Economics of Transportation, Volume 14, June 2018, Pages 42-52
DOI:10.1016/j.ecotra.2018.02.002

Price asymmetries in European airfares

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Abstract

This research analyses airlines' pricing decisions in response to changes in the market conditions. We estimate the effects of jet fuel price changes on European airfares at airline/route level by discriminating on the grounds of supplied capacity and markets' competitive structure. Our results show that airlines tend to adjust fares asymmetrically following a "rocket and feather" behaviour. The asymmetric pricing is marked in periods of decreasing capacity when the increases of fuel price are passed at a higher degree than fuel cost savings. In contrast, when capacity increases the asymmetry is lowered. Moreover, we show that highly competitive markets are characterized by a lower price asymmetry compared to low competition markets. Finally, our results show that airline price asymmetry reaches its maximum when capacity is reduced and competition is low.

Keywords: airlines, price asymmetry, pass-through rate; fuel cost.

JEL codes: L11, L93, R41

Highlights:

- The paper analyses airlines' pricing decisions in response to fuel price changes.
- Airlines adjust fares asymmetrically according to a "rocket and feather" behaviour.
- Prices are adjusted faster in case of increasing fuel prices.
- The higher the competition the lower the positive asymmetry.
- Combinations of capacity change and market competition affect the asymmetry level.

Please cite as in: https://www.sciencedirect.com/science/article/pii/S2212012217300837

1 Introduction

A relevant topic in the airline industry is whether airlines succeed in passing through cost changes to their fares. It is relevant for airlines, whose volatility in cost levels (especially in fuel cost) is a source of significant risk (Borenstein, 2011b). It is extremely important for regulators, whose policy interventions' effects depend to what extent charges are born by airlines rather than by passengers paying higher fares (Koopmans and Lieshout, 2016). It is attention grabbing for popular press, especially during periods in which consumers complain about raising airfares despite plunging oil prices (The Guardian, 2015, The Wall Street Journal, 2015). Finally, it is vital for antitrust authorities, which constantly monitor competition levels in the airline industry, especially after the recent period of major carriers' consolidation (The Economist, 2015). Recently, concerns about possible uncompetitive dynamics in the industry have gained ground among consumers and policy makers as demonstrated by the remarks of US senator Charles E. Schumer who declared: "the industry often raises prices in a flash when oil prices spike, yet they appear not to be adjusting for the historic decline in the cost of fuel; ticket prices should not shoot up like a rocket and come down like a feather" (The New York Times, 2015). This recalls to Bacon (1991) who termed "rocket and feathers" the pattern of asymmetric price adjustments of retail gasoline prices to cost changes. Despite such relevance, the empirical evidence on airline price asymmetries in response to cost changes is limited and mainly focused on US data. The aim of this paper is to shed light on carriers' response to input price changes in the European airline industry. The focus is on fuel prices that, together with labour costs, are the major factors driving the changes in airlines' input prices (Scotti and Volta, 2017). Specifically, the importance of fuel price is mainly due to its volatility: while the trend of labour costs is typically increasing on the long period (Dennis, 2007), the impact of volatile fuel price is less predictable playing a determinant role in airline' short terms input price change (Franke and John, 2011). This is demonstrated by the fact that airlines hedge a portion of their fuel needs to reduce the swings in profits (Morrell and Swan, 2006). As a further confirmation of the key role of fuel costs, the US Department of Justice began an investigation in June 2015 on major US carriers accused to have saved billions of dollars on fuel without passing these savings to the passengers (The Washington Post, 2015).

Economic theory on pricing behaviour tells that, in a context of profit maximizing firms, a general rule is that firms will charge a relative mark-up on marginal costs. Such mark-up depends on the elasticity of the demand that in turn is affected by the demand shape and the market structure. When firms face a change in their costs the way in which it is passed-through to consumers depends on the type of cost (firm specific or industry-wide), and on the firm market power. When analysing the airline industry, many papers refer to the airlines industry as highly competitive, hence considering a symmetric pass-through rate of 100%.[1] Few other contributions (e.g. Forsyth and Gillen, 2007; Forsyth, 2008 and Oxera, 2003) consider the aviation markets as oligopolies assuming a significantly lower rate. A comprehensive review on the topic is provided in Koopmans and Lieshout (2016), who discuss the expected behaviour of airlines according to market characteristics. The authors consider market routes as differentiated oligopolies where airlines compete choosing their flight schedules first (as firms choosing their quantities in a Cournot model) and then adapting their fares to the demand levels. The authors conclude that empirical studies on airline pass-through rate are however limited mainly due to lack of detailed ticket fare data. Among these few empirical analyses we mention Wadud (2015) and Cannon and Watanabe (2016). Wadud (2015) analyses US time series data finding evidence of asymmetry in the

[1] Anger and Kohler, 2010; Boon et al., 2007; Lowe et al., 2007; Mayor and Tol, 2010; Mendes and Santos, 2008; Morrell, 2007; Scheelhaase et al., 2010; Scheelhaase and Grimme, 2007.

pass-through rate. According to his results, increases in fares are quicker when fuel price increases and slower when the fuel price decreases. Cannon and Watanabe (2016) analyse US air transport industry finding evidence of asymmetric pricing in periods of contracting demand, with airlines bearing fuel cost increases while passing through fuel cost savings. Despite the important contributions, the abovementioned researches exhibit the not negligible limitation of using data aggregated at carrier or industry level hence not capturing the market (i.e. routes) heterogeneity in terms of market characteristics.[2] By using route level data, our aim is to fill this gap by estimating and analysing airlines pricing behaviours in different market conditions.

2 The Issues

It is widely acknowledged that airline managers adjust ticket fares on the basis of fuel price (Brueckner and Zhang, 2010; Borenstein and Rose, 2014). Anecdotal evidence suggests that airlines are rather reluctant to pass the cost reductions as equally as they pass cost increases (The Telegraph, 2016). In the economic literature, this kind of asymmetry is also termed "positive" and describes a situation in which firms react more and/or quicker when inputs' prices increase than when decreasing (i.e. positive asymmetry is not desirable from a consumer perspective). Oppositely, when firms react more and/or quicker after inputs' prices decreases, the asymmetry is defined as "negative". Studies on asymmetric price transmission in various industries have found evidence for rockets-and-feathers behavior (see for example Peltzman, 2000). Generally, the main proposed causes of asymmetric pricing are found to be the exercise of market power and/or industry-specific factors (Zachmann and von Hirschhausen, 2008). Many authors have suggested that market power generally leads to positive asymmetric price transmission (Meyer and Cramon-Taubadel, 2004). In this regard, European airline industry with few airlines serving OD connections (i.e. a close approximation of an oligopolistic market) may be a perfect breeding ground for it. However, Bailey and Brorsen (1989) and Ward (1982) show that also negative asymmetry may be associated with market power and, therefore, it is not possible to ascertain its type a priori.[3] Some recent research seems to support the general idea of asymmetric price adjustments in the airline industry: Wadud (2015) finds positive asymmetry; Cannon and Watanabe (2016) negative asymmetry. In a paper on asymmetric pricing in the gasoline market, Borenstein et al. (1997) provide three further explanations for price asymmetries: (i) tacit collusion with imperfect monitoring, (ii) finite inventories and (iii) consumer search cost. Similarly, Hong and Lee (2014), investigating retail gasoline market, point out that the main causes of positive asymmetry are consumer search cost and tacit collusion. More specifically, the authors show how tacit collusion facilitates the link between market power and asymmetric pricing. This relation may be of interest in the airline industry. On the contrary, consumer search costs seem to be negligible given the existence of online travel search engines. Finally, the issue of finite inventories drives the attention on airlines' capacity. In this regard, Noel (2008) underlines that capacity constraints reduce the incentives to undercut prices (strategy on which is based a further potential explanation of asymmetry, i.e. Edgeworth price cycles, that therefore we do not consider). Summarizing, we consider market power, capacity and their interaction as possible sources of asymmetry in airline's pricing.

When analyzing airline industry the asymmetric pricing evidence is still limited. Accordingly, our first hypothesis examines whether such asymmetry exists in Europe:

[2] According to Button et al. (2011) competitive pressure, combined to periodic short-term shocks, may even compromise the ability of airlines to recover their costs.
[3] Bailey and Brorsen (1989) and Ward (1982) analyse agricultural industries.

H1 - European airfares are adjusted asymmetrically and the asymmetry is positive.

In the case our hypothesis H1 is corroborated, our interest moves towards the study of the factors potentially influencing such behavior. More specifically, we study whether airlines are generally simply reluctant to pass on fuel savings, or whether they adopt different conducts on the basis of non-pricing strategic choices and of specific market conditions. Concerning airlines' strategies, the existing literature suggests that airlines can justify shifts in the selling price by changing capacity (Cannon and Watanabe, 2016). Indeed, according to airline managers, industry capacity is the dominant factor in determining airfares (Hazel, 2018). If setting capacity is seen as a mere instrument to anticipate demand, we may expect that airfares are influenced but not the pass-through rate of fuel cost (i.e. after controlling for the effect of capacity change on airfares change). However, airlines' discretion in setting capacity levels may have a whole other meaning in the light of the recent debate on the so-called "capacity discipline". Keeping capacity low compared to historical levels is a strategy initially embraced by airlines to respond to the global economic downturn and high and volatile fuel prices. This strategy has been then maintained in presence of economic recovery and more stable fuel prices (Wittman and Swelbar, 2014). Such a trend has been observed at a global level and recently defined by CAPA (2013) as a "new global religion" leading to improved airline profitability. The idea that limiting capacity may be an instrument to increase ticket prices brings into play the issue of airlines market power and tacit collusion. Indeed, the U.S. Department of Justice has been investigating major U.S. airlines for evidence of collusion by limiting their growth as part of an effort to keep ticket prices high.[4] In this regard, Hazel (2018) underlines that capacity reductions of single airlines may be seen as the result of a sort of cooperative strategy leading to market power gains towards passengers. If so, capacity changes should exert an influence on inputs' price transmissions and this idea leads to our second hypothesis:

H2 – In period of contracting capacity, airlines achieve market power gains that allows for higher positive price asymmetry.

