Explaining the Effect of Competition on Price Dispersion: Evidence from the US Airline Industry.

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Abstract

This paper studies the effect of competition on price dispersion in the airline industry by looking at how a monopolist responds to entrants. Like most studies on price dispersion in the airline industry we differentiate between different sort of entrants (LCCs and legacy carriers) and as an addition to previous literature we specify between different sorts of incumbents. Subsequently, we add another dimension by examining the differences between business and leisure routes. We find a weakly significant increase in the price dispersion of a legacy incumbent when a legacy carrier enters its market and a negative effect when an LCC enters. We find a negative effect of competition on the price dispersion of an incumbent when both incumbent and entrant are LCCs, this effect is even stronger when looking at leisure routes. Furthermore we study a possible convergence in pricing strategies between legacy carriers and LCCs but find no evidence for this.

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1. Introduction

Revenue management is the form of price setting where price elasticities of consumers are exploited. In order to maximize profit the optimal number of products (or services) is offered to the right number of consumers against the optimal price. The airline industry uses this method extensively. This results in people boarding the same plane and experiencing the same or similar service, but having paid completely different prices. When consumers pay different prices for the same service, price discrimination is evident. Price discrimination can be measured by means of price dispersion, which is heavily studied in the field of economics by for example Burdett and Judd (1983), Salop and Stiglitz (1977) and Borenstein and Rose (1994). Especially the effect of competition on price dispersion has been studied often. This is the most interesting aspect of price dispersion, because it does not always follow the general economic rules of demand and supply. In theory, an increase in competition would cause a drop in prices because of the possibility of undercutting and the limited possibilities to price discriminate. In reality we see different effects of competition on price discrimination and price dispersion.

Previous literature is inconclusive about the relation between price dispersion and competition. Borenstein and Rose (1994) were one of the first in studying the relation between competition and price dispersion. They found a positive relation between competition and price dispersion. Follow-up studies on the same subject have reported mostly negative or no effect of competition on price dispersion. A first explanation of this difference is that Borenstein and Rose (1994) lack low-cost-carriers (LCCs) in their sample. More recent studies of for example Goolsbee and Syverson (2008) found that LCC entry has a different effect on the price dispersion of incumbents compared to legacy carriers. Secondly, Borenstein and Rose (1994) do not differentiate between different sorts of routes. For example, Stavins (2001) finds that the change in price dispersion after an increase in market concentration can mostly be attributed to the decrease in prices paid by leisure travelers, whilst business travelers do not experience this decrease in prices. She argues that this phenomenon could be explained by the fact that leisure and business travelers have very different price elasticities, and that different sorts of travelers book their tickets at different moments. The latter enables airlines to distinguish between business and leisure travelers.

Gerardi and Shapiro (2009) studied the effect of competition on price dispersion by taking into account the role of these two groups of travelers (business and leisure travelers) and their different price elasticities. Based on total income and percentage of income from accommodation per metropolitan area Gerardi and Shapiro (2009) anticipate which travelers use which routes. When differentiating between business, leisure and mixed routes, they found a positive effect of competition on price dispersion on mixed routes, but no significant effect on leisure routes.

As mentioned before, other studies have tried to explain the different effects of competition on price dispersion by looking at different sorts of carriers, namely low cost carriers (LCC) and legacy carriers. These studies, performed by among others Daraban and Fournier (2008) and Goolsbee and Syverson (2008), found a negative effect of the entry of LCC on price dispersion, but no significant effect for legacy carriers.

Because of all these different factors that have been evaluated, it seems there is no good answer to what the effect of competition on price dispersion really is. For that reason we try to combine different results and use all different dimensions. Besides differentiating between different sorts of entrants and different routes, we will also distinguish between different incumbents to get a complete image about how competition affects price dispersion in the airline industry.

The rest of this paper is organized as follows, section 2 presents a literature review discussing price discrimination, price dispersion and revenue management. Based on this literature review three hypotheses are created. Section 3 presents the data and methodology that is used to analyze these hypotheses. Section 4 presents the empirical analysis and its results and section 5 concludes.

2. Literature review

In this section we will build a theoretical framework to explain the economics behind price discrimination, price dispersion and revenue management. Price dispersion is simply said the spread of prices paid. To study the effect of competition on price dispersion it is important to understand what factors influence price dispersion. Therefore we will start this literature review with price discrimination, which is for this study the most interesting determinant of price dispersion. Thereafter revenue management, another determinant of price dispersion will be discussed and lastly price dispersion itself. This theoretical framework will then be used to explain the origins of the hypotheses that are tested in the empirical section.

Price discrimination

Price discrimination occurs when different (segments of) customers pay different prices and this price difference cannot be explained by variations in marginal costs. Price discrimination is especially present in the airline industry because two important prerequisites are present. First, there are different sorts of travelers in the airline industry, mostly referred to as business and leisure travelers, and these two groups have disparate price elasticities. An example of this difference is that a business traveler is more determined to travel to a certain city than a leisure traveler who might fly to another airport, or take a different flight. Second, airlines are (up to a certain level) able to distinguish between these different sorts travelers by using ticket restrictions, including advance-purchase requirements and non-refundable tickets (Gerardi & Shapiro, 2009).

Puller and Taylor (2012) studied price elasticity by focusing on prices in relation to day-of-week purchase. They argue that the different costumer groups, business and leisure travelers purchase their tickets at different times. More specifically, that business travelers purchase tickets on weekdays and thus not in the weekend. They find that tickets sold in the weekends on average have a 5% lower price than tickets sold on weekdays. To underline this effect they distinguish between different sorts of routes, business, leisure and mixed routes, and show that this effect is a lot stronger for mixed routes.

Another element that plays a part in price discrimination is competition; Stavins (2001) shows that more competition leads to lower prices. Using data from a single day (Thursday, 28 September 1995) Stavins finds that a higher market concentration decreases the effect of ticket restrictions, when controlling for several carrier and route specifics and 'Saturday-night stayover'. Giaume and Guillou (2004) study price discrimination using a slightly larger dataset of outgoing flights from Lyon, France. They distinguish between different levels of market concentration to gain more insight on the effect of this on price discrimination. They find a negative effect of competition on price discrimination. They specify this effect by arguing that most European routes are characterized by a duopoly in which one carrier has a large proportion of the market share, and this causes fierce price competition.

