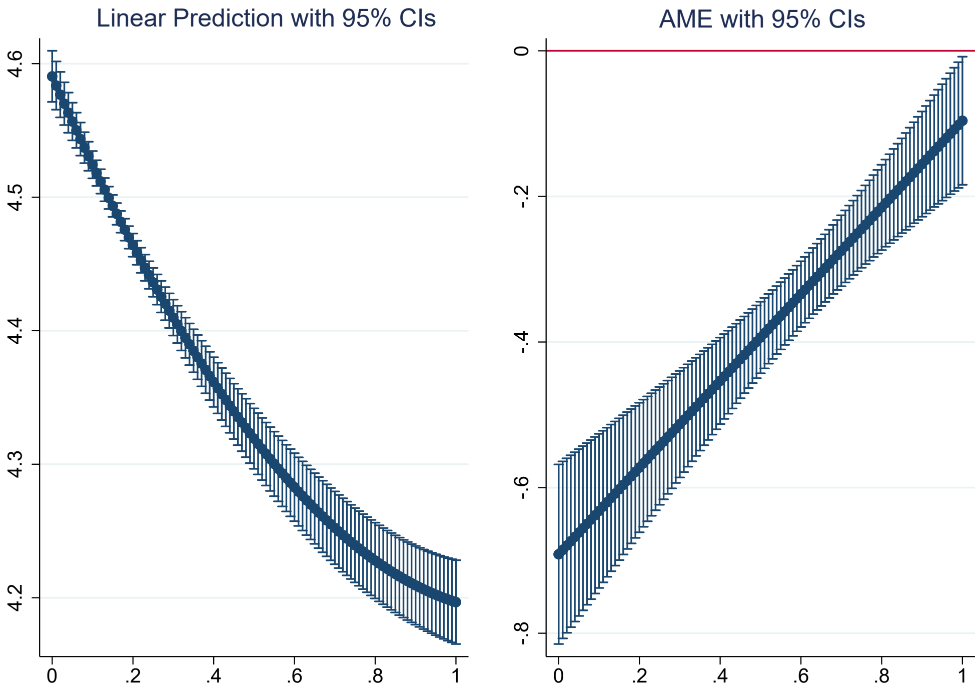

Figure 4: LCC predictions and marginal effects - full sample

Figure 4 confirms a monotone airfare reduction when LCCs operate on a route and a monotone negative trend as their market share increases. This happens till the point when $LCCINTENSITY$ equals 88% where we observe the maximum level of airfares reduction corresponding to -27%. Conversely, alliances would cause average fares to increase with a (very) subtle acceleration. However this second finding is not sustained by significant evidence.

Since Low-Cost Carriers do not often compete with Legacy Carriers, but rather they prefer to operate secondary routes where they can capture the more price elastic consumers (and sometimes operate alone on the market) the LCC effect might suffer from bias. In fact it might be the case that LCCs do not lower the average level of air fares in a market but instead they do offer new markets at low fares. To purify the estimates from this possibility we run a series of robustness checks where we include in the regressions the interaction term between $LCCPRES$ and a dummy variable identifying monopolistic routes (where $TOTCOMP$ corresponds to one).

In such a way we believe we can consistently draw conclusions on the LCCs fare effect.[11]

To investigate the FSCs behavior when competing with LCCs on the same route-month, we repeated the analysis on a subsample, where only FSCs' airfares were considered when computing the average fare for each route-month observation. For obvious reasons this reduced sample does not include routes where LCCs are monopolists and for which we provide additional insights in Table 8 in the Appendix). Table 3, provides results for the subsample.

[11]Table 8 in the Appendix reports such results without any significant change for the variables of interest apart from the reasonable and expected reduction in the magnitude (and significance) of the $TOTCOMP$ coefficient