With respect to market power, a further factor worthy of investigation is the level of competition. The theoretical paper by Weyl and Fabinger (2013) demonstrates that in a symmetric oligopoly the intensity of competition is one of the factors affecting input price transmission. However, this does not automatically convert into asymmetric behaviours. Indeed, Duso and Szücs (2017), analysing the German electricity market, find incomplete price transmission but not evidence of price asymmetries. In our context, despite the above mentioned general high level of concentration, there exist differences across European routes (e.g. from monopoly routes to highly competitive ones) which may create heterogeneity in airlines' reaction to cost changes. In general, higher market shares may facilitate coordination to the detriment of competition (Borenstein, 2011a) leading to positive asymmetries. Price asymmetries more pronounced in low competitive markets would support the concerns of policy makers and consumers regarding airlines profiteering from fuel savings. Accordingly, our third hypothesis investigates differences in asymmetries due to market competition levels:

[4] In January 2017, after a lengthy probe, the Justice Department hasn't found enough evidence that merits an antitrust case against the airline industry for collusion between carriers. However, as reported in The Wall Street Journal (2017): "*Justice Department investigators still harbor concerns about what they view as cozy relationships in the industry, but haven't found conduct that clearly crossed the line into an antitrust violation that the department should address, people familiar with the matter said.*"

H3 - Price asymmetries are influenced by the level of market competition.

Assume now that both H2 and H3 are corroborated. In this case, higher market concentrations may facilitate capacity coordination. Different influences of capacity reductions should be observed depending on the market competition levels, with airline market power reaching its maximum when competition is low and capacity is reduced. If price asymmetries are mainly influenced by the combination of market structure and capacity discipline, this may pose a threat to the efficiency of the markets. Coherently, our fourth hypothesis is:

H4 – The combinations of capacity discipline and market competition lead to different levels of price asymmetries.

3 Data

We use the Marketing Information Data Transfer (MIDT) provided by OAG traffic analyser as principal source for the data. The data set contains monthly booking numbers and the associated average booked ticket fares for each airline serving each European origin and destination airports.[5] Booked fares do not include additional government taxes, airport fees, airlines surcharges and ancillary revenues. We therefore consider the base fare which can be dynamically adjusted by airlines according to markets characteristics. We notice that most of the airlines implemented a fuel surcharge during the exceptional increase of oil prices (e.g. during the 2007-2008 crude oil price peak). These fees are carrier specific and in some cases were never levied (e.g. Ryanair), while in many other cases they were converted during low crude oil prices into other form of carrier-imposed charges (e.g. British Airways and Air France) or international/domestic surcharges (e.g. Lufthansa), hence losing any connection with their original purpose. Our analysis is not considering the evolution of these surcharges which, if the case, need to be considered on top of our results. Other variables provided by OAG comprehend the operating airline, the number and the location of the stops and the total trip distance. Data are collected from global distribution systems information (GDSs), hence bookings made directly through airlines are not included. However, OAG corrects the information in order to estimate the real size of the relevant markets. OAG schedule analyser is the source for the capacity (in terms of available seats) deployed by a specific airline on a specific route. To build our dataset, we matched the information from the two OAG databases. It is important to remark that the OAG schedule analyser dataset does not provide information on the capacity for indirect flights (i.e. one or more stops), hence our data only includes direct flights information. The sample we consider comprehends monthly observations from February 2010 to December 2015 of bookings at airline level between European airports.[6] To ensure the quality of the sample, we cleaned the data by deleting obvious miscoding (i.e. duplicates, zero fares, bookings or distance) and by removing outliers (i.e. fare must be at least 25$ and the monthly number of bookings at least 100). Starting from the booking data, we calculate a monthly HHI index to measure the degree of competition for each origin and destination city pairs (i.e. considering in competition direct and indirect routes serving the same airport system). Unfortunately, we were not able to retrieve the specific fuel price for each of the airlines considered. We therefore approximate the fuel price by collecting the monthly average U.S. Gulf Coast Kerosene-Type Jet Fuel Spot Price (US dollars per gallon) sourced from the US Energy

[5] Besides the average ticket fares, the average business class fare, the average economy fare and their spread should be of interest. However, we were not able to retrieve such information for our analysis.
[6] We follow the geographical definition of Europe provided by OAG including in the analysis both Western and Easter Europe countries. The list of countries considered is provided in Appendix A.

Information Administration. Despite airline fuel prices may differ in the absolute values, it is however reasonable to expect that prices variations are following the underlying jet fuel spot price. We acknowledge that airline practice of fuel hedging may create unpredictable distortions in the analysis, however airline fuel prices and hedging contracts (in Europe) are confidential and almost impossible to retrieve (especially if collected at monthly basis). Figure 1 presents the relation between jet fuel spot price (grey line) and the average ticket fares (black line) computed from our European sample. The two variables show a general strong relation. Such connection is evident at the end of 2014, when jet fuel prices experienced a significant fall on the back of continuing growth in global supply of crude oil.

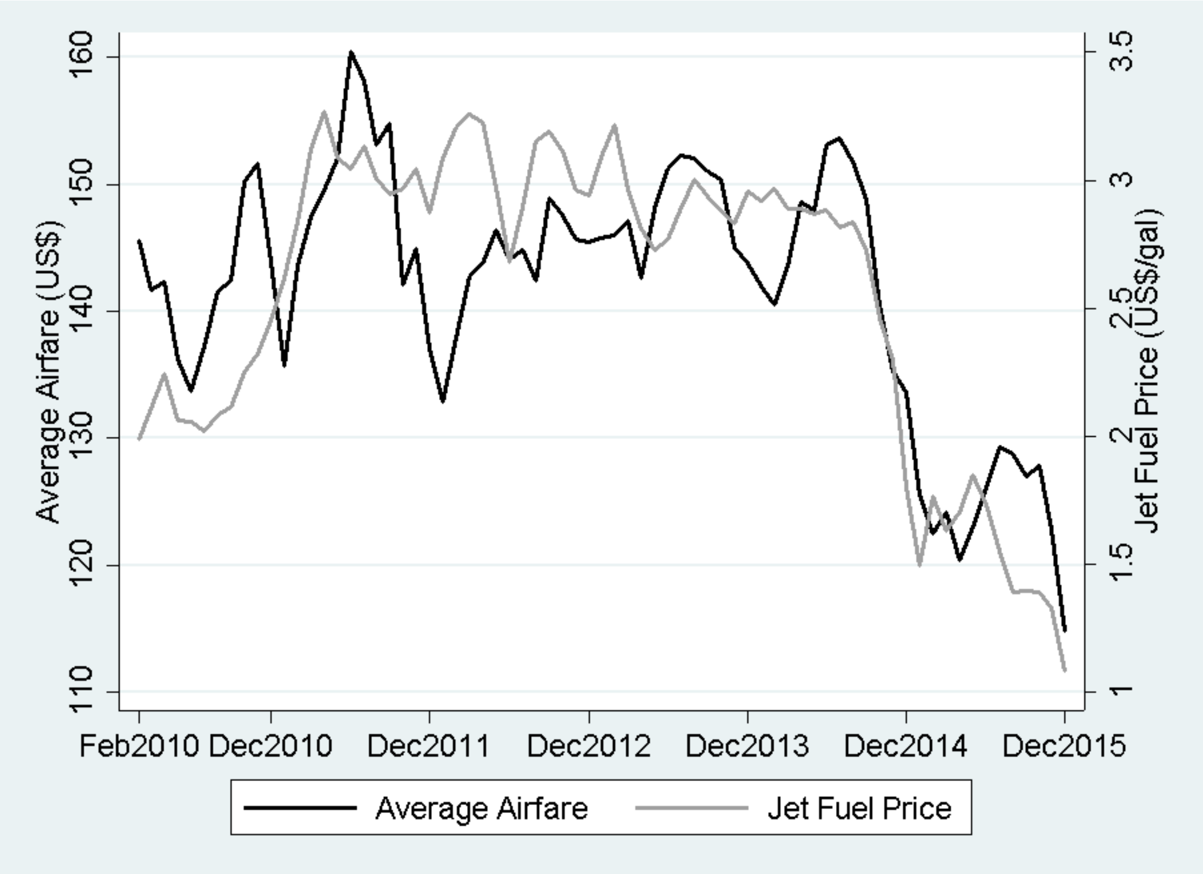

Figure 1 – Average Ticket Fare (US$) and Jet Fuel Prices (US$/Gallon)

Air travel services, especially passenger and freight services, are known to be fairly seasonal with volumes rising in spring, summer, and the early fall. This variability can be depicted in Figure 1 by the airfares falls during the winter months and the peaks during the summer periods. To allow for the estimation of price asymmetries, we therefore compute the change of the variables with respect to the same month of the previous year. By computing such change (i.e. $t/(t-12)$) we avoid possible biases due to the seasonal fluctuations. The final dataset used in the analysis is composed of 433,619 observations (decreasing to 282,709 when considering the delta changes) which are describing ≃15,000 unique city pairs served by ≃125 airlines over a 59 months period. Despite the large number of observations, our panel data set is un-balanced (due to routes ceasing or starting during the period considered) and presents time gaps (mainly because of the presence of seasonal routes). Table 2 presents the data statistics for the variables and their changes. The last four columns of the table present the mean values for the sub-samples of increasing and decreasing fuel price and capacity.

Table 2 –Descriptive statistics

	Full sample					Sub Samples			Sub Samples	
Variable	Mean	Std. Dev.	Min.	Max.		Fuel increasing	Fuel decreasing		Capacity increasing	Capacity decreasing
Fare, USD (P)	142	82	25	2357		145	138		142	141
Capacity (Cap)	7361	9452	12	149922		6580	8755		7349	7385
Fuel, USD (F)	2.57	.58	1.08	3.27		2.69	2.34		2.52	2.66
HHI	.55	.25	.06	1		.55	.55		.54	.56
#observations	433,619					278,029	155,590		295,105	138,514
P_t/P_{t-12}	1.02	.41	.06	11.9		1.08	.99		1.01	1.05
Cap/Cap_{t-12}	1.07	.44	.01	9.99		1.07	1.08		1.27	.86
F_t/F_{t-12}	0.98	.28	.49	1.55		1.21	.79		.97	.99
HHI_t/HHI_{t-12}	1.04	.27	.17	7.16		1.07	1.01		1.07	1.01
#observations	282,709					127,119	155,590		144,195	138,514

Our full sample show an average increase in ticket fares (+2%) and capacity offered (+7%), while a decrease in jet fuel price (-2%) and competition level (HHI +4%). 56% of our observations have been exposed to decreasing fuel prices and 49% to capacity contractions. Figure 2 plots the average changes $(t/(t-12))$ for the variables considered.

