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Patterns and Effects of Entry in U.S. Airline Markets

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Non-technical summary

The importance of market entry for competition and innovation is largely undisputed in the field of industrial organisation. Following the well-known methodology of Paul Geroski (1991, 1995), this importance is based on two major roles of entry: as an equilibrium force in that it competes away excess profits to an equilibrium level (so-called imitative entry) and as a disequilibrium force which propels the industry from one equilibrium state to another due to the introduction and diffusion of innovations (so-called innovative entry).

The U.S. airline industry can act as a prime example for the relevance of both types of entry. On the one hand, since the deregulation of the industry in 1978 imitative entry into many routes significantly increased competitive pressures and forced the traditional network carriers to increase their productive efficiency leading to lower fares and better service on many routes. On the other hand, deregulation allowed the appearance and growth of low-cost carriers who challenge the traditional network carriers with various forms of innovative entry.

Against this background, we use T-100 traffic data and DB1B fare data from the U.S. Department of Transportation to identify patterns and effects of entry by network carriers and low-cost carriers in non-stop U.S. airline markets. For the sample period from 1996 to 2009, we find significant entry activity for both network carriers and low-cost carriers. However, while the network carriers showed substantial entry activity between 1996 and 2000, the average number of entries dropped significantly from 2003 onwards. Since 2004, the group of low-cost carriers entered more markets per year than the group of network carriers. In addition, the analysis revealed that low-cost carrier entries have significantly higher survival rates than entries by network carriers.

With respect to the effects of entry, we apply two different approaches: a descriptive approach which studies the effects of all entry events in the TOP 500 non-stop U.S. airline markets and an econometric approach which investigates the effects of entry into existing non-stop markets for selected LCCs and NWCs separately by using logarithmic fixed effects regressions. We find that entry activity of low-cost carriers did not only experience significant absolute increases but also led to substantial fare reductions. As route entries by network carriers do not have comparable effects, the existence and expansion of low-cost carriers must be considered as the main driver of (price) competition in the domestic U.S. airline industry.

Das Wichtigste in Kürze

Die herausragende Bedeutung von Marktzutritt für Wettbewerb und Innovation gilt als unumstritten im Bereich der Industrieökonomik. Folgt man der vielfach zitierten Methodologie von Paul Geroski (1991, 1995), so gründet sich diese Bedeutung insbesondere auf zwei zentrale Funktionen von Marktzutritt: als eine gleichgewichtsschaffende Kraft in dem Sinne, dass Marktzutritt bestehende Gewinne wegkonkurriert (sog. imitativer Marktzutritt) und als gleichgewichtszerstörende Kraft indem durch Markteintritt neue Innovationen eingeführt werden (sog. innovationsgetriebener Marktzutritt).

Die U.S.-amerikanische Luftverkehrsindustrie kann als ein Paradebeispiel der Bedeutung beider Funktionen von Marktzutritt angesehen werden. Auf der einen Seite sorgte imitativer Marktzutritt seit der Deregulierung des US-Luftverkehrs im Jahre 1978 dafür, dass der Wettbewerbsdruck auf vielen Streckenmärkten anstieg und somit die traditionellen Fluggesellschaften gezwungen wurden, ihre produktive Effizienz zu verbessern und auf diese Weise für niedrigere Flugpreise und besseren Service zu sorgen. Auf der anderen Seite erlaubte die Deregulierung die Gründung und das Wachstum von Billigfluggesellschaften, die die traditionellen Fluggesellschaften mit verschiedenen Formen des innovationsgetriebenen Marktzutritts herausfordern.

Vor diesem Hintergrund verwenden wir Verkehrs- und Preisdaten des US-amerikanischen Verkehrsministeriums für eine Identifikation der Muster und Effekte von Marktzutritten traditioneller Fluggesellschaften sowie von Billigfluggesellschaften in inländische US-Direktflugverbindungen. Für die Untersuchungsperiode von 1996 bis 2009 stellen wir eine signifikante Eintrittsaktivität für beide Typen von Fluggesellschaften fest. Während allerdings die traditionellen Fluggesellschaften zwischen 1996 und 2000 eine verstärkte Eintrittsaktivität aufweisen, sinkt deren Anzahl an Marktzutritten spürbar ab dem Jahr 2003. Beginnend mit dem Jahr 2004 verzeichnet die Gruppe der Billigfluggesellschaften jährlich mehr Marktzutritte als die traditionellen Fluggesellschaften. Darüber hinaus stellen wir fest, dass Markteintritte von Billigfluggesellschaften im Durchschnitt erfolgreicher waren (gemessen in so genannten Überlebensraten) als die entsprechenden Marktzutritte der traditionellen Fluggesellschaften.

Die Effekte von Marktzutritt betrachten wir zum einen mit Hilfe eines deskriptiven Ansatzes, der die Effekte aller Marktzutritte in den 500 größten Luftverkehrsmärkten untersucht. Des Weiteren kommt ein ökonometrischen Ansatz zum Einsatz, der die Effekte von Marktzutritt für ausgewählte traditionelle Fluggesellschaften und Billigfluggesellschaften mit Hilfe sogenannter fixed effects-Regressionen untersucht. Unsere Ergebnisse zeigen, dass die Marktzutritte von Billigfluggesellschaften nicht nur absolut im Zeitablauf angestiegen sind, sondern insbesondere, dass sie zu substantiellen Preissenkungen geführt haben. Da für die Marktzutritte der traditionellen Fluggesellschaften keine vergleichbaren Effekte gefunden wurden, muss die Existenz und das Wachstum der Billigfluggesellschaften als der wesentliche Treiber des (Preis-) Wettbewerbs im US-amerikanischen Luftverkehrsmarkt angesehen werden.

PATTERNS AND EFFECTS OF ENTRY IN U.S. AIRLINE MARKETS

Kai Hüschelrath[♣] and Kathrin Müller[*]

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Abstract
We use T-100 traffic data and DB1B fare data from the U.S. Department of Transportation to identify patterns and effects of entry by network carriers and low-cost carriers in non-stop U.S. airline markets. For the sample period from 1996 to 2009, we find that entry activity of low-cost carriers did not only experience significant absolute increases but also led to substantial fare reductions. As route entries by network carriers do not have comparable effects, the existence and expansion of low-cost carriers must be considered as the main driver of competition in the domestic U.S. airline industry.

Keywords Airline industry, liberalisation, entry, low-cost carriers

JEL Class L40, L93

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1 Introduction

The importance of market entry for competition and innovation is largely undisputed in the field of industrial organisation. On the one hand, entry plays a crucial role as an equilibrium force in that it competes away excess profits to an equilibrium level. Such imitative entry occurs when the entrant can reap profits by copying the established firms product or method of production. On the other hand, entry also plays a creative role in markets, serving as a vehicle for the introduction and diffusion of innovations. Such innovative entry occurs when the entrant either finds new ways to saturate a certain customer's need or is able to produce a given product with less input. Innovative entry is seen as a disequilibrium force which propels the industry from one equilibrium state to another (see Geroski, 1991, 1995).

The U.S. airline industry can act as a prime example for the relevance of both types of entry. On the one hand, since the deregulation of the industry in 1978, imitative entry into many routes significantly increased competitive pressures and forced the traditional network carriers to increase their productive efficiency leading to lower fares and better service on many routes. On the other hand, deregulation allowed the appearance and growth of low-cost carriers who challenge the traditional network carriers with various forms of innovative entry. This unique combination of regulation and deregulation together with the presence of imitative and innovative entry makes the U.S. airline industry a prime candidate for a closer examination of the role of market entry. This general interest is increased further by the absence of studies on patterns and effects of entry that take both types of significant recent market developments into account: severe external shocks, such as the attacks on 11 September 2001 or the recent economic recession, and severe internal shocks such as the mergers of American Airlines and Trans World Airlines in 2001 or Delta Airlines and Northwest Airlines in 2008.

Against this background, we use T-100 traffic data and DB1B fare data from the U.S. Department of Transportation to identify patterns and effects of entry by network carriers and low-cost carriers in non-stop U.S. airline markets. For the sample period from 1996 to 2009, we find that entry activity of low-cost carriers did not only experience significant absolute increases but also led to substantial fare reductions. As route entries by network carriers do not have comparable effects, the existence and expansion of low-cost carriers must be considered as the main driver of competition in the domestic U.S. airline industry.

The remainder of the article is structured as follows. The subsequent second section provides a review of the existing literature on particularly the effects of entry in U.S. airline markets. Subsequently, the third section derives and discusses new evidence on entry patterns in the domestic U.S. airline industry between 1996 and 2009. In addition to the study of entry events in all non-stop airport-pair markets, we distinguish entries with respect to the type of market and length of haul. In the fourth section, the focus turns from the patterns of entry to the effects of entry. In particular, new evidence on the effects of non-stop route entry between 1996 and 2009 is derived by applying two different approaches: a descriptive approach which studies the effects of all entry events of network carriers (NWCs) and low-cost carriers (LCCs) in the TOP 500 non-stop U.S. airline markets and an econometric approach which investigates the effects of entry into existing non-stop markets for selected LCCs and NWCs separately by using logarithmic fixed effects regressions. Section five concludes the article with a summary of the key insights and the derivation of important policy conclusions.

2 Review of the existing literature

The liberalization of the U.S. airline industry in 1978 together with the availability of (route-level) traffic and fare data collected by the U.S. Department of Transportation provides a fruitful environment for empirical research. With respect to market entry, the existing literature can broadly be subdivided into two strands: the 'determinants of entry' literature and the 'effects of entry' literature. While the former set of articles investigates the key drivers of airlines' decisions to enter particular routes by either estimating structural models (see, e.g., Berry (1992), Ciliberto and Tamer (2009), Dunn (2008)) or – following a reduced form approach – estimating the likelihood of entry as a function of firm and market characteristics (see, e.g., Boguslaski et al. (2004), Lederman and Januszewski (2003), Sinclair (1995)), the 'effects of entry' literature can be subdivided further into studies of the general effects of entry and studies with a particular focus on the incumbents' reactions to entry. Given the focus of this article, the remainder of this section concentrates on a review of articles belonging to the empirical 'effects of entry' literature.

The earlier studies on the general effects of entry basically investigate the impact of route entries of particular low-cost carriers on fares and passenger numbers. For example, Whinston and Collins (1992) investigate route-level entries of the low-cost carrier People Express and find that entry on average caused a drop in the mean fare of 34 percent in 15 airport-pairs between 1984 and 1985. Windle and Dresner (1995) follow a similar research question and investigate the effects of route entry by Southwest Airlines on fares and passenger numbers. Based on a data set for the period from 1991 to 1994, they find an average price decline of 48 percent, accompanied by an average increase in passenger numbers of 200 percent.

In addition to studies that concentrate on the direct price and quantity effects of (low-cost) entry, several studies take a broader perspective and investigate the impact of low-cost carriers on airport and route competition. Most prominently, a study by Dresner et al. (1996) extends previous research by analysing the impact of low-cost entry on, first, carriers operating on other routes at the airport where entry occurred and, second, the impact of low-cost entry on carriers operating at airports in close proximity to the airport where entry occurred. The authors find that low-cost carrier entry on a route caused significant spill-over effects on both types of adjacent routes in a range of 8 to 45 percent lower average fares (for the case of Southwest Airlines). These results suggest that the real consumer benefits of low-cost carrier entry and competition are significantly larger than previously thought by focusing on the direct effects of entry into the respective airport-pairs.

Morrison (2001) builds on Dresner et al.'s (1996) approach to actually estimate the consumer savings of the presence of Southwest Airlines in U.S. airline markets. Based on an original set of competition variables, he finds that the savings due to actual, adjacent, and potential competition from Southwest sum up to USD 12.9 billion. Southwest's low fares were directly responsible for USD 3.4 billion of these savings to passengers. The remaining USD 9.5 billion represent the effect that actual, adjacent, and potential competition from Southwest had on other carriers' fares.