He (2016) supports the findings of Giaume and Guillou with empirical evidence on the international airline market between the U.S. and China. Differently from Giaume and Guillou he focuses on airlines that don't explicitly segment the costumers into groups, but the airlines offer a menu of price-quality combinations where consumers can self-select. He (2016) shows that competition is negatively correlated with second-degree price discrimination.

Summarizing, price discrimination is present in the airline industry because of the different customer segments and their different price elasticities. Airlines take advantage of this by distinguishing between them by offering different prices at different times and by offering ticket restrictions.

Revenue management

Revenue management is the form of price setting where price elasticities of consumers are exploited. In order to maximize profit, the optimal number of seats is offered to the right number of travelers against the optimal price. Examples of revenue management are peak-load pricing and stochastic demand pricing. Bilotkach, Gaggero and Piga (2015) study the effect of price elasticities on revenue management in the airline industry. They find that decreasing the average price with one standard deviation increases the flight's load factor with on average 2.7%. Interestingly they show that revenue management does not increase in effectiveness with increased competition on routes, and is even completely ineffective on routes with solely leisure travelers. This is in line with earlier results of Gerardi and Shapiro (2009) and Puller and Taylor (2012), showing that leisure travelers are price elastic. Bilotkach et al. (2015) also find that revenue management is less effective on leisure routes. Therefore it is expected that a change in market structure on this route does not have a significant effect on price dispersion.

Bilotkach et al (2015) show that changes in market structure do not have an effect on the effectiveness of revenue management. Therefore we assume that when studying the effect of a change in competitive structure on price dispersion, this can not be attributed to revenue management. Instead, this change in price dispersion is attributed to price discrimination. Thus, when measuring the effect of a change in competitive structure on price dispersion, we measure the effect of competition on price discrimination.

Price Dispersion

Price dispersion in the airline industry is the spread of prices that is paid by costumers for their flights, it represents the level of inequality of prices paid. As mentioned before, causes of price dispersion include price discrimination and revenue management. Price dispersion is mostly measured with the Gini coefficient, which represents the inequality of the entire range of fares paid, where 0 represents perfect equality and 1 represents perfect inequality.

Borenstein and Rose (1994) introduce the Gini coefficient to airline studies when studying price dispersion in the U.S. airline industry. They find that price dispersion varies strongly between routes, carriers and different levels of market concentration. The Gini coefficient in their sample ranges from 0.018 to 0.416 and is measured per carrier-route. Their main finding is that price dispersion is strongly related to the market structure of the route:

A. Tourist orientated routes have less price dispersion.
B. Airlines with computer owned reservation systems demonstrated more price dispersion.
C. A higher frequency of flights on a route decreases price dispersion.

D. Airport dominance increases price dispersion on routes served from that airport.
E. More competitors with a fixed number of flights increases price dispersion.

Finding A has already been discussed in the subchapter price discrimination and is shown to be persistent over time by different studies, including Gerardi and Shapiro (2009). Finding B is less relevant nowadays since nearly all flight reservations are done.

Findings C and D have also shown to be robust over time, consequently it is being used as control variable in more recent studies to analyze other factors that influence price dispersion. Studies on price dispersion have mostly studied finding E, the relation between competition and price dispersion.

Gerardi and Shapiro (2009) find contrasting results, they find that more competition decreases price dispersion. In their panel analysis they use different measures for market competition, including the Herfindahl-Hirschman Index, market share and the number of competitors in a certain market. Their findings on the effect of competition on price dispersion are comprehensive, taking into account several factors. They specify the effect on different routes: leisure routes and business routes.

- On business routes, an increase in competition significantly reduces price dispersion. Especially prices in the higher percentiles decrease, whilst the lower prices remain fairly stable.
- On leisure routes, the reduction of price dispersion after an increase in competition is less evident.

Gerardi and Shapiro (2009) conclude that when competition increases, the carrier's ability to differentiate between different sorts of travelers erodes. This results in business (price inelastic) travelers paying significantly smaller prices for their tickets. Since prices in the lower percentiles are barely affected, leisure travelers (price elastic) do not benefit from the increase in competition. This interestingly opposes the findings of Stavins (2001). A possible explanation given for this is the use of different samples, Gerardi and Shapiro (2009) use a more recent and extensive (1993-2006) dataset from the US market, whilst Stavins (2001) uses data from a single day in 1995.

Daraban and Fournier (2008) focus on the entry of LCCs when studying the effect of competition on price dispersion. They study what defensive pricing strategy is used by the incumbent (often legacy carrier) when an LCC enters its market. They find that incumbents decrease their prices already before entry, and decrease even further after entry until two quarters after entry when their prices reach an equilibrium. In their study this effect is strongest with the entry of Southwest Airlines, a large LCC in the United States.

In the same year Goolsbee and Syverson (2008) did a similar study focusing mainly on Southwest airlines. Their results are similar and show that legacy carriers anticipate Southwest's entry by decreasing fares before entry to prevent losing market share to the entrant. The fares decrease only on routes that are threatened by entry, while similar airports or routes to neighboring airports don't experience such a decrease. The decrease in fares is accompanied by a strong increase in passengers on that route, possibly explained by price elastic travelers attracted by the lower prices from rather similar flights.

Summarizing, different studies show different effects of competition on price dispersion, but still a general trend can be seen. On routes with a lot of leisure travelers, competition has a smaller effect on price dispersion than on other routes because of the price sensitivity of leisure travelers. Furthermore, even though there is no simple answer on what the effect of competition on price dispersion is, entry of an LCC seems to have a negative effect on price dispersion.

Hypotheses

As discussed before, the existing literature is not consistent in its predictions about what the effect of competition is on price dispersion in the airline industry. Borenstein and Rose (1994) find a positive effect of competition on price dispersion, whilst Gerardi and Shapiro (2009) find a negative effect of competition on price dispersion. Dai, Liu and Serfes (2014) give a possible explanation for this by identifying two competing forces: the direct price effect and the indirect quality effect. The direct price effect has a positive effect on price dispersion because prices in the lower percentiles decrease more (in percentage) than the prices in the higher percentiles. The indirect quality effect on the other hand has a negative effect on price dispersion. It causes a decline in the higher price percentiles and shrinks the gap between higher and lower prices. Combining these two effects Dai, Liu and Serfes (2014) argue that price dispersion increases in very competitive markets, and price dispersion decreases in less competitive markets.