dependent variable: *LFARE*				
	(2) OLS	(3) 2SLS	(4) OLS	(5) 2SLS
TOTCOMP	-0.0353***	-0.0955***	-0.0361***	-0.101***
	(-9.66)	(-20.13)	(-9.84)	(-20.81)
LCC	0.00130	0.0231***		
	(0.17)	(5.76)		
LCCINT			0.0630	0.202***
			(1.45)	(7.72)
LCCINTSQ			-0.242***	-0.380***
			(-4.93)	(-10.89)
DIST	0.842	1.095***	0.840	1.128***
	(1.36)	(5.11)	(1.36)	(5.26)
POP	-0.624***	-0.607***	-0.611***	-0.612***
	(-4.16)	(-8.58)	(-4.07)	(-8.63)
GDP	-0.296***	-0.298***	-0.293***	-0.289***
	(-3.95)	(-8.25)	(-3.90)	(-7.98)
Time Fixed Effects	Yes	Yes	Yes	Yes
Route Fixed Effects	Yes	Yes	Yes	Yes
Observations	156,413	144,963	156,413	144,963
adj. R-sq	0.05	0.01	0.05	0.01
Robust t statistics in parentheses				
Legend: + = p 0.1; * = p 0.05; ** = p 0.01; *** = p 0.001				

Table 3: Fare estimates from different specifications - restricted sample

As for Table 2, columns (2) and (4) report the coefficients of the OLS regression model, while columns (3) and (5) the 2SLS estimates. Column (3) shows that each additional competitor causes FSCs' airfares to decrease by 7%, the presence of airlines belonging to alliances ($ALLPRES$) produces an increase of FSCs' ticket prices equal to almost 4%. Column (5) reports the intensity-based estimates. We can observe that each additional competitor reduces FSCs' airfares by 6.1%. In contrast to the results from the full sample, the coefficient of $LCCINT$ is positive (and significant) while the estimated coefficient of $LCCINTSQ$ is negative (and significant) indicating an inverse U-shaped relationship that we further comment below with the support of Figure 5. As for column (5) from Table 2, unfortunately we cannot infer much regarding the causal effect that alliance intensity of operations generates on FSCs' average ticket prices. Again, monthly, yearly and city-pair dummies are also included in the model, but not reported due to space considerations.

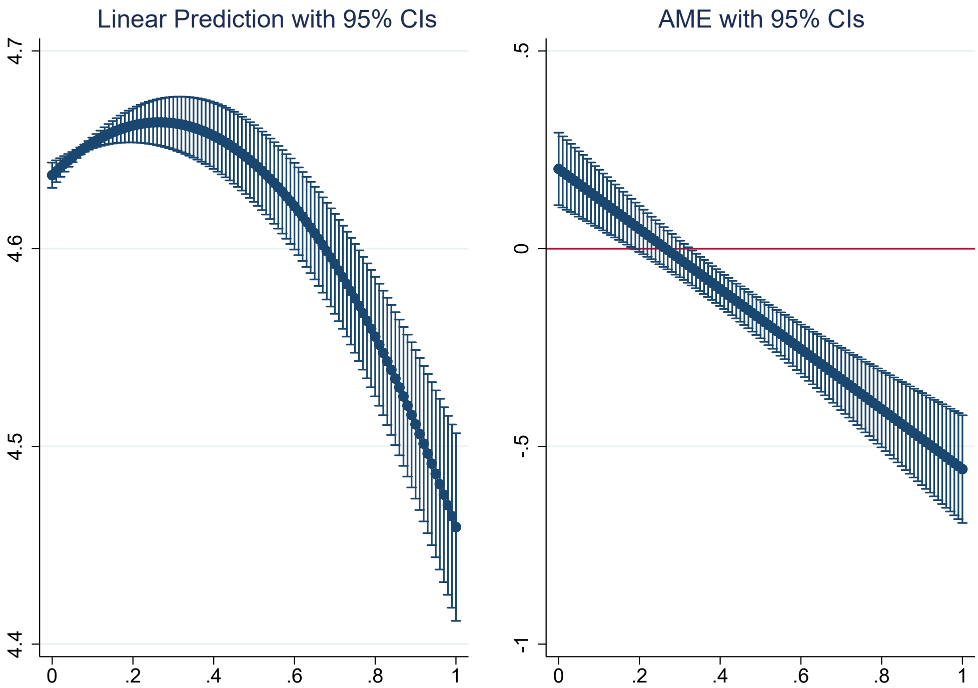

Figure 5: LCC predictions and marginal effects - subsample

As Figure 5 displays, FSCs may rise their fares when competing with LCCs, but the average increase varies with the market share of the competitors. This time the function has a maximum: below the threshold of 22.7% LCCs' market share FSCs continue to increase their fares at a decreasing rate; beyond that point the air fares variation gradually goes back to zero, and only beyond 45% LCCs' market share FSCs reduce their prices and they do so at an increasing pace. As before, we lack significant evidence to conclude about the pricing behavior when $ALLINT$ moves towards unity.

