Does Competition Increase Quality? Evidence from the US Airline Industry*

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Abstract

In this paper, we study the impact of competition on the provision of quality in the US airline industry. Using changes in competition triggered by airline mergers and LCCs entry, we find that an increase in competition increases the provision of quality of major non-merging incumbent airlines by increasing the number of flights as well as improving their on-time performance with less frequent cancellations and flight delays. Our evidence suggests an increase in competition unambiguously increases consumer surplus, because prices do not seem to change, and quality and convenience increase.

Keywords: competition, airlines, quality, flight frequency, on-time performance.

JEL codes: D22, D43, L11, L13, L93

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1 Introduction

Although the economics and management literature (Spence, 1975) has documented the effect of competition on price, non-price competition (Spence, 1977; Dixit, 1979) remains relatively understudied despite its prominent role in firms' competitive strategy and antitrust policy considerations. Because non-price competition can take many different shapes and affect consumers in many different ways, understanding its impact on other firms and ultimately consumers' well-being is particularly important. Firms may compete on location or hours in service, which are observable and unambiguous in consumer preferences. Alternatively, firms may compete on quality, which is rather subjective and affects consumers differently through vertical and horizontal differentiation. Because quality provision is costly and it has an uncertain impact on consumer demand, firms may react to increases in competition by either increasing or decreasing quality, depending on how sensitive consumers are to quality relative to prices. On the one hand, Shleifer (2004) argues that competition may decrease quality when firms are driven toward unethical behavior. For example, Becker and Milbourn (2011) find an increase in competition among credit-rating agencies may indeed lower quality and reliability because reputational incentives are weakened, and Bennett et al. (2013) show emission-test facilities are more lenient when they face more competition and fear losing customers that failed their test. On the other hand, competition may increase quality. Mazzeo (2003) shows that flights in more competitive routes are less likely to be delayed, and Seamans (2012) and Seamans (2013) find that private incumbent cable providers respond to potential entry from public firms by providing faster upgrades and engaging in limit pricing, respectively. Ultimately, whether competition increases (or decreases) quality is an empirical question that depends on the context and the specific firms's strategic incentives.

Moreover, understanding the impact of competition on all margins and strategic decisions of the firm is important for various reasons. Whereas an increase in competition may likely decrease prices and therefore unambiguously increase welfare and decrease profits, the impact on quality and other strategic variables offer ambiguous overall effects on firm profits, consumer surplus, and, most importantly, total welfare. Therefore, policy makers and government agencies attempting to regulate entry and competition in any industry should understand the consequences of their policies on both qualitative and quantitative dimensions, and not only on those that are easily observable and quantifiable.

Even though defining quality is always subject to debate and discussion, a few industries provide consensus on how to quantify quality across products and firms. For example, the letter grading system in the hospitality industry allows consumers to distinguish more hygienic restaurants from less so (Jin and Leslie, 2003). In the healthcare industry, patient recovery time is viewed as a good measure of quality (Cutler et al., 2014). Similarly, the airline industry is an optimal setting to investigate the impact of competition on quality provision. On the one hand, consumers value flight frequency because it allows them to be more flexible regarding their travel schedule (Forbes and Lederman, 2013; Berry and Jia, 2010). On the other hand, consumers also value reliability and therefore are likely to discount airlines with frequent delays and cancellations (Prince and Simon, 2015, and 2017). We contribute to this literature by simultaneously investigating the impact of competition in the US airline industry on quality through both travel flexibility and reliability. We measure the former through flight frequency, and the latter through cancellations, arrival, and departure delays.

For this purpose, we exploit two plausible sources of exogenous variation on competition in the US airline industry. As documented in the literature (Ito and Lee, 2003; Richard, 2003), over the last 30 years, the US airline industry has seen dramatic changes to its structure. On the one hand, the industry saw a significant degree of consolidation through major airlines' mergers (most recently, Delta-Northwest, United-Continental, and American Airlines-US Airways). This paper contributes to the existing literature by using the merger between two airlines that did not fly a route but had a presence at one endpoint of the route, as plausible exogenous variation in entry threat and entry probability into a market.

On the other hand, the wide adoption of regional jets[1] had a significan direct and indirect impact on the expansion strategy of multiple low-cost carriers (LCCs hereafter), such as Southwest,

[1] See Table 2 in Forbes and Lederman (2013) and http://www.nbcnews.com/id/24390211/page/2/#.Vbch1Pmzl74 for a description of the wide adoption of the regional jet as a plausible exogenous change in technology.

JetBlue, or Spirit, which increased competition on many routes. Because the lower cost of entry of LCCs (due to the adoption of regional jets or the downward pressure on the price of narrow-body aircrafts[2]) is exogenous to the incumbent legacy carriers as are mergers to non-merging airlines in a given route, we use these two sources of exogenous variation in competition to study the causal effect of entry (through mergers and LCCs expansion) on quality measures such as flight frequency, flight cancellations, and delays.[3]

Note that studying these two sources of variation in the same context is novel because these two types of events may increase competition and the distribution of firm size in different ways. Whereas the latter increases competition in any market that experiences entry by adding a small firm, the former increases competition by adding a new large firm. Thus, by examining the impact of both sources of changes in competition in an integrated manner, we are able to address potential asymmetries in the impact on non-price variables due to heterogeneity in entry.

Our data combines DB1B market and ticket data (flight-level and ticket-level data), T100 flight-characteristics data (seats, number of flights, average number of flights, distance measure, etc.), and OTP (on-time-performance data including cancellation, departure delay, arrival delay) between 1993 and 2013. In the end, our final data set provides evidence of behavior for seven major airlines in 7,762 markets[4] during 84 quarters spread along 21 years. In total, we have 79,692 airline/market/quarter/year data points[5] that allow us to explore the impact of five mergers between major carriers and one merger between LCCs in 744 routes with entry threats by the merged airlines. In addition, we study the impact of LCCs' entry threats in 1,168 routes out of 4,681 routes flown by major airlines incumbents. Note that we focus on these seven major airlines because their networks were already developed; therefore, changes in the number of flights and OTP are most likely to be the result of a strategic response to changes in their competitive

[2] While prices of wide-body aircrafts steadily increased from the 1980s to 2010s, the price of narrow-body aircrafts remained stable. This observation is consistent with regional jets being a closer substitute for narrow-body aircrafts and their wide adoption constraining their pricing. Evidence is available from the authors upon request.

[3] We show later in the paper that LCC entry in a route and mergers were uncorrelated with average airline ticket prices, load factors, and ticket sales. Similarly, we find that incumbent airlines were not likely to acquire regional jets.

[4] The number of routes ever flown by major airlines in the United States in our sample.

[5] The number of observations before trimming the sample data to look at the 25-quarter window surrounding the quarter in which merging carriers and LCCs appear at both endpoints.

environment, instead of coming from strategic network expansion.