In addition to contributions that investigate the route-level entry effects of single carriers, several studies provide a broader perspective. In a rather descriptive article, Joskow et al. (1994) examine quarterly data for 27 major, non-stop city pairs in the US between 1985 and 1987 and generally find that entry reduces fares and increases output. In particular, the authors conclude that entry reduced yield by on average about 9.2 percent and led to a corresponding increase in the number of passengers of about 56 percent. In a recent study, Brueckner et al. (2011) investigate the general effects of entry and specifically introduce a differentiation of the fare effects between network carriers and low-cost carriers. Based on a data-set consisting of four quarters for the period from 2007 and 2008, the authors conclude that "[t]he presence of in-market, nonstop LCC competition reduces fares by as much as 34 percent in the nonstop markets, and adjacent LCC competition in these markets reduces fares by as much as 20 percent" (Brueckner et al. (2011), p. 4). The effect of a second network carrier in nonstop markets is substantially smaller, reducing fares by at most 5.3 percent. Adding a third network carrier has no significant further effect on fares. Interestingly, the authors also find that the small competitive effect of entry by legacy carriers is a fairly recent phenomenon and might be explained by, first, the widening price discipline resulting from lower LCC costs and rapid LCC expansion, second, the greater price transparency due to

Internet-based airline search and, third, changes in corporate buying patterns and travel policies.

In addition to the ‘general effects of entry’ literature, a complementary set of articles specifically investigates the incumbents’ reactions to (typically low-cost) entry. Most prominently, a recent study by Goolsbee and Syverson (2008) investigates how incumbents respond to the threat of entry by competitors (as distinct from how they respond to actual entry). They find that incumbents cut fares significantly when threatened by Southwest's entry; over half of Southwest's total impact on incumbent fares occurs before Southwest starts flying. A study by Daraban and Fournier (2008) comes to comparable results. Incumbents are found to significantly reduce fares both before and after the entry of a low-cost carrier. The fare reductions are stronger for Southwest Airlines than for other low-cost carriers. The authors also find that the post-entry fare adjustment process takes place fairly quickly reaching the new equilibrium one or two quarters after entry.

Complementary to the more strategy-oriented articles on the incumbent’s reactions to entry, several researchers aim at connecting incumbent’s reactions to entry with forms of anticompetitive behaviour such as especially predatory practices. For example, Lin et al. (2002) conducted an investigation of factors contributing to competitive reactions to entry by incumbent airlines in the short and longer runs. Using data on 889 incumbent reactions to entry between 1991 and 1997, the authors identify several factors that have a significant impact on the level of incumbent price cuts in response to entry. They include the size of the entrant's price cut, the number of passengers carried by the new entrant on the route, and the costs, size and number of complaints of the entrant. Interestingly, Lin et al. (2002) find no evidence that incumbents respond more aggressively to small, low-cost carriers than to other carriers. Incumbents reserve their largest price cuts for larger new entrants with higher costs. The longer-run results of this study indicate that even if the entrant is forced to withdraw from a route, prices do not rise to pre-entry levels.

Dresner and Windle (2000) specifically seek evidence for predatory responses of network carriers to low-cost carrier entry. In particular, they investigate whether network carriers respond more aggressively to entry by small carriers and whether smaller entrants fail more often than network carriers. The authors find little evidence for predatory behaviour of network carriers against smaller low-cost carriers. Ito and Lee (2004) analyse the responses of incumbent network carriers to low-cost carrier entry on routes served to and from their hubs between 1991 and 2002. The authors not only find that highly aggressive incumbent reactions are the exception rather than the rule, but also that the median response by network carriers to low-cost carrier entry at their hubs is found to be fairly accommodating, i.e. incumbents often align their fare to the entrant's fare but they rarely undercut the entrant. Furthermore, Ito and Lee (2004) find no evidence that the incumbent's price or capacity reaction to low-cost carrier entry has a negative impact on the probability of exit of the entrant.

Last but not least, Bamberger and Carlton (2006) study the price responses of network carriers following low-cost carrier entry. As the other studies mentioned above, Bamberger and Carlton (2006) also fail to find empirical support for a predatory response of network carriers in the aftermath of low-cost carrier entry. On the contrary, the authors find, first, that most low-cost carrier entries were successful, second, incumbent carriers' average fares typically did not fall substantially after low-cost entry, and, third, incumbent carriers' average fares typically did not increase substantially after low-cost carrier exit.

Given this foray through the existing literature, our article aims at contributing to the 'general effects of entry' strand of research. In addition to the provision of new evidence on the patterns and effects of entry for a large data set comprising the entire period from 1996 to 2009, our econometric approach allows us to derive the effects of entry caused by different airlines and consequently also provides new insights from a competitive strategy perspective.

3 Patterns of entry into non-stop U.S. airline markets from 1996 to 2009

Following the review of the existing literature, this section provides new evidence on the patterns of entry into non-stop U.S. airline markets between 1996 and 2009. In addition to the study of entry events by network carriers (NWCs) and low-cost carriers (LCCs) in non-stop airport-pair markets, we distinguish entries with respect to the type of market and length of haul.[1]

The empirical analysis in this and the forthcoming fourth section is based on the U.S. DOT T-100 Domestic Segment database. We constructed a data-set of non-directional non-stop route airport-pair markets.[2] We dropped airline-route observations with less than 12 quarterly departures and airline-route observations which were only served one quarter between 1995

[1] The following carriers are classified as LCCs: Southwest Airlines, AirTran Airways, JetBlue Airways, Allegiant Air, Frontier Airlines, Spirit Airlines, Sun Country Airlines and Virgin America. All other (non-regional) airlines in the T-100 Domestic Segment database were classified as NWCs. The group of NWCs is typically supported by a larger group of regional airlines. Most of those smaller airlines operate in small feeder traffic markets and often assist one particular network carrier in the operation of its hub-and-spoke network. Although most of these regional carriers are legally independent, their economic existence is often tied to a large network carrier. For example, in most instances, regional carriers do not issue their own tickets but refer to the network carrier for all flight bookings. In the empirical analysis of entry patterns and effects of entry, regional airlines are excluded from the analysis.

[2] Although there are good reasons for applying both market delineation concepts – airport-pairs and city-pairs – we follow the more conservative approach of airport-pairs. Every effect found on an airport-pair level is

and 2009. An entry is determined by the quarter when we first observe an airline providing non-stop scheduled services. Since our data begins in 1995, all airlines enter by definition in 1995. Thus, we have to restrict our entry analysis on the time frame from 1996 to 2009. Fare data – used in Section 4 below – is retrieved from the Origin and Destination Survey DB1B Market database. In calculating average fares, zero fares, abnormally high fares and fares which required the passenger to change the airplane more than twice were excluded from the data-set. Finally, information on population and unemployment rates was received from the U.S. Census Bureau and the U.S. Bureau of Labour Statistics.

3.1 Entry into non-stop airport-pair markets

A natural starting point of the study of entry patterns is a general analysis of all entry events on the non-stop airport-pair level. In this respect, T-100 Domestic Segment Data analysis reveals that the overall number of routes operated by commercial airlines increased from 1,962 routes in 1995 to 2,658 routes in 2009. These numbers alone suggest a significant entry activity in the sample period. This finding is basically confirmed by Figure 1 which plots the number of route entries by NWCs and LCCs.

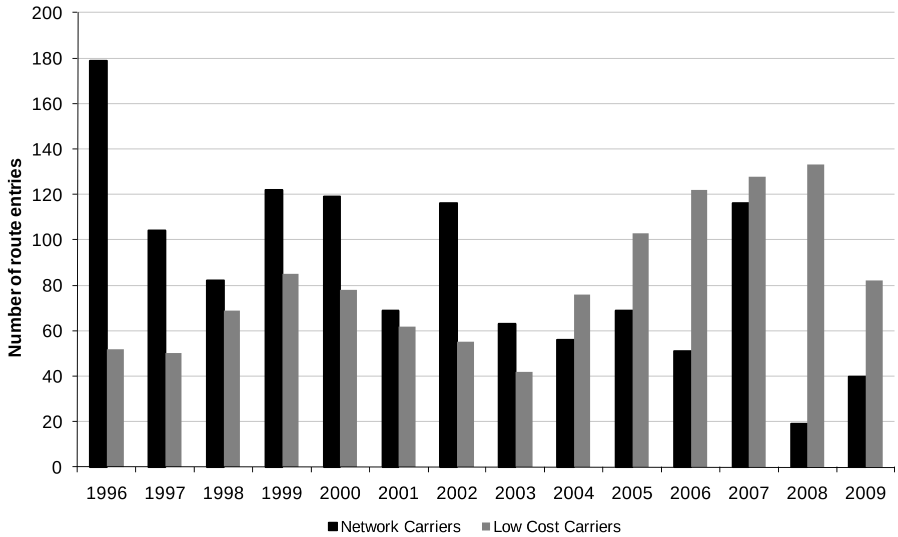

Figure 1: Number of route entries by NWCs and LCCs (all markets, 1996-2009)
Source: U.S. DOT, T-100 Domestic Segment Data, authors' calculations

As shown in Figure 1, there are substantial differences in both the absolute number of entry events per year and the shares of entry events between NWCs and LCCs. On an absolute level, there have been on average 167 market entries per year with the years 2007 (244 entries) and 2003 (105 entries) delineating the value spectrum for the sample period. Focusing

expected to be even more pronounced on a city-pair level. For a detailed discussion of airport-pairs vs. city-pairs, see Brueckner et al. (2010).

on the separation between NWCs and LCCs, the former group has launched entry into 1,205 markets between 1996 and 2009, while the entry activities of the latter group add up to 1,137 entry events. While the NWCs show significant entry activity between 1996 and 2000, the number of entries dropped significantly from 2003 onwards. Interestingly, since 2004 the group of LCCs has entered more markets per year than the group of NWCs. In the recession years 2008 and 2009, the difference in terms of entry events was particularly distinctive suggesting that the network carrier's business is more dependent on the general state of the economy than the low-cost carrier's business.[3]

While an analysis of entry events already provides valuable insights on industry dynamics, it does not allow a direct conclusion on how successful the respective entries in the sample period have been. Due to the unavailability of detailed route-specific profitability data, the success of the respective entry events has to be approximated by calculating survival rates. In the airline industry, survival rates basically reflect the relationship between the number of route entries that are still operated after a certain time period (for which it is assumed that unprofitable entry decisions have been reversed) and all route entries in the respective time period. Based on this general approach, Figure 2 shows survival rates for the respective entries by NWCs and LCCs. An entry into a particular route is counted as 'survived' if it was still operated by the respective carrier two years after entry.[4]

[3] Although the focus of this article is on the role of market entry, there is no doubt that market exit can be a closely related phenomenon. For example, entry into one market can demand exit in another market as, e.g., a particular airplane can be operated more efficiently on the new route. Furthermore, any reorganisation of the flight network typically triggers waves of entry and exit. For example, airline mergers often lead to market exits either through the elimination of overlapping parts of both networks or by the decommissioning of entire hubs of one of the merging airlines.

[4] The calculation and interpretation of survival rates offers various degrees of freedom. With respect to calculation, Bamberger and Carlton (2006), for example, decided to count an entry as 'survived' if the airline was still active on the respective route one year after entry. Consequently, they find on average higher survival rates than reported in Figure 2 above (based on a 'two-year' definition of survival). With respect to interpretation, the general results reported in Figure 2 could be specified by analysing survival rates for specific carriers or even specific route types of specific carriers (e.g., routes to/from their respective hubs versus other routes).