The baseline model and the combined use of the coefficients for the variables $TOTCOMP$, $LCCPRES$, and $ALLPRES$ (i.e., $\hat{\gamma}_1$, $\hat{\gamma}_2$, and $\hat{\gamma}_3$) allow us to simulate the effects of entry mechanisms on European routes. We predict that if a low-cost carrier enters a route (and causes $LCCPRES$ to take 1), the additional competitor generates the following effect on air fares: since we have a log-linear equation, the estimated percentage impact is computed as $(e^{\hat{\gamma}_1+\hat{\gamma}_2} - 1) \cdot 100$. Hence, the estimated effect on air fares is -21.4%. The results reported in Table 4 shows that the null hypothesis, $H_0 : \hat{\gamma}_1 + \hat{\gamma}_2 = 0$, can be rejected ($p$-value 0.005), implying that a low-cost carrier entry leads to reduced fares on a route. On the other hand, if the entrant is an alliance carrier (and causes $ALLPRES$ to take 1) the additional competitor would reduce fares by 1.7%. What happens is that the entry effect (from an additional competitor) is almost offset if the entrant belongs to an alliance. Finally, we test the effect of the simultaneous entry of an LCC and an alliance airline on a route. In this case, we have two new competitors, and the estimated total effect is -22.8%. Since we can reject the null $H_0 : \hat{\gamma}_1 + \hat{\gamma}_2 + \hat{\gamma}_3 = 0$, this combined entry has significant impact on airfares. This implies that if a low-cost carrier and an alliance competitor both enter a city-pair, the airlines behave competitively, generating a robust decrease in air fares.

TEST	(2) 2SLS
TOTCOMP + LCCPRES = 0 $\gamma_1 + \gamma_2 = 0$	$p = 0.0000$

Table 4: Tests of joint significance

5 Conclusions

This work aims at offering a first empirical evidence of airlines pricing in the intra-European nonstop market, supporting policy authorities in their understanding of the effects of open sky liberalizations (LCCs) and of informal restrictions on competition (alliances) that must be scrutinized carefully.

Since the liberalization process were put in place, the aviation industry enjoyed the advantages resulting from more competition. However, the agreements also permitted more freedom to set cooperative agreements often resulting in coordination mechanisms as the joint set of capacity, schedules, and fares. After more than 20 years since those mechanisms were allowed to exist, this research proposes to investigate two phenomenon: on the one hand, we verify the well-recognized feature of LCCs to decrease airfares; on the other hand we offer empirical evidence of the positive effect on airfares related to the presence of alliances on GTG short/medium-haul routes. Although the first part of the research questions might be already extensively investigated, we offer updated results for a market that was never studied with such a detailed dataset. In particular, our work includes all the airlines operating the in European market, and all the active routes. Regarding the second part of our research question, we offer clarity to the alliance GTG literature that reports uncertain evidence and that never focused in such a way on one among the most important market.[12]

The two ways the dependent variable is computed, allows for two levels of analysis to be studied: results from the full sample provide insights on the average ticket prices proposed on routes where LCCs are present; estimates from the subsample permit the study of the FSCs' pricing behavior with and without Low-cost competition. This second setting of the analysis obviously excludes itineraries where LCCs operates alone. Therefore, the coefficient of $LCCPRES$ indicates the average effect produced by the presence of LCCs on FSCs' ticket prices that might be not as obvious as the diminishing effect of $LCCPRES$ when including LCCs' fares in the computation of the average fares.

After controlling for route characteristics and for the level of competition on a route (that we attempt to treat in a way that solves endogeneity concerns), our results can be summarized as follows.

From the presence models, we find that LCCs' presence is associated with 17% lower fares, while the presence of alliances produces about 5% higher airfares. The entry effect of additional competitors depends upon the characteristics of the newcomer: if the entrant is a LCC the combined effect is associated with 21% lower fares; if the entrant is a carrier belonging to an

[12] According to the IATA World Air Transport Statistics 2021 report Europe represents about 24% of the world air passenger traffic IATA (2021)

alliance the effect of an increase in competition is attenuated and results in about a 2% reduction of airfares. Finally, we show that the joint entrance of a LCC and an allied carrier produces (two additional competitors) generates a 23% decrease in ticket prices.