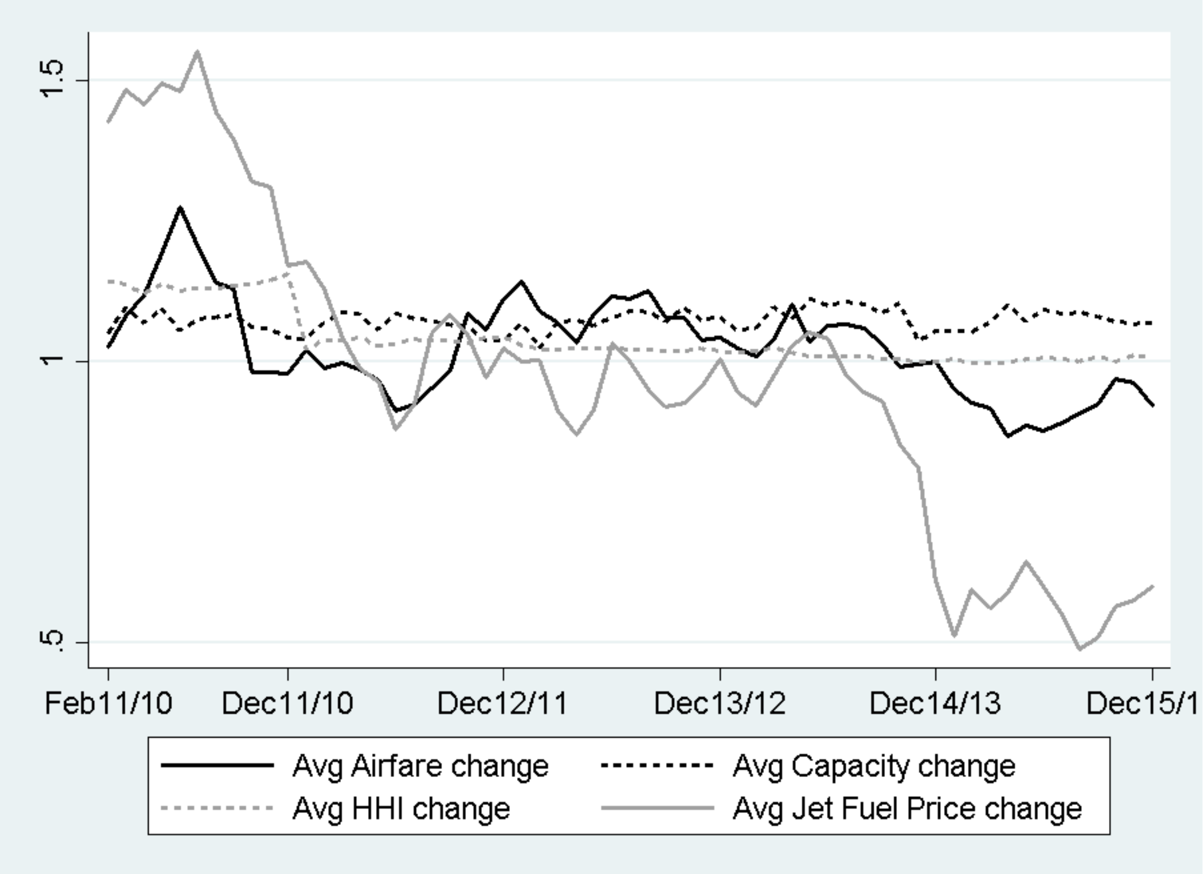

Figure 2 – Average variable changes ($t/(t-12)$)

Jet fuel price (solid grey line) shows the highest average change during the period, with the average change in ticket fares (solid black line) following a similar but smoothed trend. The average capacity change (dash black line) shows a smaller variation remaining constantly above the unit for the whole period. Similarly, the average HHI change (dash grey line) remains constant and close to the unit for the whole period. Figure 3 shows the distribution of the HHI index for the routes considered in our sample. We compute the HHI index based on the booking number for both direct and indirect routes up to two stops which are serving the same airport system (i.e. we consider in competition routes serving the same OD cities). Over the 433,619 observations considered, around 25,000 are served as a monopoly (i.e. HHI=1). The average HHI is 0.55 which is slightly higher than an index generated by 2 carriers having equal market shares on the same market. The first and third HHI quartiles are 0.35 and 0.72, respectively, hence describing the European market as highly concentrated. However, we have to consider that the data are sourced from GDSs information and, although adjusted by OAG, may not include the total demand levels biasing upwards the HHI index. To control for this possibility, we estimate our models considering different thresholds when defining the competition variables.

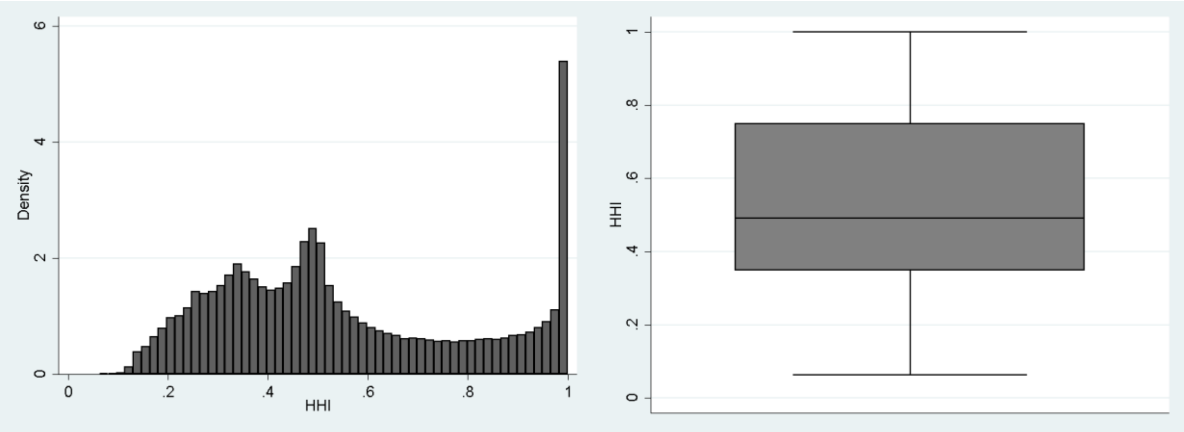

Figure 3 – HHI index distribution

4 Methodology

Our panel data estimation approach is based on the mark-up theory, with airfares set as a function of the costs incurred and of shifter variables. Two main factors may affect the level of mark-up: the capacity supplied (Cannon, 2014) and the level of competition in the market (Koopmans and Lieshout, 2016). We therefore include two variables describing the level of the capacity supplied and the level of concentration on the specific route.[7] The airfare ($P_{ai,t}$) basic equation for each airline $a = 1, \dots, A$ serving the origin destination $i = 1, \dots, I$ (origin-destination airports' pairs) in a specific time period $t = 1, \dots, T$ can be expressed as:

$$P_{ai,t} = \gamma_0 + \gamma_1 costs_{ai,t} + \gamma_2 Cap_{ai,t} + \gamma_3 Com_{i,t} + \delta_1 X_a^A + \delta_2 X_i^R + \delta_3 X_t^M + \delta_4 X_t^Y + e_{ai,t} \quad (1)$$

Where the variable $Cap_{ai,t}$ describes the capacity deployed by the airline a on the route i at time t, $Com_{i,t}$ defines the competition on the route i at time t, and $e_{ai,t}$ is the idiosyncratic error term. A set of controls for the airline X^A, the route X^R, the month X^M, and the year X^Y are included to take into account the observations' characteristics. Arguably, the airfares response to costs changes may not be immediate but distributed over time. Long and short term adjustments are usually estimated through the mostly used time series error correction models (e.g. Bachmeier and Griffin, 2003, Karagiannis et al. 2015). However, our panel dataset is not fitting a time-series approach since our disaggregated observations are spanned over a relative short period and presenting time gaps (e.g. seasonal routes, starting/ceasing routes, missing data, etc.). In order to estimate short and long-run equilibria and the adjustment speed, the observations need to be aggregated at a higher level (e.g. airlines level) and collected over a longer time period. However, a higher level of aggregation would not allow for the study of price asymmetries in different market condition (to be observed at OD level), which is the scope our research. We therefore pursue the estimation

[7] With respect to possible endogeneity problems between capacity and airfare, it is important to note that the airlines' scheduled are published several months prior to the flights (for example, British Airways releases the flights' schedule around one year in advance). Once the capacity is set, demand and airfares are jointly managed through yield management systems. Indeed, Cournot models are often used in describing airline markets - i.e. airlines choose their quantities first (flight schedules) and adapt their prices to the demand. We recognise that airlines have the possibility to adjust the capacity accordingly with a shortage (or excess) of demand. However, these limited possibilities can be applied parsimoniously on a single flight basis, for example, by swapping aircraft between routes or simply adding or cancelling flights. Since our data are describing the aggregate capacity (and the average airfare) over the month, we expect these flight changes (if any) to have a negligible impact on our values.

of short term adjustments (as in Li and Stock, 2017) expressing equation (1) as a distributed lag function:

$$P_{ai,t} = \gamma_0 + \sum_{k=0}^{K} \gamma_{1,t-k} costs_{ai,t-k} + \gamma_2 Cap_{ai,t} + \gamma_3 Com_{i,t} + \delta_1 X_a^A + \delta_2 X_i^R + \delta_3 X_t^M + \delta_4 X_t^Y + e_{ai,t} \quad (2)$$