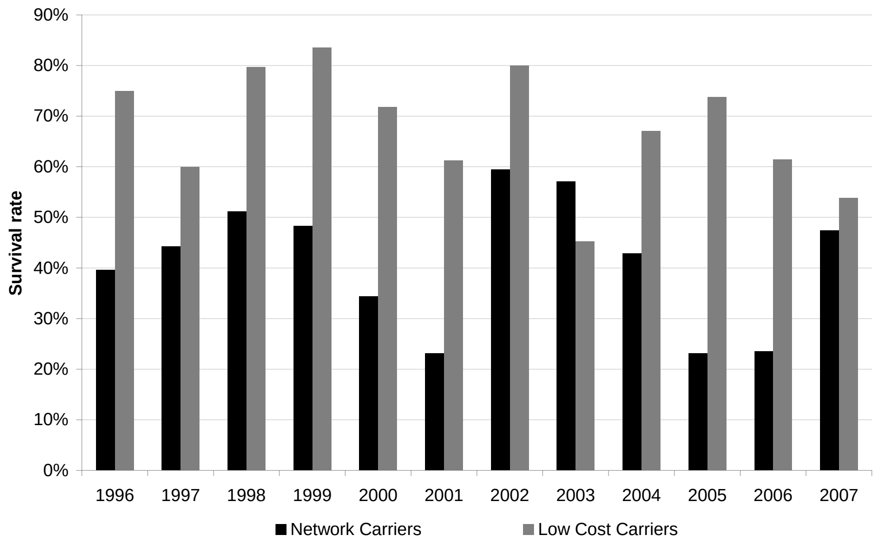

Figure 2: Survival rates of market entries by NWCs and LCCs (all markets, entry years 1996-2007)

Source: U.S. DOT, T-100 Domestic Segment Data, authors' calculations

As shown in Figure 2, although the survival rates of both groups largely follow the same (possibly macroeconomic) trends, the group of NWCs has significantly lower survival rates than the group of LCCs. For example, while about 61 percent of all LCC entries in 2001 were still operated by the respective airline two years later; the corresponding survival rate for the group of NWCs lied at about 23 percent. Over the entire sample period, NWCs show an average survival rate of about 43 percent while the LCC value lies at about 68 percent. Although these results allow the conclusion that LCC entries are on average more successful than NWC entries, it has to be reminded that both groups of airlines follow rather distinct business concepts and are at different stages in their life cycles. These differences may explain a significant part of the variation in the survival rates.

3.2 Entry into new non-stop airport-pair markets

Providing airlines with the freedom to decide on market entry and exit was one of the key accomplishments of the liberalisation of the U.S. airline industry. Since then, airlines made frequent use of the gained possibilities to optimise their route networks and to provide efficient air services to their customers. Complementary to bringing competition to existing routes, an important part of an individual airlines' market success is the identification and realisation of additional profit opportunities through the entry into new routes. Although the entry decision of the airline is typically profit driven, such 'innovative entry' clearly has positive impacts on consumers who are able to travel on the newly established airport-pair. In order to investigate the role of innovative entry, Figure 3 shows the percentages of entries by network carriers and low-cost carriers into new markets between 1996 and 2009.

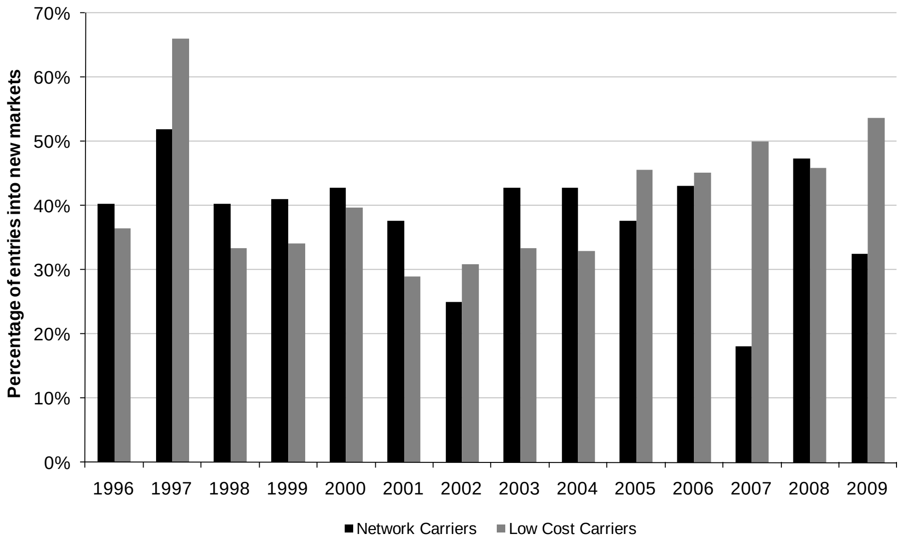

Figure 3: Percentage of entries by NWCs and LCCs into new markets (1996-2009)
Source: U.S. DOT, T-100 Domestic Segment Data, authors' calculations

As shown in Figure 3, the percentage of entries into new markets is relatively high and constant. In sum, 937 of the 2,342 entry events in the sample period were 'first mover' entries in airport-pairs that have not been served before in the sample period by any other airline. 457 of these 'first mover entries' where conducted by NWCs while the remaining 480 first mover entries were undertaken by members of the group of LCCs. On average, the group of NWCs entered 33 new markets per year with 1996 (72 entries) and 2008 (9 entries) delineating the value spectrum. For the group of LCCs, 34 new market entries were reported per year on average with the highest value of 64 entries in 2007 and the lowest value of 14 entries in 2003. As it can be expected that the more dense routes are rather mature markets, it is likely that the 'first mover' routes are relatively small and need time to develop a sufficient level of demand.

3.3 Entry into short-, medium-, and long-haul non-stop airport-pair markets

In its 1997 report on the 'Low Cost Airline Service Revolution', the U.S. DOT expected a coexistence of network carriers and low-cost carriers with the latter providing local passengers the benefit of additional service and lower prices on short- and medium-haul markets, while the former, by continuing to link the spoke city with its network, "[…] provide local passengers who prefer to use the network carrier's service and connecting passengers who wish to travel beyond the hub city in other city-pair markets additional, competitive alternatives" (U.S. DOT, 1997, p. 17).

In order to investigate the actual relevance of such a coexistence of NWCs and LCCs, Figure 4 provides an overview of the market entries of LCCs in all markets split into short-haul markets (≤ 750 miles), medium-haul markets (751-1500 miles) and long-haul markets (> 1500 miles).

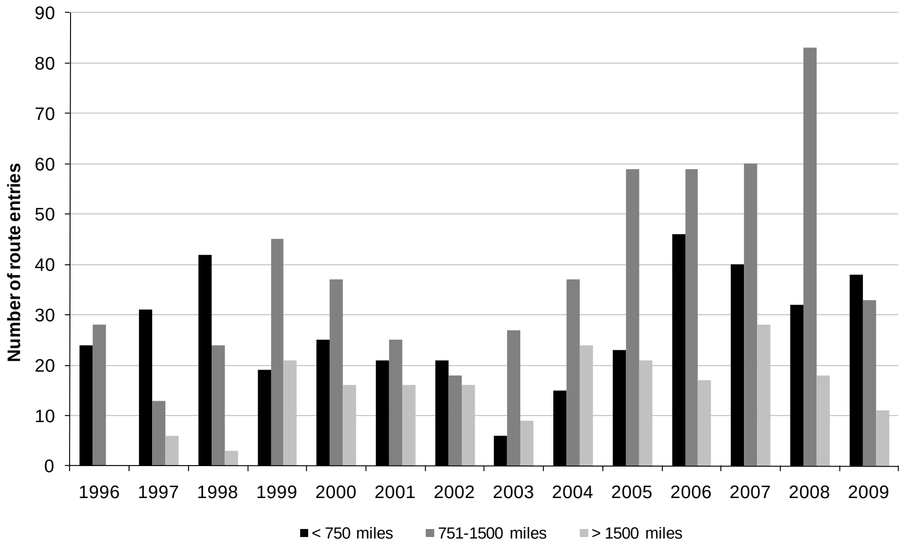

Figure 4: Number of LCC route entries in short-, medium-, and long-haul markets (1996-2009)
Source: U.S. DOT, T-100 Domestic Segment Data, authors' calculations

As shown in Figure 4, there is significant variation in the entry behaviour across short-, medium- and long-haul markets. In sum, between 1996 and 2009, low-cost carriers entered 1,137 airport-pair markets. 383 entry events (about 34 percent) took place in short-haul markets, 548 entry events (about 48 percent) in medium-haul markets and the remaining 206 entry events (about 18 percent) in long-haul markets. While short-haul entry played the by far largest role in 1997 and 1998 with percentage shares above 60 percent, its relative significance was reduced substantially since then reaching a low of 14 percent in 2003. Medium-haul entry activity is relatively strong across the entire sample period with the lowest share in 1997 (26 percent) and the highest share in 2003 (64 percent). This recent switch from short-haul to medium-haul entry could be explained by reduced possibilities for profitable short-haul entry forcing LCCs to look for business opportunities in the medium-haul segment. Finally, with respect to long-haul entry activity, Figure 4 generally shows significant entry activity since 1997 with the lowest share of 4 percent in 1998 and the highest share of 32 percent of all LCC entry events in 2004. Therefore, it can be concluded that although the key business focus of LCCs remains on short- and medium-haul markets, even long-haul markets can be entered and operated on a permanent basis. This conclusion is supported by casting an eye on the respective exit rates. In the sample period, the long-haul segment experienced 59 market exits (equal to about 29 percent of all exits), compared to 159 (about 30 percent) in the medium-haul segment and 156 (about 41 percent) in the short-haul segment.

4 Effects of entry into non-stop U.S. airline markets from 1996 to 2009

Following the characterisation of recent market entry patterns in the domestic U.S. airline industry, the logically next step is to investigate the economic effects of entry. In this respect, standard oligopoly theory suggests that, first, entry increases competition in the respective market and therefore is expected to cause a drop in the average market price and a corresponding increase in the supplied quantity (and possibly also production capacities). Second, the *relative* gains of entry for the consumers depend on the structure of the market in which entry takes place. In a standard Cournot model, the relative gains in consumer welfare are typically highest in case of entry into a monopoly market simply because the benefits of competition are brought to the respective market through a substantial reduction in the average market price. Third, the gains of entry also depend on the characteristics of the firm which enters the respective market. In a standard Cournot model, the introduction of asymmetric marginal costs typically leads to asymmetric market shares as the more efficient firm produces more (and realises higher profits) than the less efficient firm. Consumers benefit through a (further) drop in the equilibrium price compared to the case of a symmetric cost structure.

Given this brief sketch of mainstream theoretical insights on the effects of entry, the remainder of this section aims to provide new evidence on the effects of entry into U.S. airline markets. Using the data-set described in the beginning of Section 3 above, we follow two separate approaches: a descriptive approach which studies the effects of all entry events by LCCs and NWCs in the TOP 500 non-stop U.S. airline markets and an econometric approach which investigates the effects of entry into existing non-stop markets for selected low-cost carriers and network carriers separately by using logarithmic fixed effects regressions. Although rather distinctive in their execution, both approaches study the effects of entry by differentiating between the following four parameters:

- *Market yield* (in 1995 cents per mile) as a measure for the price effects of entry;
- *Number of passengers* as a measure for the demand effects of entry.
- *Number of departures* as a measure for the supply and quality effects of entry[5];
- *Number of seats* as a measure for the supply effects of entry;

[5] The number of departures can also be interpreted as a measure of quality as – with a growing number of departures – the traveller has more choices between different travel times over the day and is therefore able to reach a better fit of the transportation needs with the general work (or leisure) schedule.

As argued above, oligopoly theory would suggest that the average market yield is reduced by entry while the different measures for supply and demand are expected to increase following entry.

Given these four key market parameters, both approaches differentiate further between the following three market structures in which entry takes place:

- *Monopoly routes*, i.e. entry leads to a second carrier in a market;
- *Oligopoly routes without LCC*, i.e. entry leads to a further carrier in a NWC market;
- *Oligopoly with LCC*, i.e. entry leads to a further carrier in a NWC/LCC market.

As already sketched above, this separation is motivated by key insights from oligopoly theory which suggest that the effects of entry depend on the type of market in which entry takes place. For example, ceteris paribus, entry into monopoly markets is expected to lead to the largest percentage drop in market price. Furthermore, entry by a LCC into oligopoly markets without any other LCC can be expected to lead to more pronounced price effects than entry into oligopoly markets in which another LCC is already operating.[6] Such a hypothesis can on the one hand be based on the theory of multimarket contact which suggests that particularly NWCs have incentives to reduce competition intensity given their competitive interaction in many markets. LCCs can be expected to challenge such states of 'mutual forbearance' among NWCs thereby causing price decreases. On the other hand, the presence of another LCC in the respective market typically suggests that competition intensity is already elevated (and a significant fraction of LCC demand is already served). As a consequence, the entry of a second LCC is expected to cause smaller effects on market price.

4.1 Descriptive approach

In the descriptive approach, we identify all entry events in the TOP 500[7] non-stop U.S. airline markets between 1996 and 2009. In contrast to prior research, we split the 434 entry events with respect to the characteristics of the entering firm, i.e. either entry by a LCC or a NWC. Subsequently, we derive and study the average effects of the 197 LCC route entries and 237 NWC route entries with respect to the above mentioned four key market parameters and the three market structures for the twelve quarters before and after the respective (eventually

[6] It is important to remind at this point that our analysis concentrates on the effects of entry in existing markets only. Any study that aims at calculating the entire (consumer) welfare effect of entry, however, has to include the (consumer) welfare created by entry into new markets (i.e., markets which did not have a direct connection prior to the entry of a specific carrier).