The findings in this paper extend the literature in several ways. First, to the best of our knowledge, ours is the first paper examining the non-merging incumbents' response to a "potential entry threat" by merging airlines in a route where the merging airlines were not previously operating. We show that incumbent non-merging airlines increase their number of flights in routes not flown by merging airlines before the merger. We also find that incumbent non-merging airlines respond to the actual entry of merging airlines by reducing the number of cancellations, departure delays, and arrival delays after the merger takes place. Second, we show that incumbent carriers react to more competition by increasing the frequency of flights and by decreasing cancellations, departure delays, and arrival delays if there is a threat of an LCC entering the route. Third and last, we complement the study of Goolsbee and Syverson (2008) by evaluating how quality changes upon the entry threat of all LCCs (not only Southwest) in an extended sample data period from 1993 to 2013. In contrast to Goolsbee and Syverson (2008), we find that in response to an LCC entry threat, the airlines increase the number of flights.

Of course, our paper is not the first to study the impact of competition on quality provision or more specifically the impact of competition in the airline industry. The paper closest to ours is Prince and Simon (2015), who study the impact of Southwest entry on OTP in the US airline industry. Our paper differs from theirs in several ways. We focus on the impact of competition on quality provided by incumbent major airlines in response to entry of non-incumbent merging airlines and to all LCC entry, instead of the impact of Southwest entry alone. Additionally, whereas Prince and Simon (2015) use the methodology in Goolsbee and Syverson (2008), we complement and improve on their evidence by using their same methodology to study the impact of competition on flight frequency of incumbent non-merging airlines in a comprehensive and systematic manner. In contrast to Prince and Simon's results, we find an increase in competition increases quality provision.

We carefully examine the source of these differences in the last section of this paper. We find that in Prince and Simon (2015), only small airlines react to increases in competition by decreasing quality. In our paper, we find an increase in quality from large legacy carriers upon an increase in competition, but no such reaction to entry when using time-varying airline-specific fixed effects. Our explanation for the difference in findings across papers hinges on the network flight structure of large carriers (hub-and-spoke) versus those of smaller carriers (point-to-point). Large airlines organizing operations through a hub-and-spoke structure will experience externalities across connected routes within their network, whereas smaller airlines are able to respond to entry in isolated ways. Consistent with this idea, we find that increases in competition in a route also increases the number of flights and OTP in connecting routes, and that OTP is correlated across connected routes in hub-and-spoke structures. In addition, we find the introduction of controls, directional market definition, and the sample of LCCs are also important factors driving the results in Prince and Simon (2015) and explaining the differences in findings with our analysis.

The paper is structured as follows. We discuss the relevant literature and our contribution in further detail in section 2 below. Section 3 describes our data and methodology. In section 4, we present our results and examine whether LCC entry is driven by route-specific demand shocks that may drive major airlines to increase the number of flights and improve their OTP. Section 5 investigates the differences between our results and those in Prince and Simon (2015). We conclude in section 6.

2 Literature Review

This paper directly contributes to the literature on the impact of entry and competition on incumbent behavior. How market concentration and competition shapes firm behavior and market outcomes is a classical question in economics, and has been explored in industries as different as health care, education, financial services, manufacturing, and entertainment. Therefore, we only focus on the literature that studies the impact of regulation and competition in the airline industry and is therefore closest to our paper.

Mayer and Sinai (2003) and Mazzeo (2003) examine whether airport and route concentration lead to better OTP. Whereas the former finds that higher airport concentration leads to better OTP as large carriers internalize more of the congestion costs, the latter shows with a different sample that higher concentration in a route is correlated with higher prevalence and duration of flight delays. Consistent with our measure of quality and flexibility, Richard (2003) emphasizes the importance of flight frequency when determining the welfare consequences of an airline merger. Thus, he develops a model of airlines' passenger choice and the supply of the number of flights in order to quantify consumer welfare change in airline mergers. Using simulations, Richard (2003) finds welfare gains may exist despite price increases once flight frequency is taken into account. Therefore, when examining the impact of entry and competition in the US airline industry, one should focus not only on price, but also on quality dimensions such as OTP and flight frequency. Similarly, Brander and Zhang (1990) study market conduct in the airline industry through the use of conjectural variation methodology in duopoly markets. They find that data patterns are consistent with quantity-based competition rather than price-based competition. Their result stresses even further the need to study non-price dimensions when investigating the impact of entry and competition in the airline industry, as well as antitrust considerations (see Snider, 2008).

Ito and Lee (2003) document the entry and growth of LCCs in the US airline industry. They find LCCs are more likely to enter denser markets and that LCCs may compete for network carrier revenue. This finding is important for our empirical exercise because we and others have used LCC entry as a source of exogenous competition for major incumbent airlines.[6] In fact, Berry and Jia (2010) present and estimate a structural model of competition of the US airline industry and find that the expansion of LCCs, together with changes in the price sensitivity of airline passengers, explains up to 80% of the reduction in profit margins experienced by major incumbent carriers between 1999 and 2006. Baum and Korn (1996) show how multimarket contact among airlines decreases market entry and exit rates, whereas Prince and Simon (2009) show how multimarket contact between airlines lowers OTP by increasing flight delays and that this relation is stronger in more concentrated markets. Chen (1996) also analyzes the extent of multimarket contact in the US airlines, and shows the degree of competition between two airlines does not need to be symmetric. More recently, Ater and Orlov (2013) examine the spread of the internet in airline distribution channels and find the increase in price competition due to the spread of the internet

[6] We define the list of LCCs according to their classification in Ito and Lee (2003).

increased scheduled flight times and delays, lowering quality. Chandra and Lederman (2015) study the impact of competition on airfare price dispersion in the Canadian airline industry. Their evidence shows competition increases cross-cabin fare dispersion but decreases fare differences between economy travelers.

A number of other studies have investigated the impact of mergers on the degree of competition among rival airlines. Chen and Gayle (2013) study the impact of mergers on quality provision measured as the number of stopovers in a given airticket sale, and find quality (number of stopovers) goes down (up) when two airlines merge. Benkard et al. (2010) show that mergers of incumbents accelerates entry of other legacy carriers and LCCs due to a decrease in the degree of competition among incumbents. Steven et al. (2016) find that service quality (measured by delays, cancellations, mishandled bags, and involuntary boarding denials) deteriorates immediately after a merger both due to both the increase in market concentration and the operational disruption caused by the merger when combining resources of two independent firms. Most recently, Prince and Simon (2017) measured how merging airlines change their behavior before and after a merger. They find merging airlines improve performance in the long term (three to five years after merger) but not in the short-term (first two years after merger).[7]

Finally, the closest papers to ours are perhaps Goolsbee and Syverson (2008) and Prince and Simon (2015). Goolsbee and Syverson (2008) examine the effect of market-entry threat by Southwest on the airfares of incumbents. They find the threat of a Southwest entry leads to a decrease in airfares, but they do not find an effect on flight frequency and available seats. Prince and Simon (2015) uses LCC entry to investigate whether incumbent airlines improve OTP when competition increases. Interestingly, they find that entry of Southwest worsens OTP of incumbent airlines. They argue that airlines prioritize price competition over quality and thus when they lower prices, they must lower quality.