Besides the explanation of Dai, Liu and Serfes (2014) we propose that the different findings on the effect of competition of price dispersion are caused by yet another factor. Daraban and Fournier (2008) and Goolsbee and Syverson (2008), both having studied the effect of entrance of LCCs, found a negative effect of competition on price dispersion. Since the distinction between LCCs and legacy carriers is based on pricing we expect that the entry of a legacy carrier has a different effect on price dispersion compared to an LCC, namely a positive effect. In line with this proposed effect is the fact that the study of Borenstein and Rose is from 1994, and thus their sample does not contain many LCCs, who have very different price strategies from legacy carriers. Since we expect that different entrants evoke different defensive strategies, our first hypothesis states:

Hypothesis 1: *Legacy carrier entrants have, opposite to low-cost carrier entrants, a positive effect on the price dispersion of the incumbent.*

The difference in price elasticity between leisure and business travelers is well-known in the airline industry and airlines try to exploit this in any way. It is therefore easy to argue that airlines use different pricing strategies for routes that are known as business or leisure routes. Gerardi and Shapiro (2009) show this by looking at competition on leisure routes, where they find a less significant negative effect of competition on price dispersion. Alderighi, Cento, Nijkamp and Rietveld (2012) have contributed to this by studying prices of different (leisure and business) routes for different (LCC and legacy) entrants. They find that a new legacy carrier entry reduces the price stronger on a business route compared to a leisure route. Also, they find that an LCC entrant has a more uniform impact and reduces all fares of the incumbent. They do not study what happens when the incumbent is already an LCC. All studies on LCCs show that legacy incumbents respond strongly to the entry of an LCC, with lower prices and less price dispersion, since LCCs are price fighters. However, when the monopolist is already an LCC, our expectation is that entry of another LCC does not cause a strong price reaction.

Hypothesis 2: *The entry of an LCC into a previous monopoly does not have a negative effect on price dispersion when the previous monopolist is also an LCC.*

Tsoukalas et al. (2008) study the cost per available seat miles and how this changes over time. They find evidence of convergence between cost structures of LCCs and legacy carriers. The most important reason to keep making a distinction between LCCs and legacy carriers is the fact that prices, and more specifically price dispersion is studied and not costs. In the airline industry prices are only partly based on costs, but mostly set to absorb a large part of the consumer surplus. This does however not mean that a convergence in costs between LCCs and legacy carriers does not have any implications for this study. The distinction between LCCs and legacy carriers is based on their cost structures. LCCs are able to charge lower prices and in that way undercut legacy carriers. This resulted in the large market share they have acquired in the past 20 years. The fact that the costs per available seat miles of legacy carriers and LCCs converges means that this lower price strategy may at some point not be evident anymore, and thus possibly annihilating the pricing difference between LCCs and legacy carriers. Based on this argument, the following hypothesis will be tested.

Hypothesis 3: *From 2008 onwards, there is a convergence between pricing strategies of legacy carriers and LCCs.*

3. Data

To test these hypotheses, a dataset containing a 10% random sample of tickets sold in National flights from the United States is used. This data is from the Airline Origin and Destination Survey (DB1B), which is collected by the Office of Airline Information of the Bureau of Transportation Statistics (BTS). This is quarterly data on individual tickets sold between 1993 and 2014. It consists of information from reporting carriers and includes the origin, destination and itinerary details of the passengers transported. This is complemented with monthly route specific characteristics obtained from the T-100 Domestic Segment database, also collected by the BTS. This database includes information on all passengers transported by the reporting carriers including origin, destination, aircraft type, service class, available capacity, scheduled departures, departures performed and load factor. Lastly, airport location and regional demographic information, such as personal income, income per state and the ratio of accommodation earnings to total nonfarm earnings corresponding to metropolitan area is collected from the Regional Economic Accounts (REA) database of the Bureau of Economic Analysis.

Following previous literature on airline pricing (Borenstein and Rose, 1994; Gerardi and Shapiro, 2009) a final sample is created of 300.000 unique carrier-route-date observations in 88 quarters. This dataset contains data of a given carrier in a specific route on a specific time period.

Variables

We will now give an overview of the relevant variables used in the empirical analysis and a short overview of the control variables that are used.

Dependent variables: The main dependent variable that is used in the empirical analysis is the Gini coefficient (represented as fgini). The Gini coefficient is a measure of statistical dispersion and is based on the Lorenz curve. It measures the area between the line of equality and the Lorenz curve as a fraction of the area between the line of equality and total inequality. In this dataset it is calculated per carrier per route per time period (quarterly). Another variable used as dependent variable in this study is the average price (represented as lwaprice), which is also calculated per carrier-route-quarter. Lastly, the

10th, 25th, 50th, 75th and 90th percentile of quarterly prices per carrier-route are used as dependent variable, these are represented in tables by lp10, lp25, lp50, lp75 and lp90 respectively.

Independent variables: There is a set of variables that identify the specific conditions required to study the effect of entrance of different carriers. To identify these market entrances the following dummies are created and afterwards combined:

- *Monoduo*: This dummy takes the value 1 after a monopoly changes in a duopoly, and continues to stay equal to 1 until the market structure changes once again. A Monopoly is defined as a route where one carrier has a market share higher than 90%, whereas a duopoly is defined as a route where the sum of market shares of the two largest carriers is higher than 90%, and is not a monopoly.
- *LCC*: This dummy takes the value 1 when the carrier is identified as a low-cost carrier.
- *Legacy*: This dummy takes the value 1 when the carrier is not identified as a low-cost carrier.
- *Incumb*: This dummy takes the value 1 when this carrier is the incumbent firm of this market (route).
- *Legleg*: This dummy takes value 1 when a duopoly exists of two legacy carriers.
- *Leglcc*: This dummy takes value 1 when a duopoly exists of a legacy carrier and an LCC.
- *Lcclcc:* This dummy takes value 1 when a duopoly exists of two LCCs.
- *Secondperiod:* This dummy takes value 1 from the first quarter of the year 2008 and onwards.