Where the subscript *k=0,…,K* indicates the number of time lags considered. As in the standard distributed lag model, the parameters $\gamma_{1,t-k}$ represent the transmission of costs in a specific *k-th* time lag, while the sum over *k* of the parameters $\gamma_{1,t-k}$ (i.e. the cumulative parameter) indicates the total transmission of costs into airfares. However, the parameters $\gamma_{1,t-k}$ of equation (2) are the estimated symmetric impact over the airfares ($P_{ai,t}$) and cannot be used to discriminate between inputs' prices increases and decreases. To allow for an asymmetric relation, we firstly modify equation (2) by considering the changes in the variables between months. Specifically, given the seasonality characteristics of air transport, we express the variables as changes between t and the same month in the previous year ($t-12$). When considering variable time differences, the time invariant variables are null and can be dropped from the equation. In our case, the control variables on the airline (X^A), the route (X^R), and the month (X^M) can be eliminated since they do not change over time across our observations. Similarly, when considering the costs' changes over time, only the highly volatile fuel price may have an impact on the change of the airfares charged by the same airline on the same route. Indeed, the other major variable components of airlines' costs at route level (e.g. crew costs, taxes, catering) are almost invariant.[8] Finally, with respect to the year dummies, the term $\left(X_t^Y - X_{(t-12)}^Y\right)$ is not null and can be reparametrized as X_t^Y. Applying the logarithms to the non-dummy variables, we can rewrite equation (2) as:

$$\log \frac{P_{ai,t}}{P_{ai,(t-12)}} = \sum_{k=0}^{K} \beta_{1,t-k} \log \frac{Fuel_{t-k}}{Fuel_{(t-12-k)}} + \beta_2 \log \frac{Cap_{ai,t}}{Cap_{ai,(t-12)}} + \beta_3 \log \frac{Com_{i,t}}{Com_{i,(t-12)}} + \sigma_Y X_t^Y + \varepsilon_{ai,t}$$

or, in a more compact form, as:

$$\Delta P_{ai,t} = \sum_{k=0}^{K} \beta_{1,t-k} \Delta Fuel_{t-k} + \beta_2 \Delta Cap_{ai,t} + \beta_3 \Delta Com_{i,t} + \sigma_Y X_t^Y + \varepsilon_{ai,t} \quad (3)$$

where delta (Δ) stands for the logarithmic differences of each variable. The parameters of equation (3) evaluate the impact of independent variables changes over the change in airfares. In order to consider the possible asymmetric impact of fuel price changes, we multiply the fuel term by two dummy variables capturing the fuel price evolution:

$$\Delta P_{ai,t} = \sum_{k=0}^{K} \beta_{1,t-k}^{F+} (\Delta Fuel_{t-k}) F_{t-k}^{+} + \sum_{k=0}^{K} \beta_{1,t-k}^{F-} (\Delta Fuel_{t-k}) F_{t-k}^{-} + \beta_2 \Delta Cap_{ai,t} + \beta_3 \Delta Com_{i,t} + \sigma_Y X_t^Y + \varepsilon_{ai,t} \quad (4)$$

[8] As discussed in section 2, the airfares considered in this analysis are not including additional government taxes, airport fees, airlines surcharges and ancillary revenues. Therefore, sources for possible additional short term variations are limited.

where F_{t-k}^{+} is equal to 1 when the fuel price increases or remains equal between time $t-12-k$ and $t-k$ ($k=0,\dots,K$) and zero otherwise, while F_{t-k}^{-} is equal to 1 when the fuel price decreases and zero otherwise. The two dummies are mutually exclusive and collectively exhaustive, hence the cumulative parameters β_1^{F+} and β_1^{F-} in equation (3) are describing the asymmetric impact of fuel price change over the airfare change (β_2^{F+} when fuel price increases, β_2^{F-} when fuel price decreases). By testing the coefficients difference through a Wald test (i.e. $\beta_2^{F+}-\beta_2^{F-}=0$), we estimate if airfares are adjusted asymmetrically according to Hypothesis H1. In order to test our second hypothesis, we further disaggregate the fuel change impact by considering the case in which the capacity deployed is changing over the period as in equation (4):

$$\Delta P_{ai,t}=\left[\sum_{k=0}^{K}\beta_{1,t-k}^{F+C+}(\Delta Fuel_{t-k})F_{t-k}^{+}+\sum_{k=0}^{K}\beta_{1,t-k}^{F-C+}(\Delta Fuel_{t-k})F_{t-k}^{-}\right]C_{ai,t}^{+}$$
$$+\left[\sum_{k=0}^{K}\beta_{1,t-k}^{F+C-}(\Delta Fuel_{t-k})F_{t-k}^{+}+\sum_{k=0}^{K}\beta_{1,t-k}^{F-C-}(\Delta Fuel_{t-k})F_{t-k}^{-}\right]C_{ai,t}^{-}$$
$$+\beta_2\Delta Cap_{ai,t}+\beta_3\Delta Com_{i,t}+\sigma_Y X_t^Y+\varepsilon_{ai,t}\ (5)$$

Where the dummy variables $C_{ai,t}^{+}$ and $C_{ai,t}^{-}$ equal to 1 when the capacity increases/remains constant and when the capacity decreases, respectively. The cumulative estimated parameters are therefore describing the impact of a fuel price change over the airfare change while considering specific capacity changes: β_2^{F+C+} describes the effect under an increase of both capacity and fuel price, β_2^{F-C+} estimates the impact when fuel is decreasing but capacity is increasing, β_2^{F+C-} describes the fuel change impact when fuel price is increasing and capacity is decreasing, while β_2^{F-C-} is the estimated impact when both fuel price and capacity are decreasing. By testing the parameters $\beta_2^{F+C+}-\beta_2^{F+C-}=0$ and $\beta_2^{F-C+}-\beta_2^{F-C-}=0$, we can study if airfares are adjusted differently with respect to capacity changes according to Hypothesis H2. Similarly, in equation (6), we analyse potential price asymmetries considering the level of market competition by estimating the following equation:

$$\Delta P_{ai,t}=\left[\sum_{k=0}^{K}\beta_{1,t-k}^{F+H}(\Delta Fuel_{t-k})F_{t-k}^{+}+\sum_{k=0}^{K}\beta_{1,t-k}^{F-H}(\Delta Fuel_{t-k})F_{t-k}^{-}\right]H_{i,t}^{H}$$
$$+\left[\sum_{k=0}^{K}\beta_{1,t-k}^{F+L}(\Delta Fuel_{t-k})F_{t-k}^{+}+\sum_{k=0}^{K}\beta_{1,t-k}^{F-L}(\Delta Fuel_{t-k})F_{t-k}^{-}\right]H_{i,t}^{L}+\beta_2\Delta Cap_{ai,t}$$
$$+\beta_3\Delta Com_{i,t}+\sigma_Y X_t^Y+\varepsilon_{ai,t}\ (6)$$

where $H_{i,t}^{H}$ and $H_{i,t}^{L}$ are two dummy variables describing the competition levels of the specific route i at time t. $H_{i,t}^{H}$ equal to one is describes routes with high competition, while $H_{i,t}^{L}$ equal to one describes low competition routes. Differences between the coefficients would highlight heterogeneous asymmetries ascribed to market concentration levels (i.e. Hypothesis H3). As for equation (4), also the dummies in equation (5) and (6) are mutually exclusive and collectively exhaustive. Finally, we further disaggregate the effect by considering the effects of both capacity changes and competition levels:

$$\Delta P_{ai,t} = \left\{\left[\sum_{k=0}^{K} \beta_{1,t-k}^{F+C+H} (\Delta Fuel_{t-k})F_{t-k}^{+} + \sum_{k=0}^{K} \beta_{1,t-k}^{F-C+H} (\Delta Fuel_{t-k})F_{t-k}^{-}\right] C_{ai,t}^{+} + \left[\sum_{k=0}^{K} \beta_{1,t-k}^{F+C-H} (\Delta Fuel_{t-k})F_{t-k}^{+} + \sum_{k=0}^{K} \beta_{1,t-k}^{F-C-H} (\Delta Fuel_{t-k})F_{t-k}^{-}\right] C_{ai,t}^{-}\right\} H_{i,t}^{H} + \left\{\left[\sum_{k=0}^{K} \beta_{1,t-k}^{F+C+L} (\Delta Fuel_{t-k})F_{t-k}^{+} + \sum_{k=0}^{K} \beta_{1,t-k}^{F-C+L} (\Delta Fuel_{t-k})F_{t-k}^{-}\right] C_{ai,t}^{+} + \left[\sum_{k=0}^{K} \beta_{1,t-k}^{F+C-L} (\Delta Fuel_{t-k})F_{t-k}^{+} + \sum_{k=0}^{K} \beta_{1,t-k}^{F-C-L} (\Delta Fuel_{t-k})F_{t-k}^{-}\right] C_{ai,t}^{-}\right\} H_{i,t}^{L} + \beta_2 \Delta Cap_{ai,t} + \beta_3 \Delta Com_{i,t} + \sigma_Y X_t^Y + \varepsilon_{ai,t} \quad (7)$$

Equation (7) combines the dummies defined for equations (5) and (6). By testing the differences in the parameters, it is possible to evaluate the combined effects of the specific conditions according to Hypothesis H4.

5 Results

The parameters of the equations 3-7 are estimated with an OLS estimator within a robust framework in order to control for possible heteroscedasticity. As in Peltzman (2000), we included as many lags (*K*) as needed to describe statistically significant price adjustments processes. Specifically, we included $K = 1$ lags because the addition of more lags resulted in not significant coefficients.[9] All the non-dummy variables are transformed in logarithms and the coefficients reported can be read as elasticities. Table 2 reports the estimates of the equation 3, which analyses the symmetric impact of fuel price changes over airfare changes. The column "Coefficient" shows the estimated parameters for $k = 0$, while the "Lag1 Coefficient" column shows the parameter estimated for $k = 1$. The cumulative coefficients reported are computed as the sum of the two coefficients and represent the total impact of the specific variable on the airfares.

Table 2 – Equation 3 estimates (price symmetry)

Variable		Coefficient (k=0)	Lag1 Coefficient (k=1)	Cumulative
$\Delta Fuel_{t-k}$	Fuel price change	.275 (.011) ***	.149 (.014) ***	.424
$\Delta Cap_{ai,t}$	Capacity change	-.079 (.003)***		
$\Delta Com_{i,t}$	HHI index change	.055 (.003) ***		
X_{2011}^Y	Dummy year 2011	-.557 (.015) ***		
X_{2012}^Y	Dummy year 2012	-.501 (.011) ***		
X_{2013}^Y	Dummy year 2013	.379 (.010) ***		
X_{2014}^Y	Dummy year 2014	.423 (.010) ***		
X_{2015}^Y	Dummy year 2015	.392 (.006) ***		

Observations	243,644
F-Statistics	18580 ***

***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.
Robust standard errors reported in parenthesis.

All the variables considered are statistically significant at 1% showing the expected signs. An increase in supplied capacity (

[9] We note that our distributed lag model is defined in differences, hence $K = 1$ lags corresponds to two changes over the time: $t/(t-12)$ and $(t-1)/(t-13)$.

$\Delta Cap_{ai,t}$) results in lower airfares: given a downward sloping demand curve for air travel and an upward sloping supply curve, an increase in supplied capacity results in lower airfares ceteris paribus. As expected, route concentration increases are associated with an increase in airfares. This may confirm that highly concentrated oligopolistic markets may ease coordination to the detriment of competition (Borenstein, 2011a). Concerning the impact of fuel price changes, our model estimates that on average a 1% change in fuel prices leads to a cumulative 0.42% change in ticket prices. As already highlighted, the coefficient is not distinguishing between periods of fuel price increase or decrease not capturing potential asymmetric reaction of airfares to fuel price changes. Possible asymmetric reactions are considered in equation 4, whose estimates are reported in Table 3.