From the intensity model on the full sample we find that LCCs always lower fares up to the limit of about -27%. Evidence from the restricted sample show that when LCCs operations account for less than 45% of the market, FSCs slightly increase fares (on average of about 1.2%), while they lower ticket prices otherwise up to the limit of -18%.

To incentivize the entry of Low-Cost Carriers can be considered with no doubts a tool to provoke a fall in ticket prices. Of course, care must be taken in order to avoid losing the differentiated products offered by Full-Service Carries. The outbreak of Covid-19 was and will be a turning point in many fields and aviation is obviously one of the most affected compartments; that is why investigating this issue at this time is also more relevant. Our results aim at offering insights to help reshaping the European airline scenario according to a genuine regime of competition.

The dataset used for this paper allows for the extension of the analysis to connecting flights, but as it is does not include information on higher degrees of cooperation (i.e., joint ventures). We leave this for future research.

Estimates suggest that the presence of alliances in European GTG markets results in higher air fares, after controlling for other factors that may influence fares. However, our work is limited to the price perspective that is obviously just a piece of the puzzle and is limited to considering single routes. Other important aspects to be considered would be the network implications and service quality improvement for the final users (expanded set of destinations and easier access to the global network, higher frequency, better coordination, frequent flyer status and access to lounges, etc.). In order to take conscious decisions the whole set of information would be necessary to support the decisions of legislators and regulating authorities. That said, price implications can be considered as the most direct and perceived by consumers and therefore they could well represent the drawbacks of such a coordination mechanism and the minimum level of consumers benefit to be corresponded. The mediation of the regulators that discipline the European skies is fundamental to guarantee the adequate level competition. Future studies could be focused at describing the whole picture and possibly providing clues to manage a balanced and coordinated competitive scenario.

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6 Appendix

Country Code	Country Name	Percent	Cum.
GB	United Kingdom	13.15	13.15
ES	Spain	11.28	24.43
DE	Germany	11.27	35.70
IT	Italy	9.56	45.26
FR	France	8.33	53.59
NO	Norway	3.90	57.49
PL	Poland	3.25	60.74
NL	Netherlands	3.24	63.98
CH	Switzerland	3.15	67.13
PT	Portugal	2.82	69.95
SE	Sweden	2.64	72.59
TR	Turkey	2.62	75.21
GR	Greece	2.19	77.40
AT	Austria	2.17	79.57
IE	Ireland	2.07	81.64
DK	Denmark	1.95	83.59
BE	Belgium	1.68	85.27
FI	Finland	1.67	86.94
RO	Romania	1.60	88.54
UA	Ukraine	1.40	89.94
CZ	Czech Republic	1.15	91.09
HR	Croatia	1.00	92.09
HU	Hungary	0.84	92.93
RS	Serbia	0.84	93.77
BG	Bulgaria	0.64	94.41
LV	Latvia	0.64	95.05
LT	Lithuania	0.50	95.55
LU	Luxembourg	0.50	96.05
BY	Belarus	0.42	96.47
MT	Malta	0.41	96.88
CY	Cyprus	0.38	97.26
SI	Slovenia	0.35	97.61
IS	Iceland	0.34	97.95
EE	Estonia	0.33	98.28
SK	Slovakia	0.26	98.54
AL	Albania	0.25	98.79
MD	Moldova	0.24	99.03
GE	Georgia	0.20	99.23
MK	Macedonia	0.19	99.42
BA	Bosnia and Herzegovina	0.16	99.58
ME	Montenegro	0.16	99.74
AZ	Azerbaijan	0.15	99.89
AM	Armenia	0.11	100