Combining these dummies in different sets gives all the tools to identify different sorts of market entries, and the following independent variables:

Table 1:

Variables of interest used in this study, column 1, variable name shows how it is represented in the regression outputs, column 2 shows of which dummies the variables are created and column 3 shows what it measures. Descriptive statistics are in the appendix.

Variable name	Construction	Measuring
enleg	monoduo*incumb*legacy	Response of the incumbent to a legacy entrant
enlcc	monoduo*incumb*LCC	Response of the incumbent to an LCC entrant
inleg_enlcc	monoduo*incumb*legacy*leglcc	Response of a legacy incumbent to an LCC entrant
inleg_enlcc2	monoduo*incumb*legacy*leglcc*secondperiod	Response of a legacy incumbent to an LCC entrant for the second period (2008 and onwards)
inleg_enleg	monoduo*incumb*legacy*legleg	Response of a legacy incumbent to a legacy entrant
inleg_enleg2	monoduo*incumb*legacy*legleg*secondperiod	Response of a legacy incumbent to a legacy entrant for the second period (2008 and onwards)
inlcc_enlcc	monoduo*incumb* LCC *lcclcc	Response of an LCC incumbent to an LCC entrant
inlcc_enlcc2	monoduo*incumb* LCC *lcclcc	Response of an LCC incumbent to an LCC entrant for the second period (2008 and onwards)
lccsecondperiod	LCC*secondperiod	LCC's in the second period (2008 and onwards)

Subsequently another dimension is added to this model, to study whether the effect of entrance of LCCs and legacy carriers on the behavior of the incumbent is consistent for business and leisure routes. For the distinction between business and leisure routes the methodology of Gerardi and Shapiro (2009) is followed.

- *Business routes*: Routes where the city of departure and the city of destination are both in the top 30 largest metropolitan areas based on total income (Bureau of Economic Analysis).
- *Leisure routes*: This list is created as follows, metropolitan areas are sorted by their percentage of income from accommodation income as percentage of total nonfarm earnings (Bureau of Economic Analysis). The top 15% of this list, thus with the highest percentage accommodation income is listed as a leisure destination. Routes to leisure destinations are leisure routes.

Control variables:

A set of control variables is used to control for anything that has an influence on the airline's pricing. The chosen control variables are based on earlier studies of Borenstein (1989), Baum and Korn (1996), Goolsbee and Syverson (2008). The full set of control variables and the descriptive and summary statistics can be found in the appendix. The set of control variables consists of (potential) competitive measures, airline performance measures, airline market power measures, airline size measures and firm performance measures of the airline. Furthermore we control for time fixed effects and observations are clustered by airline.

4. Empirical section

In this section we will present the results of the regression estimates and discuss these effects and how this responds to the hypotheses that are mentioned above.

Incumbent responses to different sorts of entrants

Table 2 is constructed to test hypothesis 1, where enleg and enlcc represent the response of an incumbent to the entrance of a legacy carrier or an LCC carrier respectively. The first regression is on the full sample, using all routes. The entrance of a legacy carrier has a weakly significant positive effect on the level of price dispersion of the incumbent. This is line with the results of Borenstein and Rose (1994), even though the significance is low. When looking at business routes and leisure routes separately, there is no significant effect.

The entry of an LCC causes a significant decrease in the level of price dispersion of the incumbent. This holds for the full sample, and when looking at business and leisure routes separately. We can conclude from this that the entry of an LCC has a significantly different and more negative effect on the price dispersion of the incumbent compared to the entry of a legacy carrier. This is in line with results of Daraban and Fournier (2008) and Goolsbee and Syverson (2008) who also found a negative effect of an LCC entrant on the incumbent's price dispersion. The positive effect of entry of a legacy carrier on the incumbent's price dispersion is in line with our first hypothesis that states that the entry of a legacy carrier has a positive effect on the level of price dispersion of the incumbent. However, this is only a weak effect, our hypothesis is more supported by the fact that the entry of an LCC has a strong negative effect on the level of price dispersion of the incumbent. This strong negative effect of an LCC entry in contrast to the weakly positive effect of a legacy carrier entrant shows that the price response of an incumbent depends strongly on the type of entrant, LCC or legacy carrier

Responses of different sorts of incumbents

Table 3 is constructed to study the different responses of different incumbents to the entry of new carriers into their former monopolies. For completeness we have specific dummies for each different possible combination of different incumbents and entrants. This leaves us with three variables, since our sample does not have any routes where a former LCC monopolist encounters the entry of a legacy carrier. The variables inleg_enleg and inleg_enlcc from Table 3 are very similar to enleg and enlcc of Table 2. This is explained by the fact that enleg is the same as inleg_enleg since only legacy incumbents experience legacy entrants. enlcc is a combination of inleg_enlcc and inlcc_enlcc, but because there are more legacy carrier monopolists than LCC monopolists, enlcc is mostly influenced by inleg_enlcc.

Table 2:

Panel estimates of the Gini coefficient on a 10% random sample of tickets sold of the United States national flights. The Gini coefficient is determined per carrier-route-quarter; enleg shows the effect on the incumbent price dispersion when a legacy carrier enters this market, which before was a monopoly; enlcc shows the effect on the incumbent's price dispersion when an LCC enters his market, which before was a monopoly.

VARIABLES	All Routes	Business Routes	Leisure Routes
enleg	0.007*	0.006	0.005
	[0.004]	[0.006]	[0.011]
enlcc	-0.017***	-0.016***	-0.016**
	[0.004]	[0.005]	[0.008]
Constant	-0.145**	-0.142**	-0.084
	[0.057]	[0.063]	[0.082]
R-squared	0.260	0.267	0.256
Observations	305897	193688	45190
Control Variables	YES	YES	YES
Month FE	YES	YES	YES
Airline FE	YES	YES	YES
N of Clusters	62	62	54

Note: Airline clustered standard errors in square brackets.
*** p<0.01, ** p<0.05, * p<0.1

Table 3:

Panel estimates of the Gini coefficient on a 10% random sample of tickets sold of the United States national flights. Where the Gini coefficient is determined per carrier-route-quarter. Inleg_enlcc shows the effect on the incumbent legacy carrier's price dispersion when an LCC enters this market, which before was a monopoly. Inleg_enleg shows the effect on the incumbent legacy carrier's price dispersion when a legacy carrier enters this market, which before was a monopoly. Inlcc_enlcc shows the effect on the incumbent LCC's price dispersion when another LCC enters this market, which before was a monopoly. Inlcc_enleg is omitted since this sample does not have any markets with a duopoly of an LCC and a legacy carrier where the LCC was the incumbent.