We build on these papers by offering a comprehensive study of the impact of competition on quality provision in the airline industry. We borrow the methodology in Goolsbee and Syverson

[7] Note that Prince and Simon (2017) differs from our merger analysis in that they investigate changes in behavior of the merging airlines before and after their own merger. Our analysis explores whether non-merging incumbent response to the "entry threat" of merging airlines not flying a given route prior to their merger.

(2008) and study the impact of competition on flight frequency as an important measure of air-travel quality, because it provides more flexibility and travel options to passengers. We also provide evidence on the impact of competition on OTP as in Prince and Simon (2015) to ensure differences in quality measures do not drive our results. Moreover, we use two different sources of exogenous changes in competition. First, we use the impact of mergers as an exogenous increase in the probability of market entry when each merging airline is present at different endpoints of a route but does not fly the route itself. Second, we use entry of all LCCs in the same way that Goolsbee and Syverson (2008) and Prince and Simon (2015) used Southwest entry. Our findings using both exogenous sources in competition are consistent with each other. We now describe our data before presenting our findings.

3 Data and Empirical Methodology

3.1 Background and Data

We study the effect of competition on the service quality of incumbents using two plausible sources of exogenous entry: merger announcements of non-incumbent airlines to a route and LCCs' entry threat. Our approach is novel because we are the first to study the entry threat by merged airlines in routes not entered prior to the merger. Additionally, we also follow the empirical strategy in Goolsbee and Syverson (2008), and similar to that in Prince and Simon (2015), to study the impact of entry threat by all the LCCs on incumbents between 1993 and 2013.

The data we use in this paper are the result of combining several data sets. We obtain airfare information from the DB1B ticket data, and market data from RITA,[8] both in the Bureau of Transportation Statistics (BTS hereafter). These data contain information not only for the ticket carriers, but also for the operating carriers and reporting carriers of each flight. We complement these data with information on aircraft type and operator information, as well as flight frequency from the T100-B43 airline-aircraft data from the Department of Transportation. To merge all these data together, we checked the ownership of the flight, which allows us to match with DB1B

[8] RITA stands for "Research and Innovative Technology Administration." See https://www.rita.dot.gov/.

data and calculate concentration measures such as the HHI. We also employ other T100 flight-characteristics data (seats, number of flights, average number of flights, group of aircraft, distance flown, number of total passengers, and dummy of freighter flights) and OTP information from BTS (OTP data including cancellation, departure delay, and arrival delay). Note that because of the smaller coverage of the T100 data set, the final data sample has less than perfect coverage for small routes, which are routes that are disproportionately served by LCCs; therefore, our empirical analysis estimating the impact of LCC entry on quality may underestimate the overall effect because of the higher number of LCCs entry threats in the DB1B data set before merging with T100. Nevertheless, this shortcoming does not affect on the analysis of the impact of merger-induced entry on the provision of quality by non-merging incumbent airlines.

We first drop routes that appear in the data less than 5 times in a quarter (most likely once a month flights by single charter or regional airlines), and then we drop the freighter flights and those with 0 passengers. We take a ticketing-carrier variable from DB1B market data for two reasons: first, to identify and match with the operator from other data sets such as DB1B ticket, coupon, and T100-B43; and second, to avoid overstating the impact of merger-induced and LCC entry threat by overlooking code-sharing agreements between airlines. We define a route by its two endpoint airports, and so we consider only direct non-stop flights on a route as in Goolsbee and Syverson (2008). We construct our sample to include routes between airports that major airlines and LCCs ever fly. Our sample does not include routes where LCCs appear at a second endpoint airport simultaneously with flying the route, because of the difficulty of disentangling the entry threat from the actual entry, as discussed in Goolsbee and Syverson (2008).

When we analyze how the merger between two airlines may increase the entry threat of the new airline into a market that neither of the merging airlines was operating in prior to the merger, we study the six mergers, occurred between 1993 and 2014.[9] American Airlines merged with TWA in 2001; America West merged with US Airways in 2005; Delta merged with Northwest in 2010;[10]; United merged with Continental in 2012; American Airlines merged with US Airways in 2013; and

[9]These dates are merger-completion dates. We consider completion as the date one of the two parties' booking ended.

[10]The discussion on the possibility of a merger started around January 2008.

Southwest merged with Air Tran in 2014.[11] We study the behavior of non-merging airlines before and after the merger completion as well as before and after the merger discussion started.

When we study the effect of LCC entry threat on an incumbent's behavior, we follow the definition and classification of LCCs suggested in Ito and Lee (2003). Therefore, the list of LCCs in our data is as follows: Accessair Holdings, Air South Inc., AirTran Airways Corporation, American Trans Air Inc., Eastwind Airlines Inc., Frontier Airlines Inc., Frontier Flying Service, JetBlue Airways, Kiwi International, Morris Air Corporation, National Airlines, Pro Air Inc., Reno Air Inc., Southwest Airlines Co., Spirit Air Lines, Sun Country Airlines, Valujet Airlines Inc., Vanguard Airlines Inc., Western Pacific Airlines, and Allegiant Air.

To control severe air transportation congestion, the US Department of Transportation requires airlines to acquire the authorization of their number of flights in and out of specific airports. The slot-controlled airports are as follows: La Guardia Airport, JFK Airport, Newark Liberty International Airport, and Reagan National Airport. The slot restrictions at Chicago O'Hare have expired in the early period of our sample and are not included in our sample. Because we examine the number of flights as outcome, our sample excludes slot-controlled airports.[12]

Table 1 describes the variables used in our empirical analysis. The average incumbent airline in our sample supplied 470 flights per route and quarter. In our sample, 53% of the routes are flying in or out of a hub and have an HHI of 0.68 over 1. Arrival and departure delays are on average 6 and 10 minutes, respectively (so lots of flights "win" time in the air), whereas 20% and 16% of flights arrive and depart 15 minutes late, respectively. Finally, in our sample, only 1.3% of flights get cancelled. The fraction of cancellation varies largely across routes from zero to 7%.

Next, we want to define different trends between 1993 and 2013 that shed light on the evolution of competition in the US airline industry. Figure 1 shows the average number of carriers per route when we exclude small regional airlines. Note the average number went from 1.6 major airlines in a route in 2000 to 1.2 in 2005, and it has stayed at 1.2 since then. The graph and trend radically change when we include all airlines regardless of their size. If anything, an explosion occurred from

[11] In our sample, Southwest's merger appears as the merger in process rather than completed merger because our sample spans between 1993 and 2013.

[12] Results with slot-controlled airports are available upon request. All our findings are qualitatively equivalent.