Table 5: List of European countries included in the dataset

Airline Code	Airline Name	Percent	Cum.	Airline Code	Airline Name	Percent	Cum.
FR	Ryanair	19.57	19.57	LM	Loganair	0.30	95.09
U2	Easyjet	8.94	28.51	FI	Icelandair	0.29	95.38
W6	Wizz Air	7.08	35.59	BM	BMI Regional	0.28	95.66
VY	Vueling Airlines	4.05	39.64	XK	Air Corsica	0.28	95.94
DY	Norwegian Air Shuttle	4.00	43.64	W2	FlexFlight ApS	0.27	96.21
EW	Eurowings	3.16	46.80	TF	Braathens Regional Aviation	0.26	96.47
LH	Lufthansa German Airlines	2.91	49.71	9U	Air Moldova	0.25	96.72
SK	SAS Scandinavian Airlines	2.90	52.61	BV	Blue Panorama Airlines	0.22	96.94
LS	Jet2.com	2.82	55.43	NT	Binter Canarias	0.22	97.16
BE	Flybe	2.43	57.86	J2	Azerbaijan Airlines	0.21	97.37
V7	Volotea	2.24	60.10	EL	Ellinair S.A.	0.20	97.57
BA	British Airways	1.77	61.87	GQ	Sky Express S.A.	0.19	97.76
IB	Iberia	1.73	63.60	SP	SATA Air Acores	0.19	97.95
TK	Turkish Airlines	1.70	65.30	YM	Montenegro Airlines	0.18	98.13
HV	Transavia.com	1.41	66.71	S4	SATA International-Azores Airlines S.A.	0.16	98.29
AF	Air France	1.33	68.04	EN	Air Dolomiti S.p.A L.A.R.E	0.12	98.41
AZ	Alitalia - Societa Aerea Italiana S.p.A	1.31	69.35	SX	Sky Work Airlines	0.12	98.53
4U	germanwings	1.30	70.65	T7	Twin Jet	0.12	98.65
LX	SWISS	1.25	71.90	W9	Wizz Air UK	0.12	98.77
KL	KLM-Royal Dutch Airlines	1.24	73.14	A9	Georgian Airways	0.11	98.88
EI	Aer Lingus	1.22	74.36	CE	Chalair	0.11	98.99
A3	Aegean Airlines	1.21	75.57	T3	Eastern Airways	0.08	99.07
OS	Austrian Airlines AG dba Austrian	1.21	76.78	2N	Nextjet	0.07	99.14
LO	LOT - Polish Airlines	1.11	77.89	GR	Aurigny Air Services	0.07	99.21
AB	Air Berlin	1.07	78.96	M9	Motor Sich PJSC	0.06	99.27
0B	Blue Air	1.04	80.00	WX	City Jet	0.06	99.33
AY	Finnair	1.01	81.01	ZI	Aigle Azur	0.06	99.39
TP	TAP Portugal	0.92	81.93	5F	Fly One	0.05	99.44
UX	Air Europa	0.91	82.84	F7	Darwin Airline	0.05	99.49
A5	HOP!	0.88	83.72	8Q	Onur Air Tasimacilik A.S.	0.04	99.54
SN	Brussels Airlines	0.88	84.60	CO	Cobalt Aero	0.04	99.58
WF	Wideroe's Flyveselskap	0.85	85.45	7W	Wind Rose Aviation	0.03	99.61
BT	Air Baltic Corporation	0.76	86.21	CY	Cyprus Airways	0.03	99.64
PS	Ukraine International Airlines	0.76	86.97	YE	Yanair	0.03	99.67
TO	Transavia.com France	0.64	87.61	Z6	Dnieproavia Joint Stock Aviation Co	0.03	99.70
OU	Croatia Airlines	0.58	88.19	2L	Helvetic Airways	0.02	99.72
RO	Tarom	0.57	88.76	CA	Air China	0.02	99.74
JU	Air Serbia	0.53	89.29	EK	Emirates	0.02	99.77
OK	Czech Airlines	0.52	89.81	ET	Ethiopian Airlines	0.02	99.79
LG	Luxair	0.48	90.29	GM	Germania Flug AG	0.02	99.81
ZB	Monarch Airlines	0.45	90.74	LA	Lan Airlines	0.02	99.83
DE	Condor Flugdienst	0.44	91.18	UH	Aircompany Atlasjet Ukraine LLC	0.02	99.85
B2	Belavia	0.43	91.61	VK	LEVEL operated by Anisec Luftfahrt	0.02	99.87
PC	Pegasus Airlines	0.42	92.03	WW	WOW Air	0.02	99.89
QS	SmartWings	0.42	92.45	3U	Sichuan Airlines	0.01	99.90
JP	Adria Airways	0.38	92.83	HU	Hainan Airlines	0.03	99.93
ST	Germania	0.37	93.20	PE	Peoples Vienna Line	0.01	99.94
KM	Air Malta	0.35	93.55	QR	Qatar Airways	0.01	99.96
HG	NIKI	0.33	93.88	SE	XL Airways France	0.01	99.97
FB	Bulgaria Air	0.31	94.19	U8	TUS Airways	0.01	99.98
IG	Meridiana fly S.p.A.	0.30	94.49	VG	VLM Airlines N.V.	0.01	99.99
KK	AtlasGlobal	0.30	94.79	XQ	SunExpress	0.01	100