VARIABLES	All Routes	Business Routes	Leisure Routes
inleg_enlcc	-0.017***	-0.016***	-0.015*
	[0.004]	[0.005]	[0.008]
inleg_enleg	0.007*	0.006	0.005
	[0.004]	[0.006]	[0.011]
inlcc_enlcc	-0.018*	-0.012	-0.029**
	[0.011]	[0.012]	[0.013]
Constant	-0.145**	-0.143**	-0.084
	[0.058]	[0.063]	[0.08]
R-squared	0.260	0.267	0.256
Observations	305897	193688	45190
Control Variables	YES	YES	YES
Month FE	YES	YES	YES
Airline FE	YES	YES	YES
N of Clusters	62	62	54

Note: Airline clustered standard errors in square brackets.
*** p<0.01, ** p<0.05, * p<0.1

Because of the reasons described above, we can see Table 3 as an expansion of Table 2. This expansion allows us to see how different sorts of incumbents (legacy carrier or LCC) respond to the entry of an LCC or legacy carrier on different sorts of routes. When studying the first regression of Table 3, we see that legacy and LCC incumbents respond similarly with regards to price dispersion to the entry of an LCC. However, differences are present in the regressions on business routes and leisure routes separately. For business routes, the coefficients are rather similar, however the response of the LCC incumbent is not significant and slightly smaller than the coefficient of the legacy carrier incumbent responding to an LCC entry. Even though there is no statistical evidence to claim that inleg_enlcc and inlcc_enlcc are different from each other, inleg_enlcc is significantly smaller than zero, whilst inlcc_enlcc is not. Therefore, the claim of hypothesis 2 that the entry of an LCC into a previous monopoly does not have a negative effect on price dispersion when the previous monopolist is also an LCC finds very little support only when looking at business routes.

When looking at the leisure routes, we do not find any support for hypothesis 2, and see the opposite of what we see when looking at business routes. On leisure routes, the entry of an LCC into the market of another LCC monopolist, has a strong negative effect on the level of price dispersion of the previous LCC monopolist.

Summarizing, we find limited support for our second hypothesis. In fact only some support was found when studying business routes. A possible explanation for this is that business travelers are less price sensitive and therefore it is unsuccessful to start a price war between two LCCs.

Price Percentile changes after entry

To gain further understanding of an incumbent's pricing strategy response after an entrant enters the market we carried out additional regressions on different pricing levels, namely: The 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} percentile. Table 4 shows the first set of regressions with all three variables of interest on the complete set of routes.

Table 4 shows that when studying all routes, that the incumbent only exerts significant price changes when it is a legacy carrier and the incumbent is an LCC. The legacy incumbent lowers its prices when it encounters the entry of an LCC. Where the decrease in price for the 10^{th} percentile is about 12% and increases to a price decrease of approximately 20% for the 90^{th} percentile. These results differ from the findings of Alerighi et al. (2012) who found that competition between legacy carriers reduces prices. Additional findings of Alerighi et al. (2012) are that the reduction in prices when legacy carriers compete is stronger on business routes than on leisure routes. Table 10 (appendix) and Table 5 show the price responses of the incumbent for business routes and leisure routes.

The results of Table 4 (all routes) and Table 10 (business routes) are very similar, this can be explained by the fact that in this sample business routes represent a large proportion of all the routes. Table 10 is present for completeness reasons but placed in the appendix because of the high similarity with the results of the full sample in Table 4.

Table 5 shows the same regression outputs as Table 4, but now on leisure routes only, and it has some interesting findings. Starting with the legacy incumbent's response when an LCC enters the market, just as for the full sample, there is a decrease in prices that can be seen for all percentiles. The decrease is stronger and ranges between -21% and -25%. In previous literature we have seen that leisure travelers are more price sensitive than business travelers and thus these results are not surprising. In our case this means that the legacy incumbent has to decrease its prices significantly to stay competitive on leisure routes when an LCC enters its market.

Contrary to when an LCC enters the legacy incumbent's market, when another legacy carrier enters the market, prices of all percentiles increase with up to 21%. Table 2 shows that when a legacy carrier monopolist's leisure route is entered by another legacy carrier that there is no significant change in price dispersion. Instead, the actual tickets prices go up along all percentiles. This goes against all expectations and even shows collusive behavior.

Lastly, Table 5 also shows the LCC incumbent's price response when another LCC enters its leisure route. In Table 3 we have seen that the incumbent responds with fewer price dispersion, and Table 5 shows how that plays out. Contrary to our expectations regarding the second hypotheses, there is no evidence of any price competition on leisure routes with a duopoly of two LCCs. Table 5 shows an increase in prices in the 10^{th}, 25^{th} and 50^{th} percentile, and no significant changes other than that. This explains the decrease in price dispersion seen in Table 3, but for the wrong reasons. The increase in prices in the lower percentiles while stable prices in the higher percentiles exerts in fewer price dispersion, but not in the advantage of consumers. So, similarly to two legacy carriers, a duopoly of two LCCs on a leisure route shows signs of collusive behavior. These results are interesting new findings, since LCC incumbent behavior has not been studied much in previous literature.

Table 4:

Panel estimates of the natural log of the 10th, 25th, 50th, 75th and 90th percentile prices of a 10% random sample of tickets sold of the United States national flights. Where the percentiles are determined per carrier-route-quarter. Inleg_enlcc shows the effect on the incumbent legacy carrier's price level when an LCC enters this market, which before was a monopoly. Inleg_enleg shows the effect on the incumbent legacy carrier's price level when a legacy carrier enters this market, which before was a monopoly. Inlcc_enlcc shows the effect on the incumbent LCC's price level when another LCC enters this market, which before was a monopoly.