Table 3 – Equation 4 estimates (prices asymmetry)

Variable		Coefficient (k-0)	Lag 1 Coefficient (k=1)	Cumulative
$(\Delta Fuel_{t-k})F^{+}_{t-k}$	Fuel price increase	.491 (.025) ***	.293 (.029) ***	.784
$(\Delta Fuel_{t-k})F^{-}_{t-k}$	Fuel price decrease	.114 (.012) ***	-.0166 (.016)	.114
$\Delta Cap_{ai,t}$	Capacity change	-.081 (.003) ***		
$\Delta Com_{i,t}$	HHI index change	.056 (.003) ***		
X^{Y}_{2011}	Dummy year 2011	-.229 (.007) ***		
X^{Y}_{2012}	Dummy year 2012	-.101 (.002) ***		
X^{Y}_{2013}	Dummy year 2013	.028 (.002) ***		
X^{Y}_{2014}	Dummy year 2014	-.023 (.002) ***		
X^{Y}_{2015}	Dummy year 2015	-.097 (.008) ***		

Observations	243,644
F-Statistics	1542 ***

***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.
Robust standard errors reported in parenthesis.

Examining the impact of our variables of interest (i.e. the cumulative parameters β_2^{F+} and β_2^{F-}), the association between fare level changes and fuel price changes are statistically different from zero and concordant given the positive signs of coefficients β_2^{F+} and β_2^{F-}.[10] However, the estimated values of the two coefficients are different: an increase of 1% in fuel price leads to a cumulative increase in the fare level of 0.78%, while a 1% decrease in fuel price leads to a notably smaller cumulative decrease (0.11%) in the airfares. A Wald test confirms the significant difference between the two parameters corroborating the hypothesis of asymmetric adjustment of airfares with respect to changes in fuel prices (Hypothesis H1). On average, our results show that airlines may be profiteering from fuel savings. Moreover, the estimates show a significant difference in adjustments process with the lagged coefficients only statistically significant in the case of fuel price increases. This behaviour may be however different with respect to the different market conditions. Table 4 presents the estimates of equation 5 which disaggregates the fuel changes with respect to direction of capacity change.

Table 4 – Equation 5 estimates (asymmetries due to capacity supplied)

Variable		Coefficient (k=0)	Lag 1 Coefficient	Cumulative

[10] In the case of decreasing fuel price, the variable $\Delta Fuel$ is by construction negative. Therefore, a positive parameter indicates that the airfare decreases concordantly with fuel price.

			(k=1)	
$(\Delta Fuel_{t-k})F^+_{t-k}C^+_t$	Fuel price Increase - Capacity Increase	.600 (.034) ***	.174 (.036) ***	.774
$(\Delta Fuel_{t-k})F^-_{t-k}C^+_t$	Fuel price Decrease – Capacity Increase	.119 (.015) ***	-.012 (.019)	.119
$(\Delta Fuel_{t-k})F^+_{t-k}C^-_t$	Fuel price Increase - Capacity Decrease	.390 (.034) ***	.412 (.037) ***	.802
$(\Delta Fuel_{t-k})F^-_{t-k}C^-_t$	Fuel price Decrease – Capacity Decrease	.107 (.016) ***	-.019 (.019)	.107
$\Delta Cap_{ai,t}$	Capacity change	-.074 (.003) ***		
$\Delta Com_{i,t}$	HHI index change	.056 (.003) ***		
X^Y_{2011}	Dummy year 2011	-.223 (.007) ***		
X^Y_{2012}	Dummy year 2012	-.100 (.002) ***		
X^Y_{2013}	Dummy year 2013	.028 (.002) ***		
X^Y_{2014}	Dummy year 2014	-.024 (.002) ***		
X^Y_{2015}	Dummy year 2015	-.096 (.008) ***		

Observations	243,644
F-Statistics	1137 ***

***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.
Robust standard errors reported in parenthesis.

The coefficients associated with capacity, HHI and year dummies are robust and similar to the results reported in Table 2 and 3, confirming as well the rocket and feather behaviour (positive asymmetry). Moreover, in periods of capacity contractions (C^-) we observe that, ceteris paribus, fuel price increases are passed to the passengers at a higher degree than in periods of capacity increases (C^+). Indeed, an increase of 1% of fuel prices during capacity decreases leads to a cumulative increase of 0.80% of ticket prices, while, the cumulative increase associated to fuel price and capacity increases is significantly lower and equal 0.77%. In case of fuel price decreasing, results suggest a similar but smoothed behaviour with airlines passing lower savings in case of capacity contractions (0.11%) with respect to periods of capacity increases (0.12%). However, in this case the two coefficients are not significantly different. The result may suggest that capacity contractions increase airlines market power only in period of fuel price growth. Nevertheless, this is sufficient to corroborate the hypothesis of higher positive price asymmetry (H2).

The level of competition may be a factor affecting price transmission as well as price asymmetry. In this regard, Table 5 presents the results when estimating the asymmetries considering different competition levels (equation 6). More precisely, the price changes are estimated for routes showing high and low degrees of competition (i.e. high competition, $H^H = 1$ if $HHI < 0.5$).

Table 5 – Equation 6 estimates (asymmetries due to competition levels)

Variable		Coefficient (k=0)	Lag 1 Coefficient (k=1)	Cumulative
$(\Delta Fuel_{t-k})F^+_{t-k}H^H$	Fuel price Increase – High Competition	.500 (.032) ***	.265 (.0.35) ***	.765
$(\Delta Fuel_{t-k})F^-_{t-k}H^H$	Fuel price Decrease – High Competition	.146 (.015) ***	-.043 (.018)	.146
$(\Delta Fuel_{t-k})F^+_{t-k}H^L$	Fuel price Increase -	.483 (.036) ***	.319 (.037) ***	.802

	Low Competition			
$(\Delta Fuel_{t-k})F^{-}_{t-k}H^{L}$	Fuel price Decrease – Low Competition	.079 (.016) ***	-.011 (.019)	.079
$\Delta Cap_{ai,t}$	Capacity change	-.079 (.002) ***		
$\Delta Com_{i,t}$	HHI index change	.054 (.003) ***		
X^{Y}_{2011}	Dummy year 2011	-.229 (.007) ***		
X^{Y}_{2012}	Dummy year 2012	-.100 (.002) ***		
X^{Y}_{2013}	Dummy year 2013	.028 (.002) ***		
X^{Y}_{2014}	Dummy year 2014	-.024 (.003) ***		
X^{Y}_{2015}	Dummy year 2015	-.097 (.008) ***		

Observations	243,644
F-Statistics	1136 ***

***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.
Robust standard errors reported in parenthesis.

When analysing the parameters of interest, table 5 confirms the asymmetric pricing behaviour. Moreover, we observe that in periods of fuel price increase (F^{+}) airfares have a statistical significant higher cumulative increase in low competition markets (0.80%) compared to the high competitive ones (0.77%). Similarly, in period of fuel price decrease (F^{-}), the estimates suggest that in low competition markets airlines are passing a slightly lower level of savings compared to the high competitive ones (0.14%, 0.08%). We check the robustness of these results by changing thresholds defining the low and high competition dummies (i.e. H^{L} and H^{H}). To this extent, figures 4a-4b show the different estimated parameters (y – axis) with respect to different HHI threshold defining the low and high competition dummies (x – axis) (Table 5 uses the 0.5 thresholds). Figure 4a presents the results for fuel price increase parameters, while figure 4b the estimates for the decreasing period.

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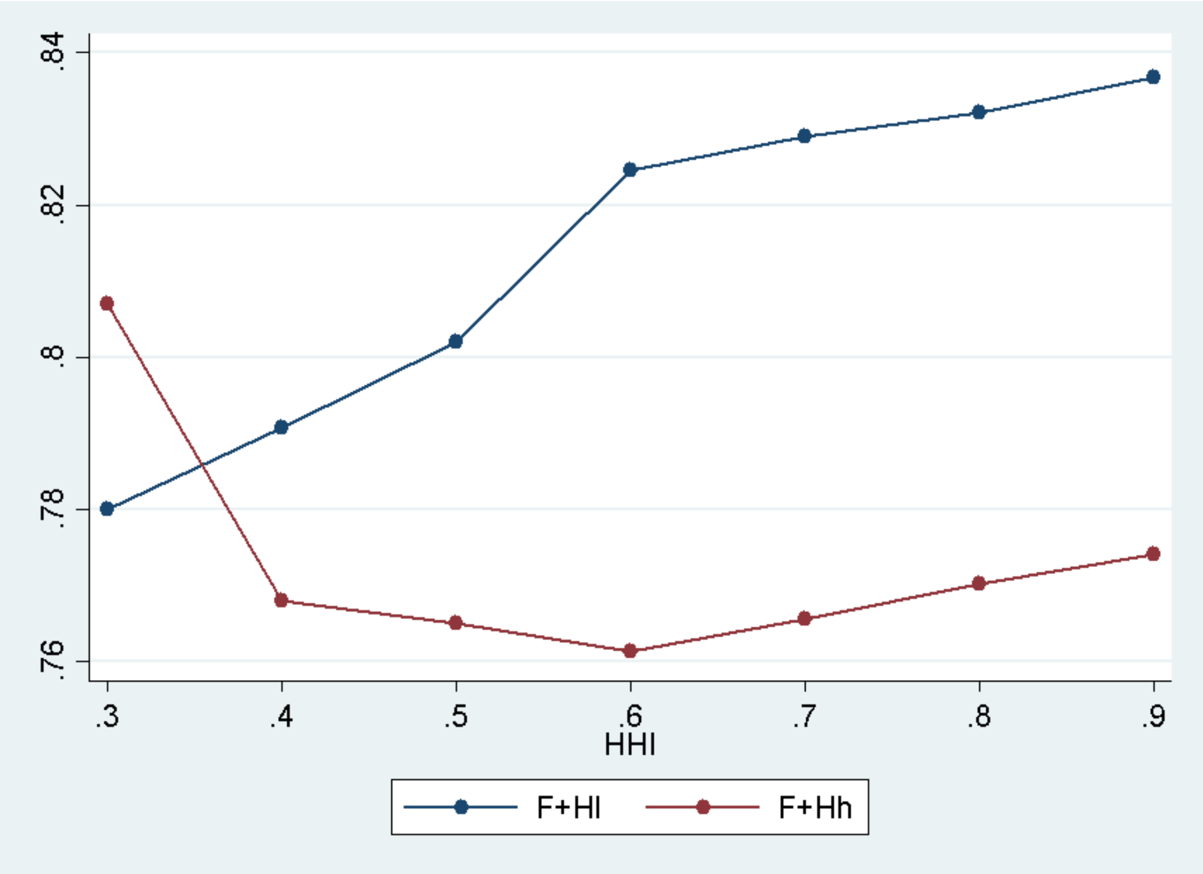