1997 (1.6 airlines per route) to 2009 (2.2). Note that since 2009 (possibly as a consequence of the financial crisis), the average number of airlines has decreased from 2.2 to 2 airlines per route.

This positive trend in Figure 2 is even steeper when we look at the average number of LCCs per route in Figure 3. We define LCC here according to our definition above. This figure shows how LCCs have expanded their networks, and their average number per route went from close to zero in 1993 to 0.5 in 2013, with an almost linear trend between 1993 and 2010. This pattern is telling of the systematic expansion of these smaller airlines in the last decade. Figure 4 combines Figures 2 and 3, and shows this increase in the presence of LCCs across routes in the United States is almost fully responsible for the increase in the average number of airlines per route in the United States during the last decade; therefore, it is not negligible as a competitive threat to major incumbent airlines. Finally, Figure 5 shows the evolution of the percentages of routes per number of airlines operating in them from one airline to four or more airlines. See that while the shares of routes flown by two or three airlines has changed little over the last 20 years, the percentage of routes under monopoly has decreased to 60%, and the percentage of routes flown by four or more airlines has increased substantially from 10% to 15%.

Because we measure entry threats in the spirit of Goolsbee and Syverson (2008), we must explain how we define potential entry in both the case of non-incumbent airlines' mergers and the case of LCCs entry. In the former, we define a variable for when a merger is first announced, based on the start of merger discussions between two airlines. The dummy variable "Merger first announced" is based on the date (year and quarter) when one of the two airlines' booking ended, meaning the merger was in process. In our data, we have 744 routes merged airlines had not flown previously. Of those routes, the merged airlines entered 661 routes after the merger. In the latter strategy, we refer to the triangle describing the threat in Goolsbee and Syverson (2008) and define LCCs entry threat as the point in time when an LCC starts operating at both end points of a route but does not have any service in the route yet. As a result of this strategy, we observe entry threats of LCCs in 1,168 routes out of a total 4,681 routes that appear in the 10% US airline sample data between 1993 and 2013, of which 797 experienced LCCs entry by the end of our sample period.

We next present our methodology.

3.2 Methodology and Identification

We follow in spirit the methodology in Goolsbee and Syverson (2008) to estimate the impact of an increase in competition on incumbent behavior. For this purpose, we use two sources of exogenous variation in the cost of entry. First, we use mergers between legacy carriers as a source of exogenous variation. In particular, a merger between two airlines that were not operating in a route but operated separately at different endpoints of that route increases the probability of entry of the newly formed airline in that route in the same way that Goolsbee and Syverson (2008) use Southwest entry.[13]

Figure 6 illustrates the exogenous variation in entry threat in a route due to a merger of non-incumbent legacy carriers. Our incumbent in the regression specifications below is American Airlines, which is the major airline flying all routes in the figure (AB, BC, CD, and DA). The merger of United Airlines and Continental Airlines led to very different consequences for entry and competition in each of these routes. Note that CD and AB are virtually unchanged, because American Airlines will continue to compete against one airline in these routes, but BC will change its competition status in a different way. The likelihood of entry of the new airline (resulting from the merger between CO and UA) in the BC route is high because both airlines had their positions in B and C, respectively. In the spirit of Goolsbee and Syverson (2008), we argue that American Airlines faces more competition in BC due to the merger, even if entry has not occurred just yet.

To analyze the potential impact of this plausible exogenous source of variation in entry probability, we run OLS regressions as in Goolsbee and Syverson (2008), such as

$$\ln y_{ijt} = \sum_{k=1}^{8} \alpha_k D_{jt}[T-k] + \sum_{l=0}^{3} \beta_l D_{jt}[T+l] + \sum_{g=0}^{2} \delta_g onRoute_{jt}[T+g] + \quad (3.1)$$

[13] Take as an illustrative example the merger between American Airlines and US Air. Prior to the merger, American Airlines operated in La Guardia Airport (NY) but not in Manchester (NH). US Air operated in Manchester (NH) but not in La Guardia (NY), with the exception of their shuttle service. Meanwhile, Delta was a monopoly on the Manchester-La Guardia route. After the American Airlines-US Air merger, and according to the Goolsbee and Syverson (2008) definition of entry threat, the probability of entry by the newly merged American Airlines increases in the Manchester-LaGuardia route, and it becomes a threat to the only incumbent carrier, Delta, in the route. In this particular market, we only evaluate the behavior of the incumbent, Delta.

$$\gamma X_{ijt} + \theta_{ij} + \theta_{it} + \theta_y + \epsilon_{ijt},$$

where y_{ijt} is the outcome variable (number of flights, and OTP variables) for airline i in route j and quarter t, $D_{jt}[T-k]$ and $D_{jt}[T+l]$ are dummy variables for whether current period t is k quarters before the entry threat due to a merger that occurs in market j or l quarters after, respectively. $onRoute_{jt}[T+g]$ is a dummy variable that takes the value of 1 once entry of the newly merged airline occurs and g periods after entry, and X_{ijt} are variables that may vary over time, airline, and location, such as the route j HHI in quarter t, whether airline i has a hub in either endpoint airport covering route j, and the interaction between these two variables. In addition to these variables, our analysis also introduces carrier-route (θ_{ij}), carrier-quarter (θ_{it}), and year (θ_y) fixed effects to control for unobservables at that level that drive airline decisions across markets and that our independent variables do not capture. The usual assumption regarding the error term ϵ_{ijt} applies.

The second source of plausible exogenous variation comes from LCC entry in route markets more directly connected to Goolsbee and Syverson (2008). Therefore, we run

$$\ln y_{ijt} = \sum_{k=1}^{8} \alpha_k D_{jt}[T-k] + \sum_{l=0}^{3} \beta_l D_{jt}[T+l] + \sum_{g=0}^{2} \delta_g Entry_{jt}[T+g] + \tag{3.2}$$

$$+\gamma X_{ijt} + \theta_{ij} + \theta_{it} + \theta_{jt} + \epsilon_{ijt},$$

where y_{ijt} is the outcome variable (number of flights, and OTP variables) for airline i in route j and quarter t, $D_{jt}[T-k]$ and $D_{jt}[T+l]$ are dummy variables for whether current period t is k quarters before LCCs entry at either endpoint of route j or l quarters after, respectively (and yet not actively flying route j), $Entry_{jt}[T+g]$ is a dummy variable that takes the value of 1 once entry occurs and g periods after entry, and X_{ijt} are variables that may vary over time, airline, and location, such as the route j HHI in quarter t, whether airline i has a hub in either airport covering route j, and the interaction between these two variables. In addition to these variables, our analysis also introduces carrier-route (θ_{ij}), carrier-quarter (θ_{it}), and year (θ_y) fixed effects to control for unobservables at that level that drive airline decisions across markets and that our independent variables do not capture. Finally, we assume the error term ϵ_{ijt} is independent and identically distributed as usual.