VARIABLES	Lp10	Lp25	Lp50	Lp75	Lp90
inleg_enlcc	-0.121***	-0.141***	-0.154***	-0.196***	-0.201***
	[0.043]	[0.050]	[0.049]	[0.053]	[0.057]
inleg_enleg	0.061	0.065	0.075	0.096	0.080
	[0.056]	[0.055]	[0.053]	[0.059]	[0.061]
inlcc_enlcc	0.045	0.011	-0.022	-0.044	-0.056
	[0.082]	[0.078]	[0.072]	[0.066]	[0.050]
Constant	2.196***	2.388***	2.449***	2.221***	1.847***
	[0.464]	[0.416]	[0.399]	[0.415]	[0.43]
R-squared	0.262	0.307	0.334	0.360	0.397
Observations	305897	305897	305897	305897	305897
Control Variables	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES
Airline FE	YES	YES	YES	YES	YES
N of Clusters	62	62	62	62	62

Note: Airline clustered standard errors in square brackets.
*** p<0.01, ** p<0.05, * p<0.1

Table 5:

Panel estimates of the natural log of the 10th, 25th, 50th, 75th and 90th percentile prices of a 10% random sample of tickets sold of the United States national flights, with only the routes that are defined as leisure routes. Where the percentiles are determined per carrier-route-quarter. Inleg_enlcc shows the effect on the incumbent legacy carrier's price level when an LCC enters this market, which before was a monopoly. Inleg_enleg shows the effect on the incumbent legacy carrier's price level when a legacy carrier enters this market, which before was a monopoly. Inlcc_enlcc shows the effect on the incumbent LCC's price level when another LCC enters this market, which before was a monopoly.

VARIABLES	Lp10	Lp25	Lp50	Lp75	Lp90
inleg_enlcc	-0.215***	-0.215***	-0.216***	-0.241***	-0.253***
	[0.070]	[0.073]	[0.072]	[0.075]	[0.081]
inleg_enleg	0.198**	0.173**	0.186***	0.207***	0.174***
	[0.076]	[0.076]	[0.068]	[0.059]	[0.059]
inlcc_enlcc	0.357*	0.324*	0.287*	0.248	0.189
	[0.180]	[0.177]	[0.171]	[0.160]	[0.134]
Constant	1.752***	1.996***	2.126***	2.015***	1.801***
	[0.460]	[0.450]	[0.468]	[0.552]	[0.554]
R-squared	0.312	0.355	0.377	0.412	0.447
Observations	45190	45190	45190	45190	45190
Control Variables	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES
Airline FE	YES	YES	YES	YES	YES
N of Clusters	54	54	54	54	54

Note: Airline clustered standard errors in square brackets.
*** p<0.01, ** p<0.05, * p<0.1

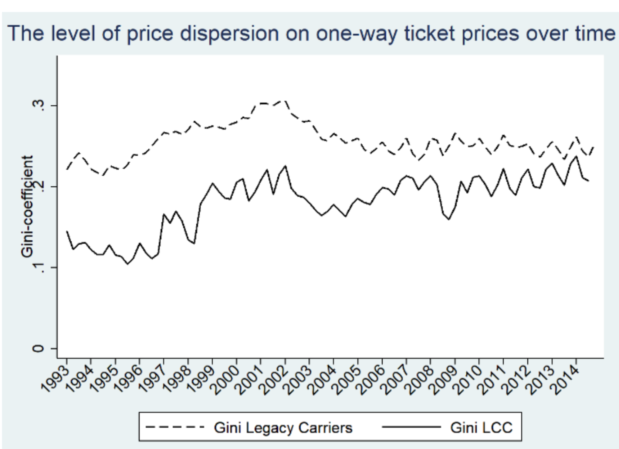
LCC and legacy carrier pricing convergence

To get more insight in the possible convergence between pricing strategies over time between LCCs and legacy carriers we created Graph 1a and Graph 1b. Graph 1a shows the average Gini coefficient of legacy carriers and LCCs over the time of our sample. Even though both averages in Graph 1a show a lot of volatility there is an observable convergence between the lines. The level of price dispersion for legacy carriers has been relatively stable over time, and the level of price dispersion of LCCs has been going up. Both legacy carriers and LCCs show almost the same amount of price dispersion near the end of our sample. Graph 1b on the other hand does not show much convergence, it has a strong correlation especially in the first half of the sample. However, it does not seem to converge nearing the end of the sample and it even seems to diverge. Furthermore, the median price of legacy carriers shows a lot of volatility. This can partly be explained by differences in seasonal demand. Another interesting thing is the price drop of the median price for LCCs in the 64th and 65th quarter, the last quarter of 2008 and the first quarter of 2009. A possible explanation for this is the financial crisis in the United States causing a drop in demand.

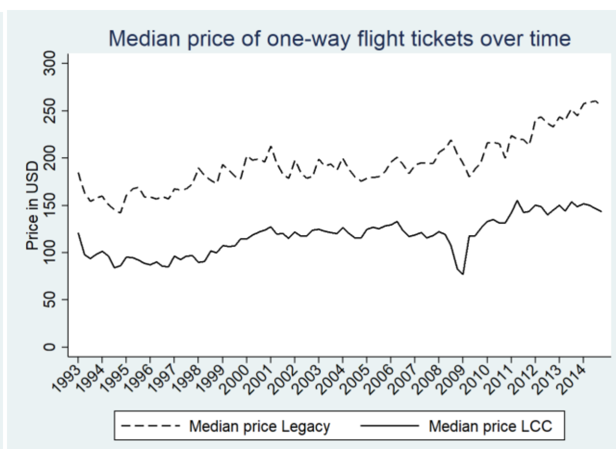
Graph 1:

Graph 1a shows the quarterly average Gini coefficient for legacy carriers and for LCCs over the full time-period of a 10% random sample of tickets sold of the United States national flights, from 1993 to 2014. Graph 1b shows the quarterly average median price coefficient for legacy carriers and for LCCs over the full time-period of a 10% random sample of tickets sold of the United States national flights, from 1993 to 2014.

Graph 1a



Graph 1b



To actually test hypothesis 3, two regressions are carried out wherein either the Gini coefficient or the median price is the dependent variable. The second period of our sample starts in the first quarter of 2008. This period has been chosen based on findings of Tsoukalas et al. (2008) on convergence between cost structures of legacy carriers and LCCs. Table 6 shows the results of these tests, and it is clear that there is no support for convergence in pricing or pricing strategies between legacy carriers and LCCs.

When comparing the graphs and the regression output we see very different results, however when making a conclusion it is wiser to follow the regression output and conclude that there is no convergence. The reason for this is the use of control variables, the regression controls for other influencers of price and price dispersion and is therefore more trustworthy.