[7] In the sample period, on average, 64 percent of all U.S. domestic passengers travelled in the TOP 500 markets.

successful or unsuccessful) entry events. Given this basic set-up, Figure 5 plots the results of the analysis for the *group of LCCs*. [8]

Starting with the top left chart in Figure 5, the respective *market yield* graphs for the three market structures confirm one basic result of the standard Cournot model: market yields in monopoly markets are on average higher than market yields in oligopoly markets. A further reduction in average yield is realised in markets in which a LCC is already operating on the respective route. Turning from this general observation to the effects of entry, the chart clearly shows that LCC entry on average leads to a significant decrease in market yield. As expected from oligopoly theory, the largest effects can be observed for LCC entries into monopoly routes. After a LCC has entered a former monopoly route, the average market yield drops by about 5 cents per mile (about 17 percent) in the quarter of the entry event and further 2 cents per mile in the quarter following entry leading to an average drop in yield of about 25 percent. This effect is less pronounced for oligopoly markets. Irrespective of the presence of a LCC in the market before entry, the average market yield drops by about 1 cent per mile in the quarter of entry and 1 additional cent per mile in the quarter following entry. In the quarters following t_{+1}, the market yield largely remains stable, i.e. the decrease in average yield appears to be permanent; only the case of entry into monopoly markets shows on average a significant increase in market yield in the twelve quarters following entry. However, the price level in t_{+12} is still about 5 cent (about 17 percent) lower than before the entry event suggesting that entry on average had a permanent impact on yield in the respective routes.

[8] The numerical values of the short-term effects of entry for the group of LCCs are summarized in Table 3 in the Appendix.

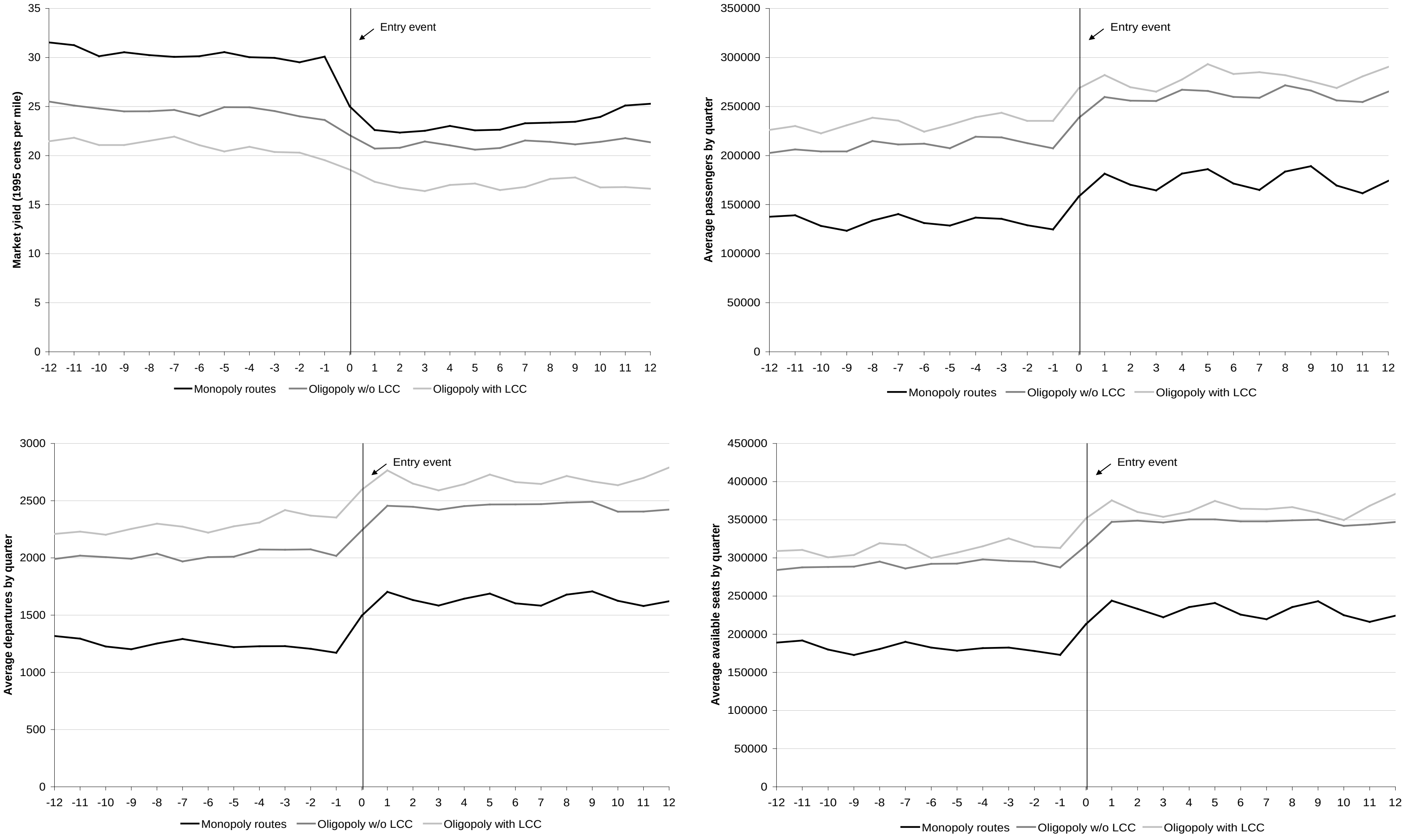

Figure 5: Average yield, passengers, departures and seats in the TOP 500 markets three years before and after LCC entry events

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations

Turning from yield to *demand-related factors*, the analysis of the effects of entry on the number of passengers – shown in the top right chart – reveals that the demand level on monopoly routes is significantly lower than in oligopoly markets. With respect to the effects of entry, in the quarter in which LCC entry occurs, the number of passengers increased on average by about 33,600 passengers (about 27 percent) in former monopoly routes and additional 23,140 passengers (in sum about 45 percent) in the quarter following entry. The total increase of the average number of passengers from the quarter before entry to the quarter after entry is about 52,300 passengers (about 25 percent) in oligopoly markets in which no LCC was active before and about 46,700 passengers (about 20 percent) in oligopoly markets in which at least one other LCC was already operating. In the quarters following t_{+1}, the number of passengers largely remains stable and only shows moderate seasonal effects.

Turning from the demand to the *supply-related factors*, the analysis of the number of departures in the bottom left chart reveals that after a LCC has entered one of the TOP 500 routes, the average frequency of flights offered increased substantially in all types of markets. In the quarter in which LCC entry occurs, the frequency of departures increased on average by about 325 quarterly departures (about 28 percent) in former monopoly routes and additional 207 quarterly departures (in sum about 45 percent) in the quarter following entry. The total increase of average frequency from the quarter before entry to the quarter after entry is about 438 quarterly departures (about 22 percent) in oligopoly markets in which no LCC was active before and about 412 quarterly departures (about 17 percent) in oligopoly markets in which at least one other LCC was already operating. In the quarters following t_{+1}, the number of departures largely remains stable and only shows moderate seasonal effects.

The analysis of the effects of entry on the average number of available seats shows comparable results. In the quarter in which LCC entry occurs, the number of seats increased on average by about 40,400 seats (about 23 percent) in former monopoly routes and additional 30,550 seats (in sum about 41 percent) in the quarter following entry. The total increase of the average number of seats from the quarter before entry to the quarter after entry is about 59,570 seats (about 21 percent) in oligopoly markets in which no LCC was active before and about 62,350 seats (about 20 percent) in oligopoly markets in which at least one other LCC was already operating. In the quarters following t_{+1}, the number of seats largely remains stable and only shows moderate seasonal effects.

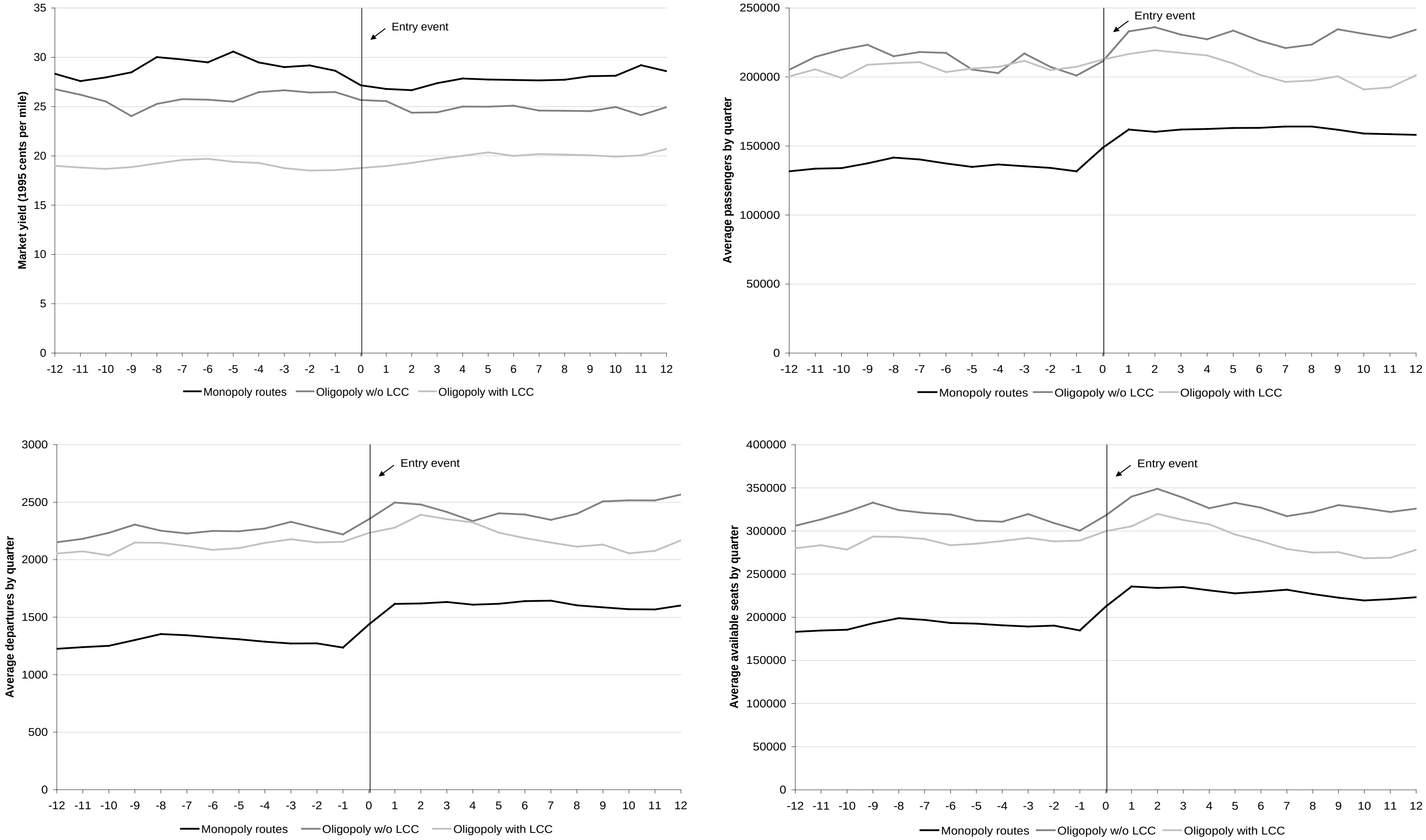

Figure 6: Average yield, passengers, departures and seats in the TOP 500 markets three years before and after NWC entry events

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations

Given the analysis of the effects of entry by LCCs, the consequential next step is to investigate the corresponding effects of entry by *NWCs*. Figure 6 shows the results of the corresponding analysis for this group of airlines. [9]

As revealed in Figure 6, entries by NWCs have less pronounced effects on average *market yields* than LCC entries. For the cases of entry into oligopoly markets, no considerable effects on market yields can be observed. In case of former monopoly markets, the overall drop in average market yield amounts to about 2 cents per mile (about 5 percent). However, extending the post-entry observation period to t_{+12} reveals that even these small market yield decreases must be considered temporary as the average market yield reaches pre-entry levels three years after entry. Given this key observation, it can be concluded that the characteristics of the airline that enters a particular market is a crucial determinant of the price effects of entry. While LCC entry leads to a large and permanent reduction of market yield on the respective route, NWC entry rather causes small and only temporary decreases in market yield.