A note on identification is needed at this point. In both specifications (1) and (2), we need the error term ϵ_{ijt} to be uncorrelated with its respective independent variables. Thus, in specification (1), entry in these markets is not driving the merger between the two non-incumbent legacy carriers, or that the merger and later entry is not timed to benefit from expected quarter-market shocks that are observed by the airlines and unobservable to the econometrician. Similarly, in specification (2), LCC-market-quarter-specific shocks that are orthogonal to the incumbent-market-quarter shocks captured in the specification drive the entry of LCCs. Whereas previous literature (i.e., Goolsbee and Syverson, 2008, and Prince and Simon, 2015) has taken as given that the expansion of Southwest in the 1990s did not follow market-quarter-specific shocks, a more careful investigation is needed when evaluating entry of merging airlines and other smaller LCCs. Therefore in section 4.3, we explore whether entry in those cases are driven by or correlated with changes over time within routes in ticket prices, load factors, and ticket sales. We are able to show entry is uncorrelated with prices, and, if anything, is negatively correlated with load factors and ticket sales. We also produce evidence that uses route/quarter and year fixed effects, so that entry does not follow route-specific seasonality characteristics that could be driving our results.

4 Main Results

4.1 Mergers As Drivers of Changes in Competition

As we show above in Figure 6, two airlines that merge may be combining resources in a market (two different airports) that neither airline was flying prior to the merger. The merger then will increase the probability of entry of the new airline in that route (route BC in Figure 6) thereby increasing the likelihood of new competition faced by the incumbent major airline (American Airlines in route BC in Figure 6). We study the significance of this effect of mergers on incumbents in Tables 2 and 3. Table 2 runs specification (1) using carrier/route, carrier/quarter, and year fixed effects. The first two columns use the number of flights per carrier, route, quarter, and year as dependent variables, and columns 3 to 7 use on-time performance measures (cancellations, arrival and departure delays). We first analyze the impact of entry of a merging airline on incumbents' flight frequency in the first two columns. Column 1 and 2 show that non-merging incumbents increase flight frequency prior to the merger, with a slight decrease in frequency two quarters after entry has occurred. These results are consistent with an increase in quality to try deterring entry at first, and accommodation to a certain degree after entry has occurred. Note that column 2 differs from column 1 in that the specifications includes HHI at the route level, a hub dummy, and their interaction.[14]

Columns 3 to 7 run the same specification as column 1 with OTP measures as dependent variables. Here we can observe that cancellations unambiguously decreased upon entry of the newly merging company. Arrival delays were higher prior to the merger announcement and decreased upon entry. Departure delays were also higher seven and eight quarters prior to the merger announcement, and decreased three and two quarters prior to the announcement, decreased again after entry in both route airports, and again upon entry of the newly merged firms. The results in columns 6 and 7 for the percentage of arrival and departure delays above 15 minutes resemble those in columns 4 and 5, respectively. Overall, the results in Table 2 seem to indicate incumbent airlines increased flight frequency prior to merger entry and slightly decreased the number of flights once entry took place. Whereas arrival delays increased and departure delays decreased after merger announcement, both arrival and departure delays decreased after entry took place. Overall, quality seems to have increased upon entry of newly merged companies both through an increase in flight frequency and a decrease in cancellations and delays.

Table 3 repeats the same exercise in Table 2 with a different set of fixed effects. Table 3 uses carrier/route, route/quarter, and year fixed effects. If anything, the new set of fixed effects used in this table controls for route-specific seasonality in flight frequency and OTP variables due to weather, vacation destinations, and other idiosyncrasies. The results we obtain are very similar to those in Table 2. Incumbents increase flight frequency prior to merger-induced entry, and adjust slightly once entry has taken place. Arrival and departure delays decrease after entry has occurred. In the next section, we explore whether our finding that competition improves quality is robust

[14] Results on the HHI and hub dummies are available upon request.

when we use LCC entry as a source of exogenous variation in competition.

4.2 Low-Cost Carriers' Entry

A second way to examine the effect of competition on quality is to use the entry of LCCs in a route. Others in the literature have used the rapid expansion of Southwest, namely, Goolsbee and Syverson (2008) and Prince and Simon (2015), arguing thee airline's rapid expansion did not follow idiosyncratic market shocks but a more general expansion strategy for the sake of expansion (see Figure 3). Here we use entry of all LCCs as a source of changes in competition for incumbent legacy carriers, arguing these smaller LCCs expanded as a result of the introduction of regional jets as well as the success of the expansion of Southwest and other regional airlines. We show later that the entry of these regional carriers does not seem to be correlated with market shocks that manifest in higher prices, more sales, or higher load factors.

We run OLS regressions of specification (2) above and show results in Tables 4 and 5. In columns 1 and 2 of Table 4, we run specification (2) using the number of flights per carrier, route, quarter, and year as dependent variable, and introducing carrier/route, carrier/quarter, and year fixed effects. Our results show the number of flights increased in all quarters prior to the LCCs entering both ends of the route and after entry in both ends of the route. Column 2 differs from column 1 in that we control for differences in HHI, whether a hub exists in the route, and the interaction. The results do not qualitatively changed in column 2 relative to column 1.

The remaining columns, 3 to 7, show a variety of interesting results. First, cancellations decrease in all quarters leading to entry of the LCC, and increase once entry has taken place. This finding is consistent with major airlines trying to deter entry and slightly adjusting their effort once they have failed to do so, and entry occurs. Arrival and departure delays measured in minutes or incidence mostly decrease except for the quarter when the LCC enters both ends of the route and the four quarters before that.

Table 5 repeats the exercise in Table 4 using carrier/route, route/quarter, and year fixed effects. The results are qualitatively similar to those in Table 4. On the one hand, flight frequency appears to increase preceding entry of the LCC in the route. On the other hand, cancellations decrease prior to entry and increase after LCC entry occurs. The results in delays resemble those in Table 4 in that both arrival and departure delays decrease except for those quarters when LCCs have entered in both ends of the route and the four-quarter lag preceding LCC entry in both ends of the route.

We note that our findings on the impact of entry on OTP are different in nature from those in Prince and Simon (2015). Because we basically use the same methodology as Goolsbee and Syverson (2008) and Prince and Simon (2015), our results may differ for a number of reasons. First, our sample is much longer and it spans between 1993 and 2013, as opposed to their paper, which only covers the time period between 1993 and 2004. Second, Prince and Simon (2015) only examines the impact of entry by Southwest on both legacy carriers and LCCs, whereas our analysis studies the impact of entry of up to 20 LCCs on only legacy carriers during our period of analysis (even though only 13 survive until 2013). The LCCs that appear in our final sample data are as follows: American Trans Air, Accessair Holdings, AirTran Airways, Allegiant Air, Eastwind Airlines, Frontier Airlines, JetBlue Airways, Kiwi International, Morris Air Corporation, Reno Air, Southwest Airlines, Spirit Air, Sun Country Airlines, Valujet Airlines, Vanguard Airlines, and Western Pacific Airlines. Note as well that Prince and Simon (2015) define a market as directional (ORD-EWR and EWR-ORD are two separate markets), whereas we follow Goolsbee and Syverson (2008) and define a market as non-directional (ORD-EWR and EWR-ORD are the same market). We carefully examine in section 5 the source of the differences in the results.