Figure 4a – Cumulative impacts of fuel price increasing parameters with respect to different HHI thresholds

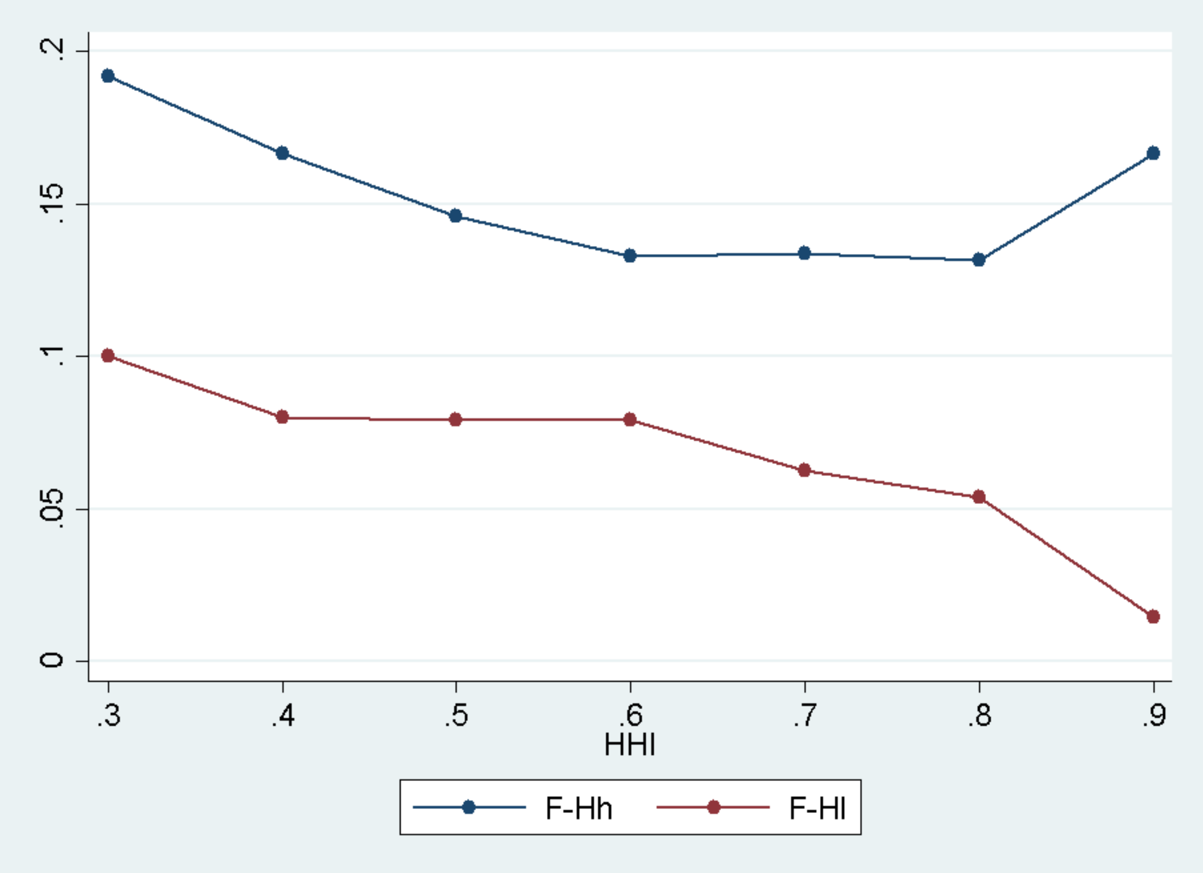

Figure 4b – Cumulative impacts of fuel price decreasing parameters with respect to different HHI thresholds

Figure 4a shows that, in case of fuel price increase, the spread between the parameters increases accordingly with the increase in the HHI threshold (Wald tests on the parameters' differences show statistically significance). Indeed, when increasing the threshold from 0.5 to 0.9 (i.e. $H^H = 1$ when $HHI < 0.9$) the cumulative parameter associated to low competition moves from 0.80 to 0.84. In other words, moving towards a monopolistic situation the airlines increase the pass-through of costs taking advantage of their increasing market power. Similar results are obtained in the case of fuel price decrease (Figure 4b), where the cumulative parameters diverge for high HHI thresholds.[11] Our hypothesis H3 is confirmed: price asymmetries differ with respect to competition levels.

The last step of our analysis is to estimate the combined effect of capacity changes and competitive levels. Table 6 reports the estimates of equation 7. The model further disaggregates the fuel price variable by considering the combined effect of capacity changes and competition levels (i.e. $H^H = 1$ when $HHI < 0.5$).

Table 6 – Equation 7 estimates (asymmetries due to capacity supplied and competition levels)

Variable		Coefficient (k=0)	Lag 1 Coefficient	Cumulative

[11] We note that for low levels of HHI thresholds (e.g. HHI=0.3) the lines are crossing in graph 4a showing a counter intuitive behaviour. This situation may be due to discrimination problems mainly caused by the low number of observations below the 0.3 threshold (only 44,000).

			(k=1)	
$(\Delta Fuel_{t-k})F_{t-k}^{+}C_{t}^{+}H^{H}$	Fuel price Increase - Capacity Increase – High Competition	.592 (.045) ***	.169 (.046) ***	.761
$(\Delta Fuel_{t-k})F_{t-k}^{-}C_{t}^{+}H^{H}$	Fuel price Decrease – Capacity Increase - High Competition	.153 (.020) ***	-.046 (.023)	.153
$(\Delta Fuel_{t-k})F_{t-k}^{+}C_{t}^{-}H^{H}$	Fuel price Increase - Capacity Decrease- High Competition	.411 (.047) ***	.368 (.048) ***	.779
$(\Delta Fuel_{t-k})F_{t-k}^{-}C_{t}^{-}H^{H}$	Fuel price Decrease – Capacity Decrease- High Competition	.137 (.022) ***	-.038 (.024)	.137
$(\Delta Fuel_{t-k})F_{t-k}^{+}C_{t}^{+}H^{L}$	Fuel price Increase - Capacity Increase – Low Competition	.610 (.052) ***	.177 (.052) ***	.787
$(\Delta Fuel_{t-k})F_{t-k}^{-}C_{t}^{+}H^{L}$	Fuel price Decrease – Capacity Increase - Low Competition	.080 (.023) ***	.025 (.0.25)	.080
$(\Delta Fuel_{t-k})F_{t-k}^{+}C_{t}^{-}H^{L}$	Fuel price Increase - Capacity Decrease - Low Competition	.369 (.049) ***	.454 (.050) ***	.823
$(\Delta Fuel_{t-k})F_{t-k}^{-}C_{t}^{-}H^{L}$	Fuel price Decrease – Capacity Decrease- Low Competition	.076 (.023) ***	-.001 (.025)	.076
$\Delta Cap_{ai,t}$	Capacity change	-.074 (.003) ***		
$\Delta Com_{i,t}$	HHI index change	.054 (.003) ***		
X_{2011}^{Y}	Dummy year 2011	-.230 (.007) ***		
X_{2012}^{Y}	Dummy year 2012	-.100 (.002) ***		
X_{2013}^{Y}	Dummy year 2013	.028 (.002) ***		
X_{2014}^{Y}	Dummy year 2014	-.024 (.002) ***		
X_{2015}^{Y}	Dummy year 2015	-.097 (.008) ***		

Observations	243,644
F-Statistics	746

***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.
Robust standard errors reported in parenthesis.

Results are in line with previous estimations, showing positive asymmetry with respect to fuel price changes. Generally, fuel price increases are passed at a higher degree in case of contraction in capacity and low competition markets (a cumulative 0.823), while savings are passed at a higher degree in situation of high competition and capacity increase (a cumulative 0.153). These behaviours can be depicted when analysing the evolution of the parameters with respect to different competition levels. We estimate equation 7 using different thresholds for the dummy variables H^H and H^L. Results are presented in figures 5a (increasing fuel price periods) and 5b (decreasing fuel price periods).