To also fall back to the earlier focus of this study, namely defensive strategies of monopolist incumbents when their route gets a new entrant, another set of regressions is carried out to test whether defensive strategies differ between the first and second period of our sample. The results of this can be found in Table 7. These results do not support our third hypothesis that there is a convergence between pricing strategies between LCCs and legacy carriers over the time period of our sample. We conclude this from the fact that there are no significant differences in defensive strategies of the incumbents between the second and the first period.

Table 6

Panel estimates of the Gini coefficient (fGini) and weighted average price (Lwaprice) on a 10% random sample of tickets sold of the United States national flights. Where the Gini coefficient and weighted average price are determined per carrier-route-quarter. LCC denotes which observations are flown by low-cost-carriers. The second period starts in the first quarter of 2008 and is present to test whether there are differences in the pricing strategies of legacy carriers and LCCs.

VARIABLES	fGini	Lwaprice
LCC	-0.021*	-0.267***
	[0.012]	[0.067]
lccsecondperiod	-0.004	-0.038
	[0.006]	[0.033]
secondperiod	0.027*	0.098
	[0.015]	[0.068]
Constant	-0.067	3.214***
	[0.054]	[0.451]
R-squared	0.264	0.339
Observations	305897	305897
Control Variables	YES	YES
Month FE	YES	YES
Airline FE	YES	YES
N of Clusters	62	62

Note: Airline clustered standard errors in square brackets.
*** p<0.01, ** p<0.05, * p<0.1

Table 7:

Panel estimates of the Gini coeffient on a 10% random sample of tickets sold of the United States national flights between 1993 and 2014. Where the Gini coefficient is determined per carrier-route-quarter. Inleg_enlcc is shows the effect on the incumbent legacy carrier's price dispersion when an LCC enters this market, which before was a monopoly. Inleg_enleg is shows the effect on the incumbent legacy carrier's price dispersion when a legacy carrier enters this market, which before was a monopoly. Inlcc_enlcc shows the effect on the incumbent LCC's price level when another LCC enters this market, which before was a monopoly. The '2' behind these variables show that these are only for the second period. The second period starts in the first quarter of 2008.

VARIABLES	All routes	Business routes	Leisure routes
inleg_enlcc	-0.019***	-0.014***	-0.014*
	[0.006]	[0.005]	[0.007]
inleg_enlcc2	0.003	-0.003	-0.002
	[0.009]	[0.009]	[0.009]
inleg_enleg	0.008	0.007	0.001
	[0.005]	[0.006]	[0.013]
inleg_enleg2	-0.001	-0.004	0.014
	[0.010]	[0.008]	[0.011]
inlcc_enlcc	-0.025*	-0.023	-0.029**
	[0.015]	[0.018]	[0.014]
inlcc_enlcc2	0.015	0.024	
	[0.016]	[0.020]	
secondperiod	0.015	0.016	0.042***
	[0.013]	[0.010]	[0.012]
Constant	-0.145**	-0.143**	-0.084
	[0.058]	[0.063]	[0.082]
R-squared	0.260	0.267	0.256
Observations	305897	193688	45190
Control Variables	YES	YES	YES
Month FE	YES	YES	YES
Airline FE	YES	YES	YES
N of Clusters	62	62	54

Note: Airline clustered standard errors in square brackets.
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

This paper studies the difference in pricing strategies between legacy carriers and LCCs in the United States. We focus on defensive strategies used by previous monopolists when a certain route becomes a duopoly. We also differentiate between business and leisure routes, and see that the incumbents respond differently depending on the sort of traveler that is most common on a route. Summarizing these results we see that when an LCC enters the monopoly route of a legacy carrier, the legacy carrier responds with a drop in both price dispersion as well as in actual prices. The higher the price percentiles, the higher the drop in price, averaging around 20% for the 90th percentile. This price drop is even more evident for leisure routes alone. The drop in prices and price dispersion when an LCC enters the market of a legacy carrier is differently from when another legacy carrier enters the monopoly route of a legacy carrier. When a legacy carrier incumbent experiences the entry of another legacy carrier a weakly significant increase in the incumbent's price dispersion is visible. Overall there are no changes in actual prices, except for leisure routes, where a significant increase in prices is observed. This is counterintuitive since leisure travelers are more price sensitive, and an increase in competition should therefore not increase prices. Lastly, there is the scenario where an LCC enters the monopoly market of another LCC. In this case the incumbent slightly decreases its level of price dispersion, this decrease is stronger for leisure routes. This seems obvious and in line with general economic expectations that an increase in competition decreases the prices and the possibility to exert price discrimination. However, when studying the actual change in prices for leisure routes we find an increase in the lower price percentiles and no significant change in the upper percentiles. This confirms the decrease in price dispersion, but not in the way that it is expected. Here again an increase in competition on leisure routes is disadvantageous for consumers.

The second part of this paper studies convergence in pricing strategies and actual pricing between legacy carriers and LCCs over the time period of our sample. Regardless of visible signs that there is a convergence in price dispersion between legacy carriers and LCCs there is no statistical evidence that this convergence is actually happening. We have not found evidence of changes in defensive strategies for monopolists who encounter entrants. A limitation to that regard is the relative early ending of our the data in 2014, a more extensive dataset with more recent data might show different results. It would be interesting for further studies to continue to investigate this possible convergence, especially in combination with the findings of Tsoukalas et al. (2008) on increasing similarities between the cost structures of legacy carriers and LCCs.

Most striking from these results is the increase in prices when two similar carriers (two LCCs or two legacy carriers) share a leisure route. We have two possible explanations for the collusive behavior in these two settings. The first explanation is about the avoidance of a price war, carriers experience a lot of multimarket contact because of the many routes they serve. They might raise prices when their market is entered by another carrier to avoid a price war that might spread to other routes as well. This explanation is best applicable to the scenario of a leisure route with two LCCs because they only raise prices in the lower percentiles, and thus stop offering stunt prices. The second explanation is about cooperating carriers from the same alliance. The incumbent has relatively low prices on their monopoly route to not make the route too attractive for new entrants. When a new entrant does enter this market, and is possible from the same alliance, they collaboratively raise prices to a more profitable level. This is possible because the route becomes less attractive for new entrants since the market is a duopoly instead of a monopoly and the incumbents are two cooperating carriers. This explanation is most suitable for two legacy carriers, but a combination of both explanations is in any case likely. However, this has not been studied in this paper and is an interesting topic for further research.