Turning from the market yields to the post-entry *supply and demand measures*, we see that the observable effects are more pronounced and largely comparable to the LCC observations with respect to both direction and dimension. For example, comparing the quarter before entry with the quarter after entry reveals that the average number of departures – shown in the bottom left chart in Figure 6 – increased by about 380 quarterly departures (about 31 percent) in former monopolies, by about 277 departures per quarter (about 12 percent) in oligopolies without any LCC and by about 123 departures per quarter (about 6 percent) in oligopoly markets in which at least one other LCC is operating. In the quarters following t_{+1}, the number of departures largely remained stable for the monopoly routes and the oligopoly routes without a LCC. The graph for oligopoly routes with a LCC, however, shows that the average number of departures decreased in the first three years after entry reaching a level even below the pre-entry value. One explanation for this observation could be that competition in these types of markets is particularly tough and likely leads to market exit of at least one carrier in the years after the entry of the second LCC. The comparable characteristics of the graphs for the number of seats and number of passengers support such an explanation.

In a nutshell, the analysis of the price and quantity effects of entry by LCCs and NWCs in the TOP 500 non-stop U.S. airport-pair markets between 1996 and 2009 reveals that substantial increases in consumer welfare can only be expected when a LCC decides to enter a certain (concentrated) non-stop airport-pair. These empirical findings largely confirm the

[9] The numerical values of the short-term effects of entry for the group of NWCs are summarized in Table 3 in

results of the standard Cournot models which suggest that low-cost entry leads to larger price decreases than entry of an equally efficient firm.

4.2 Econometric approach

Although the descriptive analysis in the preceding section already provided useful insights, our data set also allows the application of more sophisticated econometric tools to investigate especially the long-term effects of entry. In particular, given the significant heterogeneity within both groups of carriers, we complement the general descriptive analysis by investigating the effects of entry into existing non-stop markets for the four largest LCCs (Southwest (WN), JetBlue (B6), AirTran (FL) and Spirit Airlines (NK)) and the four largest NWCs (Delta (DL), American Airlines (AA), United (UA) and US Airways (US)) separately by using logarithmic fixed effects regressions. For each carrier we used the panel data set from 1996 to 2009 described in Section 3 above to estimate a model of the following structure:

$$\ln(y_{it}) = \beta_0 + \beta_1 \cdot Serve_{it} + \beta_2 \cdot Serve_{it} \times OliNWC_i + \beta_3 \cdot Serve_{it} \times OliLCC_i + \gamma \cdot Controls_{it} + a_i + u_{it}$$

This model explains the effect of a carrier serving (*Serve*) market *i*[10] in time (quarter) *t* directly on four dependent variables *y*, i.e. market yield, number of passengers, number of departures and number of available seats. The dummy variable *'Serve'* becomes one in the quarter of entry and keeps the value as long as the carrier serves the market. If the carrier exits the respective market the dummy becomes zero again. Thus, the effect estimated through the regression analyses is not restricted to a 12-quarter period but captures the full (long-term) effect of entry on our dependent variables. We allow the effect to differ with respect to the market structure directly before the respective airline has entered the market. Therefore, we interact the variable *Serve* with, first, a dummy variable which indicates if the carrier has entered into a former oligopoly market consisting of only NWC (*OliNWC*) and, second, with a dummy variable which indicates if the carrier has entered into a former oligopoly market with at least one LCC (*OliLCC*). Entry into former monopoly markets serves as reference. Due to the fact that the coefficients in our model can be interpreted as semi-elasticities, β_1 captures the relative (long-term) effect if a carrier now serves a former monopoly market. The effects of entry into former oligopolies without LCC presence and the effects of entry into former oligopolies with LCC presence can be calculated as $\beta_1 + \beta_2$ and $\beta_1 + \beta_3$, respectively. The variable a_i captures all unobserved, time-constant market characteristics

the Appendix.

[10] For each carrier, we investigate those markets *i* in which the carrier actually entered between 1996 and 2009.

that influence our dependent variable y_{it}. Fixed effects panel regressions allow us to control for time-constant market characteristics such as non-stop distance as well as connections involving secondary airports or highly congested hubs without explicitly measuring the effect of those characteristics. The idiosyncratic error term is denoted by u_{it}. We control for time-varying market characteristics ($Controls_{it}$) through the inclusion of the total number of carriers serving the market (except for the entering carrier), the number of (other) LCCs serving the market, the average plane size, the average unemployment rate and the number of inhabitants in the respective metropolitan statistical area. A more detailed variable description and summary statistics are provided in Table 4 in the Appendix.

We present the effects of entry for each of the *LCCs* in Table 1 while the effects of entry for each of the *NWCs* can be retrieved from Table 2.[11] As shown in the tables, entry into *monopoly markets* by all low-cost carriers in our sub-sample led to statistically as well as economically significant drops in the average price between 10.9 percent and 18.1 percent. Entry into monopoly markets by network carriers, however, only led to significant drops in the average price for two carriers: Delta (3.8 percent) and US (6.2 percent). While the weakly significant entry effect for Delta might have to do with its substantially higher entry activity in combination with two (failed) attempts to introduce an own low-cost brand[12], the observable effect for US Airways can most likely be attributed to its 2005 merger with the low-cost carrier America West Airlines leaving the merged entity as a hybrid carrier between NWC and LCC.

All in all, the conclusions of the descriptive analysis for the effects of entry into monopoly markets in the preceding section are largely confirmed: While LCC entry consistently leads to a significant drop in the average market yield, NWC entry does not show comparably consistent effects. Comparing both sets of results, however, reveals that the size of the price reductions following LCC entry is substantially smaller in the econometric framework compared to the descriptive framework. One explanation for this finding might be that the

[11] The complete regressions are provided in Tables 5 to 12 in the Appendix on an airline-by-airline basis.

[12] The post-deregulation era has seen several attempts by network carriers to launch their own low-cost carriers. For example, Delta founded Delta Express in 1996. The airline operated a hub at Orlando airport and focused particularly on leisure routes. In order to be able to compete on price, Delta Express' fleet consisted of only one aircraft type with an all coach class configuration. No in-flight entertainment or meal service was offered. Delta Express ceased operations in 2003 and was replaced by Song as the new low-fare brand of Delta. Song, however, ceased operations in 2006 and was reintegrated into its parent company. Comparably unsuccessful launches of low-fare brands were experienced by United (Ted, 2004-2009) and US Airways (MetroJet, 1998-2001). From an analytical perspective, T-100 data does not provide an easy solution to separate between entries of the respective network carrier and entries by its respective low-cost branch as the respective airline codes for both carriers are identical. However, the length and breadth of our data set together with the rather short, rather small and rather unsuccessful low-cost endeavours of the network carriers make it unlikely that they affect our results to a larger degree.

latter analysis measures the long-term effects while the descriptive analysis concentrated on the short- and medium-term effects. As shown in Figure 5, the price reaction following LCC entry overshoots in the first quarter as prices increase slightly in the following quarters partly diminishing the long-term effect obtained from the descriptive analysis. Furthermore, it is important to remind that the descriptive analysis – due to the pooling of all LCC and NWC entries – focused on entries into the TOP 500 markets only, while the econometric analysis is able to include all entry events of the respective carriers in the sample period. Our analysis therefore also suggests that competition in the TOP 500 markets is tougher – in the sense that the effects of entry are more pronounced – than in cases of entry into smaller markets.

Table 1: Effects of entry by LCCs - Results from logarithmic fixed effects regressions

Market yield												
Market structure quarter before entry	*WN*		*(s.e.)*	*B6*		*(s.e.)*	*FL*		*(s.e.)*	*NK*		*(s.e.)*
Monopoly	-0.109	***	(0.040)	-0.114	***	(0.020)	-0.181	***	(0.031)	-0.117	***	(0.035)
Oligopoly w/o LCC	0.007		(0.036)	-0.058		(0.035)	-0.180	***	(0.047)	-0.088	**	(0.039)
Oligopoly with LCC(s)	-0.104		(0.068)	0.049		(0.041)	-0.024		(0.021)	-0.018		(0.022)
Number of entries	163			79			159			44		

Passengers												
Market structure quarter before entry	*WN*		*(s.e.)*	*B6*		*(s.e.)*	*FL*		*(s.e.)*	*NK*		*(s.e.)*
Monopoly	0.222	**	(0.095)	0.400	***	(0.094)	0.512	***	(0.073)	0.441	***	(0.103)
Oligopoly w/o LCC	0.337	***	(0.076)	0.188	***	(0.041)	0.369	***	(0.066)	0.296	***	(0.084)
Oligopoly with LCC(s)	0.104	**	(0.045)	-0.017		(0.055)	0.377	***	(0.065)	-0.084	*	(0.047)
Number of entries	163			79			159			44		

Departures												
Market structure quarter before entry	*WN*		*(s.e.)*	*B6*		*(s.e.)*	*FL*		*(s.e.)*	*NK*		*(s.e.)*
Monopoly	0.255	**	(0.110)	0.362	***	(0.061)	0.447	***	(0.072)	0.438	***	(0.098)
Oligopoly w/o LCC	0.332	***	(0.073)	0.159	***	(0.049)	0.310	***	(0.064)	0.303	***	(0.078)
Oligopoly with LCC(s)	0.087	**	(0.038)	0.091		(0.106)	0.385	***	(0.075)	-0.024		(0.045)
Number of entries	163			79			159			44		

Seats												
Market structure quarter before entry	*WN*		*(s.e.)*	*B6*		*(s.e.)*	*FL*		*(s.e.)*	*NK*		*(s.e.)*
Monopoly	0.278	**	(0.113)	0.425	***	(0.094)	0.502	***	(0.071)	0.450	***	(0.097)
Oligopoly w/o LCC	0.334	***	(0.075)	0.207	***	(0.044)	0.348	***	(0.066)	0.326	***	(0.083)
Oligopoly with LCC(s)	0.101	**	(0.041)	0.090		(0.102)	0.378	***	(0.073)	-0.042		(0.046)
Number of entries	163			79			159			44		

*Notes: Significance levels *** $p<0.01$, ** $p<0.05$, * $p<0.1$ for H_0: Effect = 0, cluster-robust standard errors in parentheses.*
Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 2: Effects of entry by NWCs - Results from logarithmic fixed effects regressions

Market yield												
Market structure quarter before entry	*AA*		*(s.e.)*	*DL*		*(s.e.)*	*UA*		*(s.e.)*	*US*		*(s.e.)*
Monopoly	-0.030		(0.026)	-0.038	*	(0.021)	0.028		(0.065)	-0.062	*	(0.034)
Oligopoly w/o LCC	0.011		(0.035)	0.005		(0.046)	0.000		(0.059)	-0.064	***	(0.023)
Oligopoly with LCC(s)	-0.063	***	(0.021)	-0.101	***	(0.030)	0.039		(0.032)	-0.041		(0.041)
Number of entries	123			100			37			105		
Passengers												
Market structure quarter before entry	*AA*		*(s.e.)*	*DL*		*(s.e.)*	*UA*		*(s.e.)*	*US*		*(s.e.)*
Monopoly	0.262	***	(0.093)	0.254	***	(0.089)	0.236	***	(0.065)	0.274	*	(0.151)
Oligopoly w/o LCC	0.105		(0.066)	0.212	*	(0.127)	0.464	***	(0.112)	0.246	***	(0.090)
Oligopoly with LCC(s)	0.452	***	(0.079)	0.364	**	(0.181)	0.262	***	(0.096)	0.144	***	(0.047)
Number of entries	123			100			37			105		
Departures												
Market structure quarter before entry	*AA*		*(s.e.)*	*DL*		*(s.e.)*	*UA*		*(s.e.)*	*US*		*(s.e.)*
Monopoly	0.303	***	(0.092)	0.270	***	(0.076)	0.307	***	(0.072)	0.328	**	(0.147)
Oligopoly w/o LCC	0.126	*	(0.071)	0.313	***	(0.107)	0.483	***	(0.139)	0.249	**	(0.104)
Oligopoly with LCC(s)	0.486	***	(0.083)	0.361	*	(0.191)	0.279	***	(0.095)	0.162	***	(0.051)
Number of entries	123			100			37			105		
Seats												
Market structure quarter before entry	*AA*		*(s.e.)*	*DL*		*(s.e.)*	*UA*		*(s.e.)*	*US*		*(s.e.)*
Monopoly	0.304	***	(0.088)	0.307	***	(0.082)	0.320	***	(0.075)	0.342	**	(0.144)
Oligopoly w/o LCC	0.128	*	(0.073)	0.301	**	(0.118)	0.497	***	(0.138)	0.281	***	(0.096)
Oligopoly with LCC(s)	0.489	***	(0.081)	0.394	**	(0.197)	0.279	***	(0.094)	0.168	***	(0.052)
Number of entries	123			100			37			105		