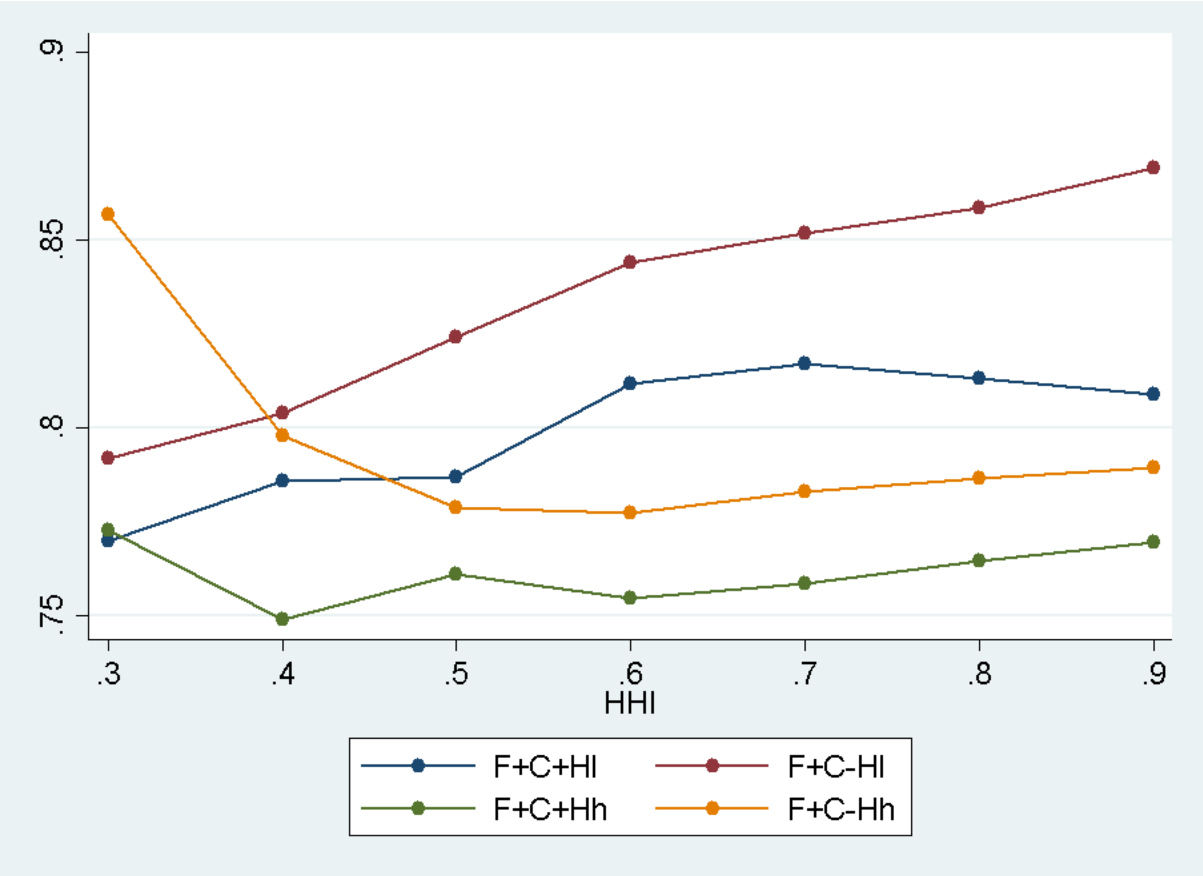

Figure 5a – Estimated cumulative parameters during increasing fuel price periods with respect to different HHI thresholds.

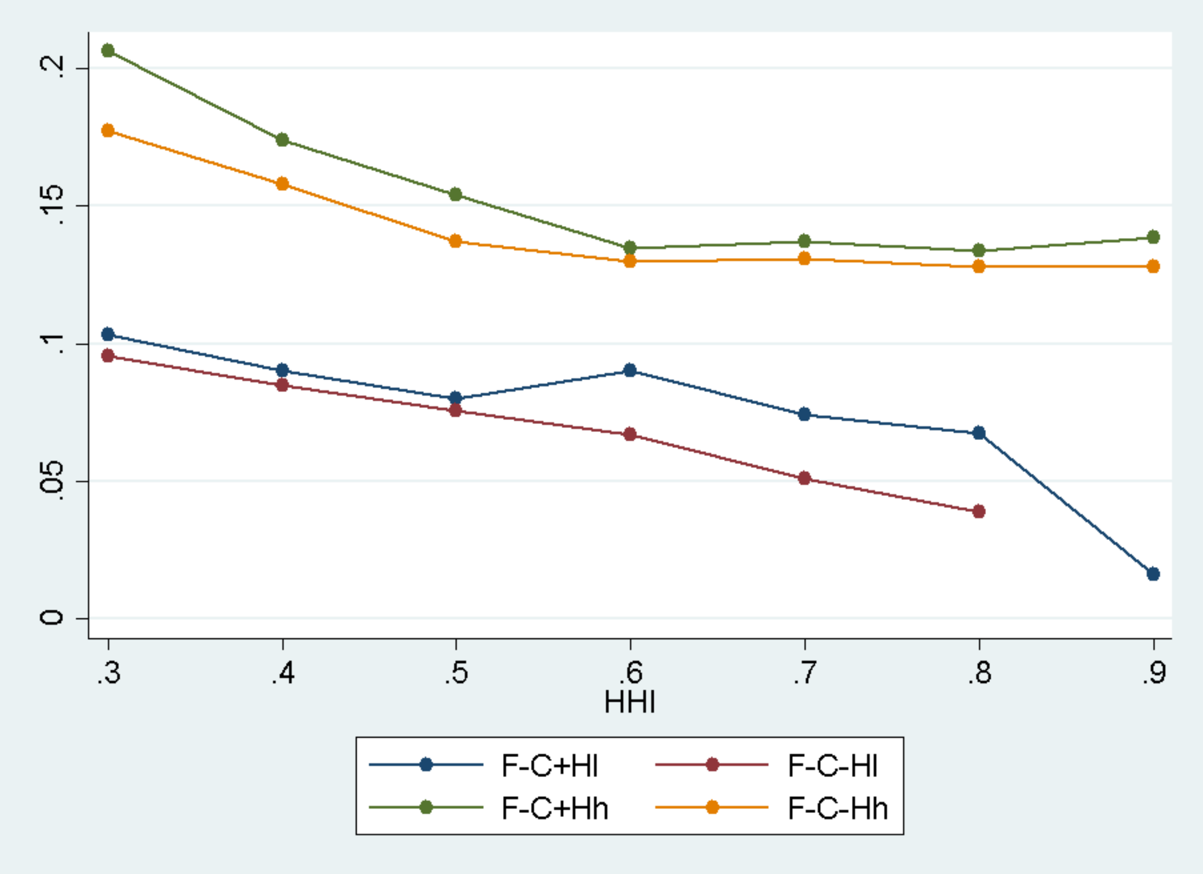

Figure 5b – Estimated cumulative parameters during decreasing fuel price periods with respect to different HHI thresholds.

Figure 5a shows that airlines' market power reaches its maximum in situation of capacity reduction and low competition (red line). This effect increases with the increase of the HHI threshold. On the opposite, the lowest market power is produced by combining capacity increase and high competition (green line), with the cumulative parameters remaining similar despite the HHI threshold. When combining capacity increase (decrease) with low (high) competition, the cumulative parameters are the results of conflicting effects. The estimations show similar fuel price transmissions (blue and yellow lines) lying in between the two others cases. Summarising, during periods of fuel price increases, the combination of capacity change and competition levels may result in different price transmissions (H4). Figure 5b shows different results. Indeed, in cases of fuel price reduction, the differences in price transmission ascribable to capacity states are small (with the only exceptions of high HHI thresholds coefficients in low competitive markets). Generally, the reduced importance of capacity in case of fuel price reduction is in line with the result obtained from Equation 5. This result may be interpreted as a signal of the fact, when pressure on margins relaxes and there is room for increasing profits, capacity coordination among airlines is more difficult (i.e. feasible only in very highly concentrated market).[12]

The estimates of equations (4)-(7) show the price elasticities and not the pass-through level itself. Indeed, it is not straightforward to move from the estimated elasticities to the

[12] As in Figures 4a, also in Figures 5a the coefficients are misbehaving for small HHI thresholds possibly due to discrimination problems. With respect to Figure 5b, the coefficients for F-C-Hl at HHI=.9 were not significant and therefore the cumulative value is not plotted.

corresponding pass-through value since fuel cost is only one of the components of the airfare. However, some considerations may help in this regard. For example, Stalnaker et al. (2016) show that fuel expenses range between the 17% and 38% of passenger revenues. Based on such considerations, on average we can expect that elasticities between 0.2 and 0.4 may be interpreted as a pass-through rate of ≃100%. Our base estimates (i.e. Table 3), assuming the 0.4 elasticity, show that airlines pass cost increases more than proportionally (on average ≃190% of fuel increases), while retaining most of the fuel savings passing only ≃30% of them. However, the pass-through rate may change significantly with respect to different market conditions. Indeed, when fuel price increase, the estimated pass-through rate ranges from ≃190% in case of capacity increasing and high competition markets to a ≃205% in case of capacity decreasing and low competition markets. In case of fuel price decrease, the estimated pass-through of savings ranges from a ≃20% in case of capacity contracting and low competition to 40% when capacity is growing in high competitive markets (cumulative estimates of Table 6). Generally, our results show that airlines tend to act opportunistically either by appropriating a significant part of fuel savings or by increasing their fares more than proportionally in case of fuel price rise. However, we note that a correct estimation of the pass-through rate should consider a more accurate computation of fuel expenses. These expenses may vary between airlines, for example on the basis of fuel purchase agreements. Moreover, airlines locked into hedge contracts can only partially (if not at all) benefit from potential saving coming from a reduction in fuel prices. However, the effects of fuel hedging are unpredictable given that information on contracts are not publicly available.

6 Conclusion

In this paper, we estimate the dynamics of fuel price change on European airfares taking into account the effect of supplied capacity and the competitive market structure. We apply a distributed lag model describing European airlines/routes level data over the period 2010-2015.

Our results confirm the recent press argument that airlines adjust airfares asymmetrically. On average, the increase of fares is proportionally higher during periods of fuel prices increase than their decrease during fuel prices' contractions following a "rocket and feather" dynamic. Furthermore, our estimates show that positive adjustments are quicker than the negative ones. We extend previous literature by looking at the influence on asymmetry rate exerted by capacity adjustments and competitive pressure. Our results suggest that reductions in capacity can increase airlines' market power and, in turns, the asymmetric pricing behaviour. The role played by capacity reduction is emphasized in low competitive environments during periods of fuel price increases. This may indicate that airlines choices are driven by a sort of cooperative implementation of capacity discipline when coordination is easier (i.e. when competitive pressure is lower). However, the influence of capacity reduction is dampened by route competition and tends to disappear when fuel price decreases. These results may be of interest for the regulatory authorities since we show that airline capability of profiteering on fuel price changes, to the detriment of passengers, is the combined result of capacity change and high concentration at the route level.

The paper has some limitations. Due to the nature of our data (large number of observations, short periods and gaps in the temporal coverage) we do not apply a time-series approach hence not separating the effects of short and long-time fare adjustments. Moreover, our fuel price variable is considering the market jet fuel spot price which may be not relevant in case of airlines hedging fuel prices. Our estimates may only be analyzed as general trend and may result being biased for specific airline cases. We therefore invite further research inquiry in this area.