A limitation of this study is the focus on only one sort of change in market structure, namely from monopoly to duopoly. This is a limitation since this is only a small of the possible market structures, and price responses of incumbents may be different when more competitors are present in a market. Studying these same effects for markets with more players would give interesting new insights in the pricing strategies of different carriers on different routes.

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7. Appendix

Table 8:

Summary statistics of the variables used in this study, all data is per carrier-route-quarter and over the period 1993-2014. The data is collected from the Airline Origin and Destination Survey (DB1B) and this contains of a 10% random sample of tickets sold in the United States.

	mean	sd	min	max
Gini coefficient	0.25	0.08	0	0.93
inleg_enlcc	0.01	0.11	0	1
inleg_enleg	0.01	0.03	0	1
inlcc_enlcc	0.00	0.03	0	1
inlcc_enleg	0.00	0.00	0	0
leisure_dum	0.15	0.35	0	1
Logarithm of the 10th price percentile per carrier-route-quarter	4.51	0.46	2	7
Logarithm of the 25th price percentile per carrier-route-quarter	4.76	0.43	2	7
Logarithm of the 50th price percentile per carrier-route-quarter	5.09	0.44	2	7
Logarithm of the 75th price percentile per carrier-route-quarter	5.48	0.50	2	8
Logarithm of the 90th price percentile per carrier-route-quarter	5.78	0.54	2	8
Competitive indicator (based on passenger tickets from DB1B)	0.12	0.32	0	1
Number of carriers on route (based on passenger tickets from DB1B)	2.11	1.28	1	11
Square of the enplanement instrument (Borenstein and Rose, 1994)	0.56	0.40	0	1
Potential competition at the origin airport	13.30	5.66	0	31
Potential competition at the destination airport	13.27	5.65	0	31
Percentage of unperformed flights per carrier-route-quarter	0.02	0.04	0	1
Percentage of unscheduled flights per carrier-route-quarter	0.01	0.08	0	1
Average quarterly load factor (i.e. percentage of filled seats) per carrier-rout	0.71	0.15	0	1
Average yearly load factor (i.e. percentage of filled seats) per carrier-route	0.71	0.14	0	1
Average number of routes the carrier performs from the origin and destination airports	25.21	13.73	1	96
Number of routes the carrier performs from other airports	409.70	246.00	1	1,149
Total available seat miles per carrier per year	6.38e+10	3.84e+10	14099102	1.215e+11
Percentage of round trip tickets sold per carrier-route-quarter	0.68	0.18	0	1
Logarithm of total assets reported	15.74	1.62	9	18
Cash reported relative to assets	0.06	0.08	-0	1
Operating expenses reported relative to assets	0.22	0.18	0	5
Non-operating income reported relative to assets	-0.01	0.05	-2	2
Bankruptcy indicator (equal to 1 during the period reported)	0.01	0.10	0	1
N	306,397			

Table 9:

This table shows all the variables that are used in a regression when "Control Variables" is "YES" in the regression outputs. Table 8 shows summary statistics of these variables.

Variable names	Measuring	Specification
Comp	Competition	Competitive indicater (based on passenger tickets from DB1B)
n_carr	Number of carriers	Number of carriers on a route (based on passenger tickets from DB1B)
potcomp_oa;	Potential competition at origin airport	Number of carriers present at the airport of origin
potcomp_da	Potential competition at destination airport	Number of carriers present at the destination airport
perc_unperformed;	Percentage of unperformed flights	Percentage of unperformed flights as percentage of scheduled flights, per carrier-route-quarter
perc_unscheduled	Percentage of unscheduled flights	Percentage of unscheduled flights as percentage of scheduled flights, per carrier-route-quarter
avgload_q;	Average quarterly load factor	Percentage of seats filled
avgload_y	Average yearly load factor	Percentage of seats filled
n_routes_odc;	Number of routes	Average number of routes the carrier performs from the origin and destination airport
n_routes_otherairc	Total number of routes	Number of routes the carrier performs from other airports
tot_asm_c;	Total available seat miles per carrier per year	Firm size control
lassets	Assets	Logarithm of total assets reported
Cash;	Cash	Cash reported relative to assets
opexp;	Operating expense	Operating expenses reported relative to assets
nonopinc;	Non-operating income	Non-operating income reported relative to assets
bankr	Bankruptcy indicator	Equal to 1 during the period reported
Pc_roundtrip	Percentage of roundtrips	Percentage of roundtrips to control for price discrimination between one-way and roundtrip

Table 10:

Panel estimates of the natural log of the 10th, 25th, 50th, 75th and 90th percentile prices of a 10% random sample of tickets sold of the United States national flights, with only the routes that are defined as leisure routes. Where the percentiles are determined per carrier-route-quarter. Inleg_enlcc shows the effect on the incumbent legacy carrier's price level when an LCC enters this market, which before was a monopoly. Inleg_enleg shows the effect on the incumbent legacy carrier's price level when a legacy carrier enters this market, which before was a monopoly. Inlcc_enlcc shows the effect on the incumbent LCC's price level when another LCC enters this market, which before was a monopoly.

VARIABLES	Lp10	Lp25	Lp50	Lp75	Lp90
inleg_enlcc	-0.142***	-0.151***	-0.157***	-0.195***	-0.195***
	[0.039]	[0.040]	[0.040]	[0.042]	[0.042]
inleg_enleg	0.059	0.060	0.072	0.096*	0.074
	[0.044]	[0.043]	[0.045]	[0.054]	[0.054]
inlcc_enlcc	0.042	0.013	-0.009	-0.017	-0.028
	[0.110]	[0.107]	[0.100]	[0.089]	[0.064]
Constant	2.195***	2.421***	2.539***	2.310***	1.877***
	[0.424]	[0.394]	[0.402]	[0.448]	[0.475]
R-squared	0.290	0.325	0.343	0.355	0.388
Observations	193688	193688	193688	193688	193688
Control Variables	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES
Airline FE	YES	YES	YES	YES	YES
N of Clusters	62	62	62	62	62

Note: Airline clustered standard errors in square brackets.
*** p<0.01, ** p<0.05, * p<0.1