*Notes: Significance levels *** p<0.01, ** p<0.05, * p<0.1 for H_0: Effect = 0, cluster-robust standard errors in parentheses.*
Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Turning from the discussion of the results for entry into monopoly markets to the respective results for oligopoly markets, Table 1 reveals that entry into *oligopoly markets without LCC* presence led to significant *price* drops for the entries of AirTran (18.0 percent) and Spirit Airlines (8.8 percent) only. Interestingly, while entries of Spirit into oligopolies of NWCs resulted in a significantly lower price drop than the airline's entries into monopolies, the change in yields for AirTran's entries into monopoly markets does not differ from its entries into oligopolies without LCC presence suggesting different entry strategies of the two carriers. As further revealed by Table 1, entry by both Southwest and JetBlue do not show significant effects on market yield (although the respective coefficient for JetBlue is close to significance with a p-value of 0.102). Both results are likely driven by the small number of observations in this category since a large percentage of the entries of both airlines took place in either former monopoly markets (studied above) or created new markets (which are outside the scope of this article).[13] An alternative explanation could be built on the results of the study by Goolsbee and Syverson (2008). Given their key finding that incumbents cut fares significantly when only threatened by Southwest's entry (i.e., before actual entry takes place), the insignificant price effects at the time of entry might have to do with the fact that prices already experienced a significant drop at the time when the likelihood of entry by Southwest (or JetBlue) increased above a certain threshold level.[14] Such an interpretation of our results would then suggest that Southwest and JetBlue are the two low-cost carriers, incumbent's fear most and therefore reduce prices significantly even before the actual entry event.

Interestingly, the estimations for the group of LCCs reveal further that AirTran is the 'most effective' carrier in terms of (immediate) price reductions following entry. Taking together the number of entries with the average effects of entry, our analysis suggests that the times where low-cost carrier competition was set equal to competition by Southwest are over. While Southwest entered 163 markets in the sample period, the other three larger LCCs managed to enter 282 markets (AirTran having the largest share with 159 entries) with at least similar average price drops after entry. However, the recently announced and already approved merger between Southwest and AirTran will very likely help Southwest to defend and extend its position as the largest and most successful LCC in the domestic U.S. airline industry.

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13 For example, between 2000 and 2009, JetBlue entered 131 domestic markets. On average, 40 percent of all entries created new routes, with 14 percent in 2005 and 83 percent in 2002 delineating the spectrum. However, despite the significance of entry into new markets, in 2009, only 30 percent of the 20 million JetBlue passengers traveled in new markets while the remaining 70 percent flew in existing markets.

14 An example for such an increase in the likelihood of entry could be the announcement of Southwest or JetBlue to include a new airport into their route network. Given the (partly sunk) investments in new airport presence together with the possibilities to exploit network economies makes it very likely that the respective carrier will extent its number of connections from the respective airport.

Turning from the LCCs to the NWCs, the estimations show a significant price drop of 6.4 percent only for US Airways while all the other entries of NWCs into oligopoly markets of NWCs show very small and insignificant coefficients. Generally, this result suggests that NWCs compete in quality dimensions – most prominently the sizes of their (inter)national networks – rather than price. Given their elevated cost structure, the possibilities (and incentives) to compete over price are small in the absence of a LCC. With respect to US Airways, the significant coefficient is again likely related to the merger between US Airways and America West leaving the merged entity as a hybrid carrier between NWC and LCC.

Furthermore, within our econometric framework, we do not find any statistically significant price effect of LCC entry into *oligopolies in which another LCC is already present*. Although this observation might again be driven by the relatively rare occurrence of such events, an alternative explanation can be based on the already elevated level of competition in these markets and the therefore limited possibilities for further price reductions after entry of an additional LCC. However, interestingly, for the group of NWCs, our estimations show significant and relatively large yield reductions following entries of American (6.3 percent) and Delta (10.1 percent). In line with the results of Lin et al. (2002), one explanation for this observation could be tough competition (or even price wars) between LCCs and especially the NWCs' low-fare brands on a number of dense and often prestigious routes.[15] The corresponding substantial capacity increases for American (+ 48.9 percent) and Delta (+ 39.4 percent) entries (in terms of available seats) support this hypothesis. Additionally, these routes might also have an important role in transporting international (connecting) passengers, possibly allowing NWCs to cross-subsidise the domestic flight segment with the international flight segment. Generally, the combination of insignificant results for entries into oligopoly markets of NWCs only and significant results for the same category but with LCC presence suggests that NWCs who decide to enter these markets are fully aware that they will only be able to compete by offering lower fares than they would offer on routes on which they only have to compete against other NWCs. In essence, this result suggests that the entry strategies of NWCs change substantially with the types of players active in the market pre-entry. This general result is again supported by the coefficients for US Airways which is the only NWC that shows insignificant results in the oligopoly entry with LCC category, and a large and significant coefficient in the oligopoly entry with NWC only category.

[15] One example of such fierce competitive interaction was JetBlue and Song (the former low-fare brand of Delta) on flights to Florida (which both carriers picked as key region in their respective entry strategies).

Complementary to the price effects of entry, Table 1 and Table 2 also report the corresponding *quantity effects* of entry split into passengers, departures and available seats. Starting with the group of low-cost carriers, the results show that the long-term demand increases following entry diverge substantially between the carriers. While Southwest entry into *monopoly markets* on average led to a demand increase of 22.2 percent, the other three LCCs realized substantially higher values of up to 51.2 percent in the case of AirTran. This might have to do with both different stages in the development of the companies and different business (and entry) strategies. Furthermore, while an entry of AirTran increased the number of available seats by 50.2 percent and the number of departures by 44.7 percent on average, available capacity and frequency increased on average only by 27.8 percent and 25.5 percent, respectively, following an entry of Southwest.

The picture changes when entry effects into *oligopoly markets* (only NWC) are investigated. In this category, Southwest reaches a substantially higher demand increase of on average 33.7 percent, only overtopped by AirTran with 36.9 percent. Interestingly, capacity and frequency increases have been on a similar level following the entry events of both airlines. With the exception of Southwest, the results of the descriptive analysis are confirmed in the sense that entry into oligopoly markets lead to lower percentage increases in demand than entries into monopoly markets.

Turning from the group of LCCs to the *group of NWC*, the coefficients for the entry effects into *monopoly markets* reveal comparable demand increases of about 25 percent for all carriers although capacity increases were significantly higher (30 to 34 percent). In this respect, the results of the descriptive analysis are confirmed which showed that the demand increases following entry are substantially higher for the group of low-cost carriers (triggered by their lower prices).

The effects of *NWC oligopoly entry* are rather mixed. While American and Delta entries into oligopoly markets with an LCC show very substantial demand increases of 45.2 percent and 36.4 percent (suggesting the above mentioned fierce competition in this market category), the coefficient for American and entries into oligopolies with only NWC turns out to be much smaller and partly insignificant. For the remaining two NWC, United and US Airways, the coefficient show inverted characteristics in the sense that the demand effects of entry into NWC oligopoly markets are higher than the effects of entry into oligopoly markets in which another LCC is already present. Although these results have to be interpreted cautiously as the majority of NWC entries (about 70 percent) took place in monopoly markets, they do suggest a substantial heterogeneity in the business (and entry) strategies of the four NWCs under investigation.

In a nutshell, we can conclude that the demand effects of entry largely confirm the theoretical reasoning and the results of the descriptive analysis. However, the analysis reveals that neither the group of LCCs nor the group of NWCs are homogeneous in the sense that entries by the respective carriers always lead to comparable economic effects. Quite the contrary, these companies partly have quite different historic backgrounds and follow quite different business (and entry) strategies and therefore cause quite distinctive economic effects of entry. For the group of LCCs, one key impression from the price effects analysis can be confirmed, namely that Southwest cannot be considered as the only significant LCC anymore. In fact, the effects of entry by other LCCs are more significant than the (immediate) effects found for Southwest.

5 Conclusion

Providing airlines with the freedom to decide on market entry and exit was one of the key accomplishments of the deregulation of the U.S. airline industry in 1978. Since then, airlines made frequent use of the gained possibilities to optimise their route networks and to provide efficient air services to their customers. Although entry in deregulated U.S. airline markets has been the focus of prior research, significant recent market developments such as severe external and internal shocks or the continuing growth of low-cost carriers demand a revisit of this important topic. Against this background, we use T-100 traffic data and DB1B fare data from the U.S. Department of Transportation to identify patterns and effects of entry by network carriers and low-cost carriers in non-stop U.S. airline markets.

Summarising the key insights of the article, the section on *patterns of entry* into non-stop U.S. airline markets from 1996 to 2009 generally identified significant entry activity for both network carriers and low-cost carriers over the last fifteen years. However, while the network carriers showed substantial entry activity between 1996 and 2000, the average number of entries dropped significantly from 2003 onwards. Since 2004, the group of low-cost carriers entered more markets per year than the group of network carriers. In addition, the analysis revealed that low-cost carrier entries have significantly higher survival rates than entries by network carriers. Finally, it was found that low-cost carriers recently started to enter long-haul markets with a travel distance of more than 1,500 miles. This finding suggests that competitive pressure on network carriers will increase even further in the years to come.

Turning from the patterns of entry to the *effects of entry*, new evidence on the effects of non-stop route entry between 1996 and 2009 was derived by applying two different approaches: a descriptive approach which studied the effects of all network carrier and low-cost carrier entries in the TOP 500 non-stop U.S. airline markets and an econometric approach which investigated the effects of entry into existing non-stop markets for selected low-cost carriers and network carriers separately by using logarithmic fixed effects regressions. The descriptive approach revealed that only entry by low-cost carriers on average led to significant decreases in market yield. The largest effect – a (permanent) reduction of market yield by about 5 cents per mile (about 17 percent) in the quarter of the entry event and further (temporary) 2 cents per mile in the quarter following entry (in sum about 25 percent) – was observed for entries of low-cost carriers in monopoly routes, followed by entry into oligopoly markets. By contrast, entry events of network carriers generally had less pronounced effects on average market yields. For the cases of entry into oligopoly markets, no considerable effects on market yields were observed. In case of former monopoly markets, the (temporary) overall reduction in average market yield amounts to about 2 cents per mile (about 5 percent).

The results of the econometric approach by and large confirmed the general findings of the descriptive analysis although the sizes of the effects partly showed significant differences. Interestingly, the econometric approach further revealed that the economic effects of entry differed not only between the three different pre-entry market structures and the two groups of carriers but also showed a substantial within-group variation likely driven by different business (and entry) strategies of the respective network or low-cost carriers. In particular, our analysis suggested that, first, Southwest cannot be considered as the only significant low-cost carrier anymore since several other members of this group showed equal or even more significant effects of entry. Although it seems likely that part of this result is driven by Southwest's (and JetBlue's) outstanding reputation – leading the respective incumbent carriers to substantial price reductions as soon as it becomes sufficiently likely that one of those carriers will eventually enter the respective route (i.e., *before* the actual entry event) – entries by other low-cost carriers are found to cause substantial drops in the average market yield in the quarter of entry. Second, due to its merger with the low-cost carrier America West in 2005, US Airways must be considered as a hybrid carrier positioned between network carriers and low-cost carriers. This hypothesis is basically supported by the econometric approach which identified that the effects of entry of US Airways are comparable to those of a low-cost carrier rather than a network carrier. Last but not least, the highly significant yield reductions after entries by American Airlines and Delta Air Lines into oligopoly markets in which a low-cost carrier was already present suggested that both carriers follow a rather aggressive strategy to fight their low-cost rivals in those markets (and/or are aggressively fought by the respective incumbent carriers in the market).