4.3 Exogeneity of Entry

As explained above, we use two sources of plausible exogenous variation in competition for the incumbent legacy carriers. Our first source of exogenous variation in competition is the entry of a newly merged airline into a market, that prior to the merger, none of the merging airlines had entered, but each one of them had entered one end of the route. As a result of the merger, following the spirit of Goolsbee and Syverson (2008), the newly created airline will be likely to enter those markets with presence at both ends. One may argue the merger has taken place precisely to enter these markets that neither of the airlines had entered previously or that entry occurs because after the merger takes place, a local market shock induces the newly created airline to enter the market. Remember that in our exercise, our focal airlines are non-merging incumbent legacy carriers in a given route. Despite the reasons the newly merged airline enters a route, our estimates should be unbiased as long as the incumbent airlines do not react to those same factors (network complementarity factor or local demand shock) but react to entry itself.

Our second source of plausible exogenous variation in competition is LCC entry to a route. Previous papers in the literature have used the rapid expansion of Southwest as a source of exogenous variation in competition, arguing its expansion did not follow market-specific characteristics or local demand shocks. Because our definition of LCC is more comprehensive, our assumption of exogenous entry may be at risk. Similarly to merger-induced entry above, using LCC entry as source of variation in competition will not bias our estimates as long as LCC entry is driven by LCC–market-specific shocks that are not affecting the incumbent legacy carriers in our sample. Our estimates here would be biased if the observed change in behavior were driven by the same local demand shocks that drive entry, and not entry directly. In this paper, we argue the expansion of smaller LCCs did not follow route-specific demand shocks that also affected incumbent airlines. Instead, we claim that smaller LCCs expanded over time for two reasons. First, the introduction of regional jets lowered entry costs for smaller airlines. Second, smaller airlines aimed to imitate the successful expansion strategy implemented by Southwest and other mid-size LCCs such as Jet Blue or Spirit Airlines.

In this section, we provide evidence that supports our exogeneity claims. First, in Table 6, we run OLS regressions of specifications (1) and (2) above with average prices by incumbent carrier, route, quarter, and year as dependent variable, preceding and leading merger-induced entry and LCCs entry. If local demand shocks were driving entry, we should observe positive correlations between prices and entry lags. Column 1 shows the results of regressing average carrier prices on entry of non-incumbent merged airlines and finds no statistical relation. Columns 2, 3, and 4 regress average prices on LCC entry of three different samples: routes with entry threats by Southwest, routes with entry threats by Southwest, Jet Blue, and Spirit, and a full sample of routes with entry threats from all LCCs. Note that, overall, no statistically significant correlations exist between prices and LCC entry. If anything, prices decreased in routes after a year of Southwest entry, and prices were higher six quarters before LCCs entered both endpoints of a route. Because more than 95% of coefficients are not statistically significant, we argue that higher prices in markets entered by Southwest, Jet Blue, Spirit, or any smaller LCC did not drive entry.

Table 7 repeats the same exercise as in Table 6 with load factor (sales divided by seats) as the dependent variable. Column 1 shows that load factors of non-merging incumbents are negatively correlated with merger-induced entry in the quarters preceding entry, and are positively correlated during the quarter when the new merging firm is on the route. Note this observation is consistent with our findings on the number of flights, in that we found incumbents increased their number of flights prior to entry and reduced them once entry occurred. Columns 2, 3, and 4 show that most coefficients (again over 95% of relevant coefficients) show either non-statistically significant or negative correlation with LCC entry. Note that overall (column 4), load factors are not positively correlated with LCC entry. Therefore, local demand shocks manifested through increases in load factors do not appear to drive merger entry or LCC entry in our sample.

Finally, Table 8 repeats the exercise in Tables 6 and 7 using total ticket sales in a route as the dependent variable. Column 1 in Table 8 shows that merger-induced entry is never positively correlated with lags and leads of the merger announcement. Therefore, our exercise that uses mergers as a source of plausible exogenous variation seems to be validated by evidence in all columns 1 of Tables 6, 7, and 8. The results of columns 2, 3, and 4 in Table 8 deserve a more careful description. Column 2 shows that, despite the generally accepted assumption in the literature, Southwest entry does seem to follow positive increases in sales. Column 3 show this positive correlation is not as robust once we include Jet Blue and Spirit, and column 4 with all LCCs, entry shows only one positive coefficient seven quarters before LCCs entry threat (entry in both endpoints of a route) occurs. In summary, the introduction of the entry of smaller LCCs does not seem to endanger the exogeneity assumption. If anything, entry of smaller LCCs seems to be more unrelated to prices, load factors of incumbents, and route-level sales than entry of Southwest (generally accepted as exogenous in the literature). Our evidence shows Southwest entry is marginally correlated with sales at the market level, but uncorrelated with prices and load factors.

Although not relevant for our study of the impact of entry of merging legacy carriers, another source of exogenous variation that would explain the expansion of LCCs in this time period is the wide adoption of regional jets, because the adoption decreased the cost of entry of LCCs in routes (Forbes and Lederman, 2013). Interestingly enough, note that Southwest is well-known for only using B737s and not regional jets. This fact does not affect our exogeneity assumption, in that others (Goolsbee and Syverson, 2008; Prince and Simon, 2015) have assumed Southwest entry to be exogenous. Yet, the rapid expansion of regional jets may have decreased prices of narrow-body airplanes as well because these airplanes are the closest substitutes to regional jets in medium, and short-haul routes.[15] To shed light on this particular concern, we want to be clear about two facts. First, our dependent variables are composed only of legacy carrier flight data. Therefore, an increase in outsourcing to regional airlines DBA does not drive the increases in the number of flights per route and improvements in OTP variables. Second, we show in Figure 7 that incumbent airlines did not purchase regional jets relative to wide and narrow-body airplanes before and during our sample period. Figure 7 shows the number of newly purchased or acquired airplanes by airline and by body type (wide, narrow, and regional jet). We show graphs (a)-(f) for United Airlines, American Airlines, Delta, Northwest, US Airways, and Continental, respectively. One can see all six airlines are more likely to acquire wide and narrow airplanes than regional jets in any given year. The only exception would be Continental Airlines in the year 2000, with 60 regional jets, but this purchase incident resembles a similar increase in narrow-body planes the year before and a moderate increase of wide-body planes during the same period of time.