References

1. Anger, A., Kohler, J. 2010. Including aviation emissions in the EU ETS: much ado about nothing? A review. Transportation Policy, 17, 38-46.
2. Bachmeier, L.J., Griffin, J.M. 2003. New evidence on asymmetric gasoline price responses. The review of economics and statistics, 85(3), 772-776.
3. Bacon, R.W. 1991. Rockets and feathers: the asymmetric speed of adjustment of UK retail gasoline prices to cost changes. Energy Economics, 13(3), 211-218.
4. Bailey, D., & Brorsen, B. W. (1989). Price asymmetry in spatial fed cattle markets. Western Journal of Agricultural Economics, 246-252.
5. Boon, B., Davidson, M., Faber, J., van Velzen, A. 2007. Allocation of allowances for aviation in the EU ETS – the impact on the profitability of the aviation sector under high levels of auctioning. A report for WWF UK, Delft, CE Delft.
6. Borenstein, S., Cameron, C., A., Gilbert, R., 1997. Do gasoline prices respond asymmetrically to crude oil price changes? The Quarterly Journal of Economics,112, 305-339.
7. Borenstein, S. 2011a. What Happened to Airline Market Power?. University of California Berkeley Haas School of Business working paper
8. Borenstein, S. 2011b. Why can't US airlines make money? Am. Econ. Rev., 101 (3) (2011), pp. 233–237
9. Borenstein, S., Rose, N.L. 2014. How airline markets work… or do they? Regulatory reform in the airline industry. In Economic Regulation and Its Reform: What Have We Learned? (pp. 63-135). University of Chicago Press.
10. Brueckner, J. K., Zhang, A. 2010. Airline emission charges: Effects on airfares, service quality, and aircraft design. Transportation Research Part B: Methodological, 44(8), 960-971.
11. Button, K., Costa, Á., Costa, F., Cruz, C. 2011. Problems of cost recovery by European airlines since market liberalization. Transportation Planning and Technology, 34(2), 125-138.
12. Cannon, J. N. 2014. Determinants of "sticky costs": An analysis of cost behavior using United States air transportation industry data. The Accounting Review, 89(5), 1645-1672.
13. Cannon, J. N., Watanabe, O. 2016. Do Firms Pass Commodity Costs Savings to Consumers? Evidence of Asymmetric Pricing Behavior in the United States Air Transportation Industry.
14. CAPA - Centre for Aviation, 2013. Airline capacity discipline: a new global religion delivers better margins – but for how long? https://centreforaviation.com/insights/analysis/airline-capacity-discipline-a-new-global-religion-delivers-better-margins---but-for-how-long-96762
15. Dennis, N. 2007. End of the free lunch? The responses of traditional European airlines to the low-cost carrier threat. J. Air Transp. Manage., 13 (5) (2007), pp. 311–321.
16. Duso, T., Szücs, F., 2017. Market power and heterogeneous pass-through in German electricity retail. European Economic Review, 98, 354-372.
17. Forsyth P., 2008. The impact of climate change policy on competition in the air transport industry. OECD/ITF Joint Transport Research Centre Discussion Paper – 18.
18. Forsyth P., Gillen, D. 2007. Climate change policies and impacts on air fares. GARS Workshop Cologne, 28-29.
19. Franke M., John, F. 2011. What comes next after recession?–Airline industry scenarios and potential end games. J. Air Transp. Manage., 17 (1) (2011), pp. 19–26.
20. Hazel, R., 2018. Airline capacity discipline in the US domestic market. Journal of Air Transport Management, 66, 76-86.

21. Hong, W-H., Lee, D., 2014. Asymmetric Pricing Dynamics with Market Power: Investigating Island Data of the Retail Gasoline Market. Working Paper.
22. Karagiannis, S., Panagopoulos, Y., Vlamis, P. 2015. Are unleaded gasoline and diesel price adjustment symmetric? A comparison of the four largest EU retail fuel markets, 48, 281-291.
23. Koopmans, C., & Lieshout, R. 2016. Airline cost changes: To what extent are they passed through to the passenger?. Journal of Air Transport Management, 53, 1-11.
24. Li, J., Stock, J. H., 2017. Cost Pass-Through to Higher Ethanol Blends at the Pump: Evidence from Minnesota Gas Station Data. Monthly data 2007 to 2015 panel and use dynamic. Working Paper.
25. Lowe, S., Faber, J., Mason, A., Veldhuis, J., Lieshout, R., Nelissen, D. 2007. Implications of EU emission trading scheme for competition between EU and non-EU airlines. MVA consultancy C3652100. London.
26. Mayor, K., Tol, R. 2010. The impact of European climate change regulations on international tourist markets. Transportation Research Part D, 15, 26-36.
27. Mendes, L., Santos,G. 2008. Using Economic instruments to address emissions from air transport in the European Union. Environment and Planning A, 40, 189-209.
28. Meyer, J., Cramon-Taubadel, S., 2004. Asymmetric price transmission: a survey. Journal of agricultural economics, 55(3), 581-611.
29. Morrell, P. 2007. An evaluation of possible EU air transport emissions trading scheme allocation methods. Energy Policy, 35, 5562-5570.
30. Morrell, P., Swan, W, 2006. Airline jet fuel hedging: theory and practice. Transport Reviews, 26, 713-730.
31. Noel, M.D., 2008. Edgeworth Price Cycles and Focal Prices: Computational Dynamic Markov Equilibria. Journal of Economics & Management Strategy, 17, 345-377.
32. Oxera, 2003. Assessment of the financial impact on airlines of integration into EU greenhouse gas emissions trading scheme. Oxford, UK.
33. Peltzman, S. 2000. Prices rise faster than they fall. The Journal of Political Economy, 3, 466-502.
34. Scheelhaase, J., Grimme, W. 2007. Emission trading for international aviation – an estimation of the economic impact on selected European airlines. Journal of Air Transport Management, 13, 253-263.
35. Scheelhaase, J., Grimme, W., Schaefer, M. 2010. The inclusion of aviation into the EU emission trading scheme – impacts on competition between European and non-European network airlines. Transportation Research Part D, 15, 14-25.
36. Scotti, D., Volta, N. 2017. Profitability change in the global airline industry. Transportation Research Part E: Logistics and Transportation Review, 102, 1-12.
37. Stalnaker, T., Usman, K., Taylor, A. 2016. Airline economic analysis. Oliver Wyman.
38. The Economist, 2015. The collusion delusion. http://www.economist.com/blogs/gulliver/2015/07/airline-competition
39. The Guardian, 2015. Airlines – but not passengers – see benefits as crude oil prices drop. Available at https://www.theguardian.com/business/2015/mar/15/airlines-passengers-crude-oil-prices-drop
40. The New York Times, 2015. As Oil Prices Fall, Airfares Still Stay High. https://www.nytimes.com/2015/03/24/business/dealbook/as-oil-prices-fall-air-fares-still-stay-high.html?mcubz=0
41. The Telegraph, 2016. Airlines accused of 'profiteering' from fall in price of fuel. http://www.telegraph.co.uk/news/aviation/12155815/Airlines-accused-of-profiteering-from-fall-in-price-of-fuel.html
42. The Wall Street Journal, 2015. Why a Big Swing in Jet Fuel Costs Brings Small Change to Airfares. https://blogs.wsj.com/economics/2015/01/16/why-a-big-swing-in-jet-fuel-costs-brings-small-change-to-airfares/
43. The Wall Street Journal, 2017. Obama Antritrust enforcers Won't Bring Action in Airline Probe. https://www.wsj.com/articles/obama-antitrust-enforcers-wont-bring-action-in-airline-probe-1484130781

44. The Washington Post, 2015. Justice Dept. investigating potential airline price collusion. https://www.washingtonpost.com/business/economy/doj-investigating-potential-airline-collusion/2015/07/01/42d99102-201c-11e5-aeb9-a411a84c9d55_story.html?utm_term=.702f59b11749
45. Zachmann, G., von Hirschhausen, C., 2008. First evidence of asymmetric cost pass-through of EU emissions allowances: examining wholesale electricity prices in Germany. Economics Letter, 99, 465-469.
46. Wadud, Z. 2015. Imperfect reversibility of air transport demand: Effects of air fare, fuel prices and price transmission. Transportation Research Part A: Policy and Practice, 72, 16-26.
47. Ward, R. W., 1982. Asymmetry in retail, wholesale, and shipping point pricing for fresh vegetables. American journal of agricultural economics, 64(2), 205-212.
48. Weyl, E.G., Fabinger, M., 2013. Pass-Through as an economic tool: principles of incidence under imperfect competition. Journal of Political Economy, 121, 528-583.
49. Wittman, M., Swelbar, W., 2014. Capacity discipline and the consolidation of airport connectivity in the United States. Transportation Research Record: Journal of the Transportation Research Board, (2449), 72-78.

Please cite as in: https://www.sciencedirect.com/science/article/pii/S2212012217300837

Appendix A – Countries included in the analysis

Frequencies between origin and destination vary due to data cleaning.

Origin	Frequency	Destination	Frequency
Albania	900	Albania	931
Armenia	1,146	Armenia	1,221
Austria	11,434	Austria	11,864
Azerbaijan	1,740	Azerbaijan	1,948
Belarus	2,251	Belarus	2,276
Belgium	6,256	Belgium	6,432
Bosnia and Herzegovina	677	Bosnia and Herzegovina	676
Bulgaria	2,966	Bulgaria	2,877
Croatia	4,346	Croatia	4,232
Cyprus	2,495	Cyprus	2,486
Czech Republic	6,024	Czech Republic	6,181
Denmark	8,614	Denmark	8,670
Estonia	1,541	Estonia	1,557
Faroe Islands	91	Faroe Islands	107
Finland	6,500	Finland	6,478
France	35,526	France	35,033
Georgia	1,605	Georgia	1,582
Germany	51,139	Germany	52,336
Gibraltar	71	Gibraltar	71
Greece	16,372	Greece	15,409
Hungary	2,774	Hungary	2,857
Iceland	1,060	Iceland	1,081
Ireland Republic of	5,081	Ireland Republic of	5,438
Italy	40,316	Italy	39,774
Latvia	3,293	Latvia	3,279
Lithuania	1,224	Lithuania	1,208
Luxembourg	1,619	Luxembourg	1,822
Macedonia Former Yugoslav Republic of	450	Macedonia Former Yugoslav Republic of	450
Malta	2,375	Malta	2,370
Moldova Republic of	1,247	Moldova Republic of	1,312
Montenegro	1,395	Montenegro	1,384
Netherlands	8,979	Netherlands	9,142
Norway	12,237	Norway	12,155
Poland	7,493	Poland	7,547
Portugal	10,044	Portugal	9,869
Romania	5,578	Romania	5,605
Russian Federation	29,334	Russian Federation	29,380
Serbia	3,430	Serbia	3,364
Slovakia	394	Slovakia	401
Slovenia	1,549	Slovenia	1,561
Spain	46,729	Spain	45,489
Sweden	9,933	Sweden	10,082
Switzerland	13,394	Switzerland	13,775
Turkey	13,031	Turkey	12,457
Ukraine	9,141	Ukraine	9,040
United Kingdom	39,825	United Kingdom	40,410