Given this recapitulation of the key results of the article, it can be concluded that the appearance and growth of low-cost carriers is one of the most important developments in the deregulated U.S. airline industry. Given the substantial effects of low-cost carrier entry on market price and therefore consumer welfare, the responsible competition authorities – not only in the United States but in all countries with a significant presence of low-cost carriers – are well advised to closely monitor the industry and to intervene in cases of welfare-reducing strategic behaviour of incumbents that only aim at deterring market entry of potential competitors. Such a pro-active competition policy is an important cornerstone in an overall strategy to keep the airline industry competitive and to continue harvesting the sweet fruits of deregulation.

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Appendix

Table 3: Average value and percentage changes for yield, passengers, departures, and seats from the quarter before entry (t-1) to the quarter after entry (t+1)

	Monopoly routes		**Oligopoly w/o LCC**		**Oligopoly with LCC**	
	Average value	*%-change (t_{-1} basis)*	*Average value*	*%-change (t_{-1} basis)*	*Average value*	*%-change (t_{-1} basis)*
Average Yield – LCC entry						
Quarter before entry	30.08		23.62		19.54	
Quarter of entry	25.01	*-16.86*	22.08	*-6.54*	18.57	*-4.94*
Quarter after entry	22.61	*-24.85*	20.72	*-12.29*	17.33	*-11.29*
Average Yield – NWC entry						
Quarter before entry	28.63		26.47		18.56	
Quarter of entry	27.16	*-5.11*	25.66	*-3.05*	18.77	*1.12*
Quarter after entry	26.79	*-6.44*	25.55	*-3.47*	18.97	*2.20*
Average Passengers – LCC entry						
Quarter before entry	124,755		207,339		235,375	
Quarter of entry	158,352	*26.93*	238,494	*15.03*	268,633	*14.13*
Quarter after entry	181,491	*45.48*	259,644	*25.23*	282,074	*19.84*
Average Passengers – NWC entry						
Quarter before entry	131,637		201,104		207,397	
Quarter of entry	148,727	*12.98*	211,355	*5.10*	212,669	*2.54*
Quarter after entry	161,969	*23.04*	233,054	*15.89*	216,629	*4.45*
Average Departures – LCC entry						
Quarter before entry	1171		2017		2353	
Quarter of entry	1496	*27.80*	2241	*11.09*	2596	*10.34*
Quarter after entry	1703	*45.47*	2455	*21.71*	2765	*17.49*
Average Departures – NWC entry						
Quarter before entry	1236		2220		2155	
Quarter of entry	1438	*16.32*	2352	*5.96*	2233	*3.60*
Quarter after entry	1616	*30.71*	2497	*12.47*	2278	*5.73*
Average Seats – LCC entry						
Quarter before entry	172,932		287,576		313,070	
Quarter of entry	213,329	*23.36*	316,101	*9.92*	351,756	*12.36*
Quarter after entry	243,881	*41.03*	347,145	*20.71*	375,421	*19.92*
Average Seats – NWC entry						
Quarter before entry	184,896		300,490		288,916	
Quarter of entry	212,509	*14.93*	318,165	*5.88*	299,875	*3.79*
Quarter after entry	235,673	*27.46*	340,035	*13.16*	305,494	*5.74*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 4: Description and summary statistics of all variables used in fixed effects regressions

	Description	Mean for regressions of carrier X's effect of entry							
		WN (Southwest)	B6 (JetBlue)	FL (Air Tran)	NK (Spirit)	AA (American)	DL (Delta)	UA (United)	US (US)
Dependent variables									
ln(yield)	Logarithm of market fare per mile in 1995 real terms (U.S. cents)	2.565	2.537	3.007	2.791	2.963	2.962	3.009	2.971
ln(pass.)	Logarithm of market size as measured by the quarterly number of all airlines' non-stop passengers	11.334	11.558	11.701	11.530	11.061	10.558	11.212	11.286
ln(dep.)	Logarithm of the number of quarterly departures (all airlines)	6.744	6.899	7.197	6.903	6.759	6.425	6.827	6.868
ln(seats)	Logarithm of the number of available quarterly seats (all airlines)	11.624	11.799	12.011	11.807	11.426	10.919	11.548	11.622
Independent variables									
X Serve	Carrier X serves the market non-stop in quarter *t* (dummy variable)	0.891	0.946	0.737	0.460	0.681	0.613	0.556	0.657
Market structure before entry									
Monopoly	Before X entered the market, the market was a monopoly *(reference category).*	0.648	0.586	0.472	0.503	0.537	0.658	0.597	0.523
OliNWC	Before X entered the market, the market was a duopoly of network carriers (dummy variable).	0.207	0.346	0.426	0.426	0.216	0.165	0.250	0.181
OliLCC	Before X entered the market, the market was a duopoly with at least one low-cost carrier (dummy variable).	0.145	0.068	0.102	0.071	0.247	0.176	0.153	0.296
# LCC w/o X	Number of (other) LCCs serving the market	0.188	0.185	0.205	0.281	0.441	0.433	0.311	0.450
# Carrier w/o X	Total number of carriers serving the market (except of the carrier X).	1.090	1.305	1.342	1.782	1.173	1.186	1.320	1.255
Avg. plane size	Average plane size (average number of available seats per flight)	134.160	139.281	128.490	140.002	117.319	103.066	128.104	123.117
Unempl. rate (mean)	Average unemployment rate (MSA, arithmetic mean of endpoints, in percent)	5.362	5.772	5.397	5.901	5.576	5.273	5.476	5.536
Population (mean)	Number of inhabitants (MSA, arithmetic mean of endpoints, in 100,000 persons)	36.316	79.600	39.958	70.682	51.567	55.498	66.198	45.525
Quarter									
Q1	First quarter dummy variable *(reference category)*	0.236	0.226	0.234	0.239	0.244	0.237	0.235	0.226
Q2	Second quarter dummy variable	0.248	0.246	0.252	0.247	0.248	0.247	0.245	0.236
Q3	Third quarter dummy variable	0.254	0.256	0.251	0.248	0.252	0.253	0.259	0.262
Q4	Fourth quarter dummy variable	0.261	0.272	0.263	0.265	0.257	0.263	0.260	0.276
Year	Trend variable (year)	2004.6	2006.6	2005.0	2004.8	2004.9	2004.5	2004.3	2005.8

Sources: U.S. DOT, T-100 Domestic Segment Data, Airline Origin and Destination Survey (DB1B), U.S. Census Bureau, U.S. Bureau of Labor Statistics; authors' calculations.

Table 5: Fixed effects regressions for Southwest Airlines

Variable	*ln(yield)*	*(s.e.)*	*ln(pass.)*	*(s.e.)*	*ln(dep.)*	*(s.e.)*	*ln(seats)*	*(s.e.)*
WN Serve	-0.109***	(0.040)	0.222**	(0.095)	0.255**	(0.110)	0.278**	(0.113)
WN Serve x OliNWC	0.115**	(0.054)	0.114	(0.124)	0.077	(0.134)	0.056	(0.137)
WN Serve x OliLCC	0.005	(0.079)	-0.119	(0.105)	-0.168	(0.116)	-0.177	(0.119)
# LCC w/o WN	-0.002	(0.020)	0.065	(0.073)	0.049	(0.071)	0.071	(0.071)
# Carrier w/o WN	-0.021***	(0.007)	0.168***	(0.039)	0.198***	(0.039)	0.185***	(0.038)
Avg. plane size	0.000	(0.000)	0.003*	(0.001)	-0.005***	(0.002)	0.004**	(0.002)
Unempl. rate (mean)	-0.005***	(0.002)	-0.027***	(0.004)	-0.028***	(0.005)	-0.028***	(0.005)
Population (mean)	0.007	(0.007)	0.060**	(0.023)	0.067***	(0.024)	0.072***	(0.024)
Q2	-0.020***	(0.003)	0.082***	(0.010)	0.018***	(0.006)	0.018***	(0.006)
Q3	-0.074***	(0.006)	0.032**	(0.015)	0.009	(0.008)	0.011	(0.008)
Q4	-0.030***	(0.004)	-0.010	(0.011)	0.002	(0.008)	0.002	(0.008)
Year	-0.011***	(0.004)	0.000	(0.012)	-0.009	(0.013)	-0.011	(0.013)
Constant	24.924***	(7.256)	9.445	(23.686)	22.665	(26.326)	29.455	(25.018)
Observations	4609		4609		4609		4609	
Routes	163		163		163		163	
R^2 within/betw./total	0.151/0.001/0.008		0.196/0.030/0.027		0.278/0.033/0.013		0.210/0.031/0.023	

*Notes: *** p<0.01, ** p<0.05, * p<0.1, cluster-robust standard errors in parentheses.*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 6: Fixed effects regressions for JetBlue Airways

Variable	*ln(yield)*	*(s.e.)*	*ln(pass.)*	*(s.e.)*	*ln(dep.)*	*(s.e.)*	*ln(seats)*	*(s.e.)*
B6 Serve	-0.114***	(0.020)	0.400***	(0.094)	0.362***	(0.061)	0.425***	(0.094)
B6 Serve x OliNWC	0.056	(0.040)	-0.212**	(0.103)	-0.203**	(0.078)	-0.218**	(0.104)
B6 Serve x OliLCC	0.164***	(0.046)	-0.417***	(0.110)	-0.271**	(0.123)	-0.335**	(0.139)
# LCC w/o B6	-0.006	(0.026)	-0.017	(0.059)	-0.049	(0.063)	-0.034	(0.064)
# Carrier w/o B6	-0.015	(0.012)	0.193***	(0.040)	0.213***	(0.044)	0.212***	(0.043)
Avg. plane size	-0.002***	(0.000)	0.007***	(0.001)	-0.002	(0.001)	0.005***	(0.001)
Unempl. rate (mean)	-0.013***	(0.004)	-0.041***	(0.006)	-0.039***	(0.006)	-0.039***	(0.006)
Population (mean)	-0.042***	(0.015)	0.155**	(0.066)	0.196***	(0.068)	0.182***	(0.068)
Q2	-0.004	(0.008)	0.059**	(0.025)	-0.005	(0.020)	-0.003	(0.020)
Q3	-0.053***	(0.012)	0.039	(0.039)	-0.036	(0.033)	-0.032	(0.033)
Q4	-0.004	(0.008)	-0.011	(0.023)	-0.032*	(0.019)	-0.027	(0.019)
Year	0.030***	(0.010)	-0.013	(0.035)	-0.047	(0.035)	-0.038	(0.035)
Constant	-54.887***	(19.674)	24.977	(64.227)	86.028	(65.007)	72.053	(65.262)
Observations	1342		1342		1342		1342	
Routes	79		79		79		79	
R^2 within/betw./total	0.164/0.001/0.002		0.353/0.128/0.112		0.323/0.101/0.079		0.336/0.129/0.115	

*Notes: *** p<0.01, ** p<0.05, * p<0.1,cluster-robust standard errors in parentheses.*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 7: Fixed effects regressions for AirTran Airways

Variable	*ln(yield)*	*(s.e.)*	*ln(pass.)*	*(s.e.)*	*ln(dep.)*	*(s.e.)*	*ln(seats)*	*(s.e.)*
FL Serve	-0.181***	(0.031)	0.512***	(0.073)	0.447***	(0.072)	0.502***	(0.071)
FL Serve x OliNWC	0.001	(0.058)	-0.143	(0.094)	-0.137	(0.091)	-0.153*	(0.092)
FL Serve x OliLCC	0.157***	(0.037)	-0.135	(0.096)	-0.061	(0.101)	-0.124	(0.100)
# LCC w/o FL	-0.100***	(0.033)	0.117	(0.100)	0.054	(0.080)	0.092	(0.082)
# Carrier w/o FL	-0.061***	(0.016)	0.255***	(0.045)	0.276***	(0.038)	0.275***	(0.041)
Avg. plane size	0.000	(0.000)	0.008***	(0.001)	-0.001	(0.001)	0.008***	(0.001)
Unempl. rate (mean)	-0.012***	(0.002)	-0.017***	(0.006)	-0.021***	(0.005)	-0.020***	(0.005)
Population (mean)	0.006	(0.008)	-0.020	(0.020)	-0.028*	(0.015)	-0.014	(0.017)
Q2	-0.024***	(0.004)	0.064***	(0.016)	-0.014	(0.013)	-0.009	(0.013)
Q3	-0.102***	(0.007)	0.029	(0.024)	-0.026	(0.020)	-0.017	(0.020)
Q4	-0.059***	(0.004)	0.017	(0.015)	0.000	(0.013)	0.003	(0.013)
Year	-0.016***	(0.005)	0.048***	(0.017)	0.043***	(0.014)	0.034**	(0.015)
Constant	35.779***	(10.563)	-84.794	(34.142)	-78.222	(26.938)	-57.915	(28.736)
Observations	3907		3925		3925		3925	
Routes	159		159		159		159	
R^2 within/betw./total	0.286/0.043/0.073		0.265/0.050/0.045		0.236/0.011/0.023		0.290/0.107/0.110	