Table 6: List of airlines included in the dataset

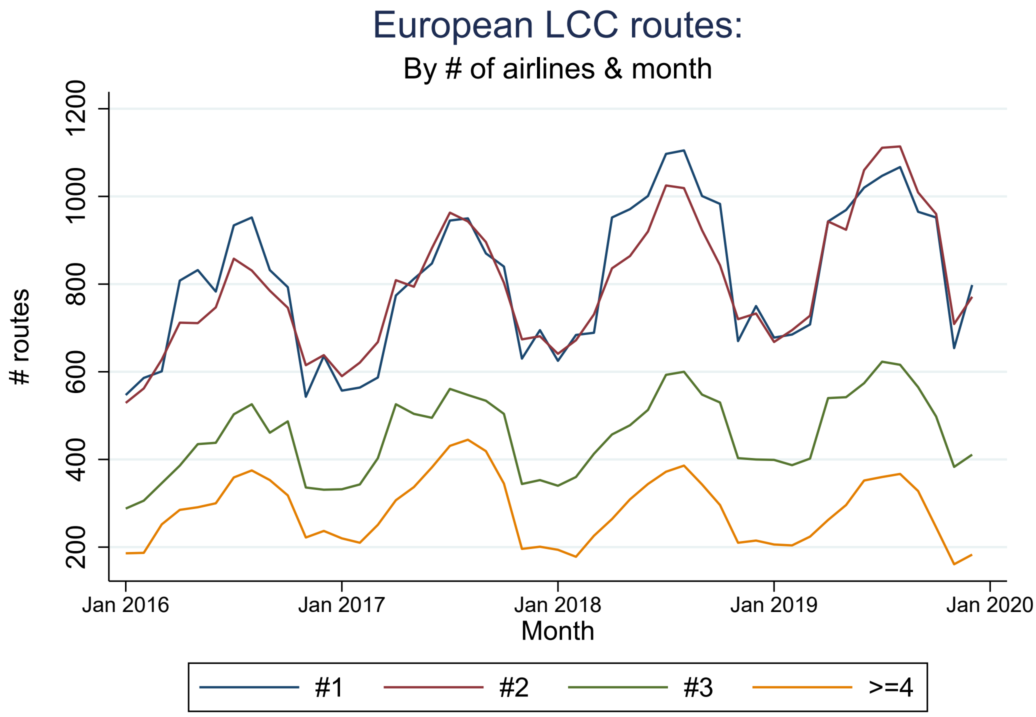

Figure 6: European LCCs routes by # of airlines and month

dependent variable: *LFARE*				
	(2)	(3)	(4)	(5)
	OLS	2SLS	OLS	2SLS
TOTCOMP	-0.0478***	-0.201***	-0.0519***	-0.207***
	(-10.04)	(-33.14)	(-11.21)	(-34.83)
LCC	-0.170***	-0.110***		
	(-13.17)	(-21.31)		
LCCMONOPOLY	-0.0504**	-0.209***	-0.00815	-0.150***
	(-3.11)	(-21.13)	(-0.51)	(-15.00)
LCCINT			-0.880***	-0.687***
			(-14.11)	(-26.22)
LCCINTSQ			0.520***	0.347***
			(10.62)	(14.85)
DIST	0.622	1.072***	0.336	0.874***
	(1.00)	(4.55)	(0.55)	(3.82)
POP	-1.323***	-1.356***	-1.234***	-1.264***
	(-9.15)	(-17.56)	(-8.65)	(-16.39)
GDP	-0.337***	-0.245***	-0.371***	-0.272***
	(-4.63)	(-6.35)	(-5.15)	(-7.09)
Time Fixed Effects	Yes	Yes	Yes	Yes
Route Fixed Effects	Yes	Yes	Yes	Yes
Observations	217,847	201,244	217,847	201,244
adj. R-sq	0.14	0.09	0.15	0.09
Robust t statistics in parentheses				
Legend: + = p 0.1; * = p 0.05; ** = p 0.01; *** = p 0.001				

Table 7: Fare estimates from different specifications - explicitly controlling for the effect of LCC monopoly