These two facts combined are difficult to reconcile with a potential alternative explanation for our findings, namely, that the introduction of regional jets lowered the cost of entry for all airlines and not only LCCs. Moreover, Tan (2016) examines whether major airlines use outsourcing to regionals to deter LCC entry. Instead, he finds evidence against the entry-preemption motive.

[15] In fact, while prices of wide-body aircrafts increased over time during our sample period, narrow-body aircrafts stayed constant. Evidence is available upon request.

Major airlines increase outsourcing to regionals as a result of LCC entry, but the increase in outsourcing takes place after LCC entry and not before. This observation suggests changes in outsourcing strategies do not drive changes in behavior by legacy incumbent carriers before and after merger and LCC entry.

Finally, we show in Table 9 how LCC entry at one or both endpoints changes the probability of LCC entry in a given route.[16] We break this exercise into three parts, by examining the impact of Southwest entry alone in one or both endpoint airports of a route, entry of Southwest, Jet Blue and Spirit only, and entry of all LCCs as defined by Ito and Lee (2003). Similarly to Goolsbee and Syverson (2008) with Southwest entry, we find in Figure 9C that entry of any LCC in both endpoints multiplies by eight the probability of entry in a given route from 3.68% to 24.15%. When we investigate entry of Southwest, Jet Blue, and Spirit alone in Figure 9B, we find the probability of entry goes from 2% to 32% (multiplied by a factor of 16), and when only looking at Southwest in Figure 9A, the probability increases by a factor of five from 7% to 35%. This evidence provides stronger support for our claim about the exogeneity of LCCs entry to market and route characteristics.

5 Discussion of Results and Differences from Literature

Our findings differ from those in Prince and Simon (2015) and, to some degree, those in Goolsbee and Syverson (2008). Whereas Prince and Simon (2015) find Southwest entry is positively associated with increases in delays, GS find no correlation between Southwest entry and the number of flights flown by a carrier in a route. By contrast, we find delays and cancellations mostly decrease, and the number of flights increases, upon LCC entry. Many potential explanations exist for the difference in results, because we use data from different years (1993-2004 vs. 1993-2013), different airlines (all types vs. only major airlines), different markets (markets experiencing Southwest entry vs. markets with entry of all LCCs), different market definitions (directional vs. non-directional), and different specifications (choice of controls and fixed effects).

[16] We follow here Table 1 in Goolsbee and Syverson (2008), where they show how Southwest's entry at both endpoint airports increases the probability of actual entry into the route.

To identify the source of the difference in results, we downloaded the data[17] used by Prince and Simon (2015) and slowly transitioned from their main set of results and data to our data and set of results using the average arrival delay at the carrier/route/quarter/year level as dependent variable. We start off in column (1) of Table 10 with PS's main result using their data and specification such that Southwest entry lags and leads are positively correlated with arrival delays. In column (2), we get closer to our exercise by focusing only on major airlines, and note that some of the results closer to Southwest entry in both ends of the route and entry on the route disappear. The results on the 6-, 7-, and 8-quarter lags to entry in both ends of the route still hold in column (2). When we drop the four regressors that control for route popularity in column (3), only the 8-quarter lag is significant. In column (4), we use a different set of fixed effects; that is, we substitute carrier/quarter/year fixed effects for carrier/quarter and year fixed effects. The results show positive and statistically significant correlations between arrival delays and leads of Southwest entry. When we jump to columns (5) and (6), we use our data that defines the markets as non-directional routes (EWR-ORD and ORD-EWR are different markets in PS, but are the same market in GS and our analysis). Column (5) matches the routes in column (4), and column (6) matches all origin and destination airports that experienced Southwest entry between 1993 and 2004. Here the results are radically different and go from positive in column (4) to negative non-significant coefficients in column (5) and a negative significant coefficient in column (6). This radical change in results suggests market definition is an important component and driver of the results in PS. Finally, columns (7) and (8) add data from markets that experienced entry from other LCCs besides Southwest, and column (8) expands their time period to 2013. The results then show a negative correlation between LCC entry and arrival delays.

The gradual transition from Prince and Simon's results to ours seems to suggest a number of key differences. Their main conclusions do not apply to major airlines (Table 7 in page 387 of PS already hinted at this fact), and their results are not robust to the use of different regressors. Moreover, an interesting difference is whether the market is directional or non-directional (transition from

[17] Check data available in the supplementary material for the paper on the Management Science website, http://pubsonline.informs.org/doi/suppl/10.1287/mnsc.2014.1918.

column 4 to columns 5 and 6). Finally, the results in the last two columns of Table 10 suggest that the strength of our results does not rely so much on the extra amount of years in our data. Instead, the number of routes that experienced entry by other LCCs that followed the big push of Southwest in the 1990s seems to be the driver of our finding; that is, legacy carriers' increased their on-time performance after LCCs entry.

In a nutshell, the difference in results come from a variety of factors such as the focus on the reaction of major airlines only, the massive amount of entry of other LCCs fueled by the Southwest experience, the non-standard market definition used by Prince and Simon (2015), and the choice of controls and fixed effects (carrier/quarter/year fixed effects). Note here that although setting such types of fixed effects when studying prices may be appropriate (a la Goolsbee and Syverson, 2008), this fixed effect may be too strict when studying operational outcomes in airlines (or other firms) organized around a hub-and-spoke structure. Because major airlines react to market-specific entry in the context of their network, increasing flights or decreasing delays in a specific route as a response to market entry of a competitor ought to mechanically have an impact on other routes in their network. Therefore, using carrier/quarter/year fixed effects may absorb changes in performance in routes not directly affected by entry in a given route. Instead, we use carrier/quarter (and route/quarter fixed effects) together with carrier/route and year fixed effects. The propagation of an effect across the network may be less of a problem in LCCs (in the analysis of Prince and Simon, 2015) because their operations are organized in a point-to-point structure, a very different type of network structure from those hub-and-spoke structures of major airlines (Alamdari and Fagan, 2005). Because LCCs use a point-to-point structure, they may be able to react in a market-per-market basis in the way that Prince and Simon (2015) show, that is, trading off lower prices for lower quality on a market-per-market basis.

We aim to show the incidence of this propagation effect in our data of hub-and-spoke legacy carriers by providing two sets of evidence. First, Table 11 runs the same specification in column 8 of Table 10, adding lags and leads of the average OTP in all connecting routes to the focal route flown by the same carrier. To preserve uniformity in the units, the average connecting OTP variable is measured with the same metric as the dependent variable used in each column. The inclusion of this variable has two major effects in our original results of Table 10. On the one hand, now all lags of entry are negatively correlated (even the four-quarter lag) with the OTP dependent variable. On the other hand, delays in the nearby network are always positively correlated with delays in the focal route. This second piece of evidence suggests changes in OTP in a given route have consequences in other routes, and therefore carrier/quarter/year fixed effects may be absorbing too much variation in airlines organized around a hub-and-spoke structure.