*Notes: *** p<0.01, ** p<0.05, * p<0.1, cluster-robust standard errors in parentheses.*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 8: Fixed effects regressions for Spirit Airlines

Variable	*ln(yield)*	*(s.e.)*	*ln(pass.)*	*(s.e.)*	*ln(dep.)*	*(s.e.)*	*ln(seats)*	*(s.e.)*
NK Serve	-0.117***	(0.035)	0.441***	(0.103)	0.438***	(0.098)	0.450***	(0.097)
NK Serve x OliNWC	0.028	(0.051)	-0.145	(0.120)	-0.136	(0.115)	-0.123	(0.114)
NK Serve x OliLCC	0.099***	(0.034)	-0.525***	(0.103)	-0.462***	(0.098)	-0.491***	(0.099)
# LCC w/o NK	0.011	(0.031)	0.001	(0.105)	0.008	(0.102)	0.032	(0.103)
# Carrier w/o NK	-0.049**	(0.023)	0.333***	(0.063)	0.313***	(0.055)	0.333***	(0.059)
Avg. plane size	-0.002**	(0.001)	0.010***	(0.002)	0.001	(0.002)	0.011***	(0.002)
Unempl. rate (mean)	-0.009**	(0.004)	-0.008	(0.010)	-0.005	(0.010)	-0.002	(0.010)
Population (mean)	-0.005	(0.012)	0.067**	(0.028)	0.110***	(0.028)	0.097***	(0.028)
Q2	-0.041***	(0.008)	0.024	(0.044)	-0.023	(0.039)	-0.020	(0.038)
Q3	-0.131***	(0.016)	-0.006	(0.058)	-0.053	(0.049)	-0.042	(0.049)
Q4	-0.061***	(0.007)	-0.059*	(0.034)	-0.055*	(0.030)	-0.050	(0.030)
Year	-0.019***	(0.007)	-0.021	(0.017)	-0.050***	(0.016)	-0.044**	(0.017)
Constant	41.073***	(13.046)	47.338	(32.715)	97.987***	(31.759)	90.816	(32.503)
Observations	1332		1332		1332		1332	
Routes	44		44		44		44	
R^2 within/betw./total	0.271/0.322/0.315		0.319/0.118/0.189		0.271/0.033/0.070		0.391/0.083/0.144	

*Notes: *** p<0.01, ** p<0.05, * p<0.1, cluster-robust standard errors in parentheses.*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 9: Fixed effects regressions for American Airlines

Variable	*ln(yield)*	*(s.e.)*	*ln(pass.)*	*(s.e.)*	*ln(dep.)*	*(s.e.)*	*ln(seats)*	*(s.e.)*
AA Serve	-0.030	(0.026)	0.262***	(0.093)	0.303***	(0.092)	0.304***	(0.088)
AA Serve x OliNWC	0.041	(0.044)	-0.156	(0.109)	-0.177	(0.114)	-0.177	(0.111)
AA Serve x OliLCC	-0.033	(0.032)	0.190*	(0.112)	0.184	(0.114)	0.185*	(0.108)
# LCC w/o AA	-0.122***	(0.025)	0.048	(0.100)	-0.014	(0.090)	0.018	(0.090)
# Carrier w/o AA	-0.042***	(0.013)	0.239***	(0.050)	0.238***	(0.049)	0.246***	(0.050)
Avg. plane size	-0.001**	(0.000)	0.007***	(0.002)	-0.003	(0.002)	0.008***	(0.002)
Unempl. rate (mean)	-0.008***	(0.003)	-0.028***	(0.007)	-0.022***	(0.007)	-0.021***	(0.007)
Population (mean)	0.013	(0.010)	0.121***	(0.035)	0.117***	(0.034)	0.120***	(0.033)
Q2	-0.013***	(0.004)	0.143***	(0.014)	0.031***	(0.010)	0.032***	(0.010)
Q3	-0.043***	(0.008)	0.134***	(0.022)	0.034**	(0.016)	0.035**	(0.016)
Q4	-0.035***	(0.005)	0.030*	(0.015)	-0.019	(0.013)	-0.018	(0.012)
Year	-0.019***	(0.006)	-0.047***	(0.016)	-0.059***	(0.015)	-0.062***	(0.015)
Constant	41.012***	(11.097)	98.242***	(30.976)	119.711***	(28.332)	129.162***	(29.588)
Observations	3745		3748		3748		3748	
Routes	123		123		123		123	
R^2 within/betw./total	0.228/0.001/0.004		0.291/0.163/0.153		0.227/0.119/0.099		0.341/0.159/0.151	

*Notes: *** p<0.01, ** p<0.05, * p<0.1, cluster-robust standard errors in parentheses.*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 10: Fixed effects regressions for Delta Air Lines

Variable	*ln(yield)*	*(s.e.)*	*ln(pass.)*	*(s.e.)*	*ln(dep.)*	*(s.e.)*	*ln(seats)*	*(s.e.)*
DL Serve	-0.038*	(0.021)	0.254***	(0.089)	0.270***	(0.076)	0.307***	(0.082)
DL Serve x OliNWC	0.043	(0.050)	-0.042	(0.153)	0.043	(0.129)	-0.006	(0.143)
DL Serve x OliLCC	-0.063*	(0.036)	0.110	(0.195)	0.091	(0.201)	0.088	(0.209)
# LCC w/o DL	-0.044	(0.031)	0.060	(0.110)	0.059	(0.105)	0.065	(0.108)
# Carrier w/o DL	-0.015	(0.016)	0.428***	(0.081)	0.440***	(0.081)	0.444***	(0.083)
Avg. plane size	-0.001**	(0.000)	0.007***	(0.002)	-0.002	(0.002)	0.008***	(0.002)
Unempl. rate (mean)	-0.004	(0.004)	-0.035***	(0.010)	-0.028***	(0.010)	-0.028***	(0.010)
Population (mean)	-0.007	(0.015)	0.028	(0.040)	0.042	(0.038)	0.032	(0.040)
Q2	-0.022***	(0.006)	0.081***	(0.021)	-0.004	(0.016)	-0.004	(0.016)
Q3	-0.092***	(0.010)	0.033	(0.032)	-0.029	(0.028)	-0.025	(0.028)
Q4	-0.060***	(0.006)	0.017	(0.023)	-0.020	(0.020)	-0.016	(0.020)
Year	-0.010	(0.008)	0.025	(0.020)	-0.002	(0.017)	0.006	(0.019)
Constant	24.201	(15.337)	-41.402	(37.365)	6.958	(33.165)	-4.637	(35.532)
Observations	3196		3215		3215		3215	
Routes	100		100		100		100	
R^2 within/betw./total	0.116/0.008/0.004		0.173/0.181/0.141		0.173/0.079/0.052		0.184/0.197/0.151	

*Notes: *** p<0.01, ** p<0.05, * p<0.1, cluster-robust standard errors in parentheses.*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 11: Fixed effects regressions for United Airlines

Variable	*ln(yield)*	*(s.e.)*	*ln(pass.)*	*(s.e.)*	*ln(dep.)*	*(s.e.)*	*ln(seats)*	*(s.e.)*
UA Serve	0.028	(0.065)	0.236***	(0.065)	0.307***	(0.072)	0.320***	(0.075)
UA Serve x OliNWC	-0.028	(0.055)	0.228*	(0.131)	0.176	(0.146)	0.177	(0.152)
UA Serve x OliLCC	0.011	(0.055)	0.026	(0.127)	-0.028	(0.115)	-0.041	(0.122)
# LCC w/o UA	-0.300***	(0.093)	-0.007	(0.137)	-0.121	(0.149)	-0.085	(0.148)
# Carrier w/o UA	-0.038	(0.037)	0.366**	(0.138)	0.401***	(0.142)	0.425***	(0.145)
Avg. plane size	-0.001	(0.001)	0.002	(0.003)	-0.006**	(0.003)	0.003	(0.003)
Unempl. rate (mean)	-0.015**	(0.007)	-0.049***	(0.009)	-0.039***	(0.009)	-0.043***	(0.009)
Population (mean)	-0.015	(0.029)	0.050	(0.037)	0.051	(0.042)	0.055	(0.043)
Q2	-0.013	(0.010)	0.117***	(0.036)	0.060**	(0.026)	0.054*	(0.028)
Q3	-0.034**	(0.015)	0.157***	(0.056)	0.094**	(0.044)	0.089*	(0.044)
Q4	-0.041***	(0.011)	0.009	(0.041)	-0.001	(0.035)	-0.005	(0.035)
Year	0.000	(0.016)	-0.010	(0.021)	-0.027	(0.022)	-0.028	(0.024)
Constant	5.082	(30.488)	27.761	(40.722)	57.271	(40.897)	62.935	(45.629)
Observations	1157		1160		1160		1160	
Routes	37		37		37		37	
R^2 within/betw./total	0.229/0.005/0.025		0.241/0.184/0.124		0.305/0.168/0.110		0.282/0.216/0.147	

*Notes: *** p<0.01, ** p<0.05, * p<0.1, cluster-robust standard errors in parentheses.*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.

Table 12: Fixed effects regressions for US Airways

Variable	*ln(yield)*	*(s.e.)*	*ln(pass.)*	*(s.e.)*	*ln(dep.)*	*(s.e.)*	*ln(seats)*	*(s.e.)*
US Serve	-0.062*	(0.034)	0.274*	(0.151)	0.328**	(0.147)	0.342**	(0.144)
US Serve x OliNWC	-0.002	(0.030)	-0.028	(0.141)	-0.079	(0.145)	-0.062	(0.139)
US Serve x OliLCC	0.021	(0.053)	-0.130	(0.147)	-0.166	(0.144)	-0.175	(0.143)
# LCC w/o US	-0.084***	(0.031)	0.370*	(0.214)	0.298	(0.189)	0.330*	(0.196)
# Carrier w/o US	-0.035**	(0.017)	0.146*	(0.080)	0.153**	(0.073)	0.140*	(0.075)
Avg. plane size	0.000	(0.001)	0.004**	(0.002)	-0.004**	(0.002)	0.006***	(0.002)
Unempl. rate (mean)	-0.010***	(0.003)	-0.028***	(0.010)	-0.030***	(0.012)	-0.031***	(0.011)
Population (mean)	0.001	(0.018)	-0.074**	(0.032)	-0.071*	(0.037)	-0.071**	(0.035)
Q2	-0.028***	(0.005)	0.105***	(0.019)	0.015	(0.012)	0.020*	(0.012)
Q3	-0.065***	(0.007)	0.049*	(0.026)	-0.010	(0.018)	-0.004	(0.017)
Q4	-0.038***	(0.006)	0.009	(0.021)	-0.019	(0.017)	-0.021	(0.017)
Year	-0.016	(0.014)	0.080***	(0.026)	0.074**	(0.030)	0.073**	(0.028)
Constant	34.468	(26.445)	-147.080***	(52.042)	-138.461**	(58.373)	-133.473**	(56.050)
Observations	1829		1831		1831		1831	
Routes	105		105		105		105	
R^2 within/betw./total	0.155/0.112/0.165		0.174/0.066/0.085		0.224/0.118/0.178		0.184/0.080/0.115	

*Notes: *** p<0.01, ** p<0.05, * p<0.1, cluster-robust standard errors in parentheses.*

Sources: U.S. DOT, T-100 Domestic Segment Data and Airline Origin and Destination Survey (DB1B), authors' calculations.