Second, in Table 12, we run again the same specification as in column 8 of Table 10, with a different dependent variable, namely, the average OTP in all connecting routes flown by a carrier to the focal route. Consistent with our findings in the previous Table 11, we find LCC entry in he focal route affects OTP in connecting routes as well. This finding suggests that markets as independent units in a hub-and-spoke structure and using time-varying airline-specific fixed effects may underestimate (and even misrepresent) the impact of entry and competition on airline performance and quality provision, the goal of our study here.

In summary, we conclude this section with a clear understanding of the differences between our results and those in Prince and Simon (2015) and Goolsbee and Syverson (2008). We are able to show the difference in results does not hinge on the number of years of data or the identification strategy per se. The difference depends on the identity of the focal airlines (legacy carriers vs. low-cost airlines), the markets in the sample (those with Southwest entry vs. all of those with any LCC entry), the market definition (directional vs. non-directional), and finally, the use of carrier/quarter/year fixed effects (as opposed to carrier/quarter and year fixed effects). We argue that improvements in one route within a network of major airlines propagates to other points in the network, and therefore time-varying airline-specific fixed effects may involuntarily absorb the competitive reaction upon entry of incumbent airlines.

6 Conclusion

In this paper, we study the impact of competition on the provision of quality in the US airline industry. Using methodology previously used by Goolsbee and Syverson (2008) and Prince and

Simon (2015), we find that major incumbent airlines increase the convenience of travel through increasing the number of flights in response to an increase in competition due to merger-induced entry and LCCs entry. We also find the same major airlines also decreased the number of cancellations and delays when they faced entry. Therefore, one may conclude that an increase in competition in the airline industry unambiguously increases consumer surplus since prices did not increase (stayed constant in our evidence in Table 6 and decreased in Goolsbee and Syverson, 2008) while quality went up.[18]

Our results complement those in Goolsbee and Syverson (2008) because they show that not only did major incumbent airlines react to LCC entry with a decrease in prices, but they also provide higher-quality travel. From an ex-ante perspective, we see that incumbent airlines increase the number of flights available to travelers. From an ex-post perspective, we see they reduce the number of cancellations and delays. However, our results are at odds with evidence in Prince and Simon (2015), who find Southwest entry drives incumbent airlines to increase delays and therefore lower their on-time performance. Despite using the same methodology, our analysis is slightly different from theirs in three main ways. First, our data set covers 10 more years (1993 to 2013) than theirs. Second, our list of LCCs is more comprehensive and contains 16 LCCs. Third, we use two sources of plausible exogenous variation to study the impact of competition on quality, namely, merger-induced entry and LCC entry. We carefully examine the source of the difference in results and find that differences in incumbent identity (only major airlines vs. major and low-cost airlines), differences in specification (fixed effects and controls), market definitions (directional vs. non-directional), and the identity of entrant (Southwest vs. all LCCs) are main reasons for the radically different results. The growing importance of LCCs and the ever-changing nature of the airline industry may be a reason airlines are changing the way they react to entry when we examine this topic, and yet another reason future research should study further the impact of competition on quality provision in airlines and other industries.

Our findings offer clear policy implications. From the policy perspective, evaluating the impact of competition on both prices and quality is important. Failing to recognize the impact of compet-

[18] Because we do not observe costs of raising quality, we cannot qualitatively evaluate changes in total welfare.

ition on quality may lead policy makers to underestimate or overestimate total gains of changes in regulation and industry liberalization.

Finally, our evidence suggests the presence of heterogeneity in how incumbents react to changes in competition depending on the identity of the entrant, mode of entry, and network structure of the incumbent. To the best of our knowledge, the heterogeneity of the impact of competition on quality provision has been understudied in the existing literature, and therefore remains an interesting topic for future research. Furthermore, because quality changes may undo gains from price cuts, understanding how competition policy and regulation affect all margins of firm decisions is important. Our study has focused on a few measures of quality in airline service, such as convenience and flexibility with the number of flights and on-time performance with the number of flight cancellations and delays. Future research should provide evidence on other quality measures in this industry and even look for new measures that are easily comparable across other transportation sectors and other industries in general.

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Figure 1: Industry Features: Average number of carriers per route excluding tiny airlines

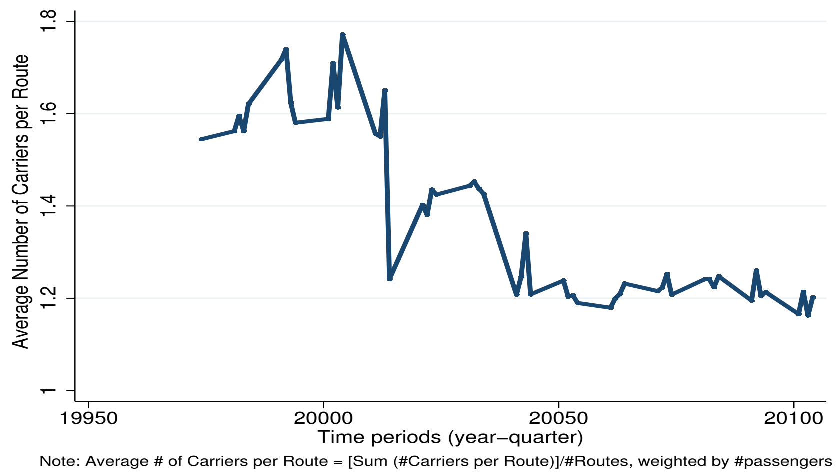


Figure 2: Industry Features: Average number of carriers per route

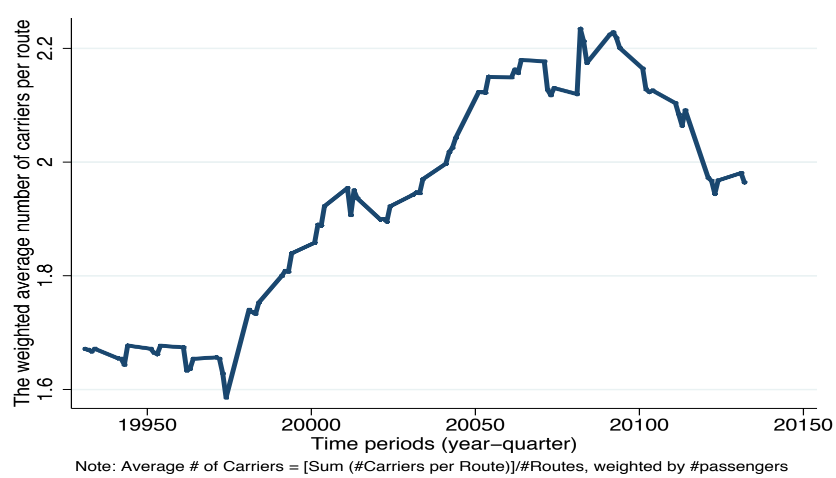


Figure 3: Industry Features: Average number of LCCs per route

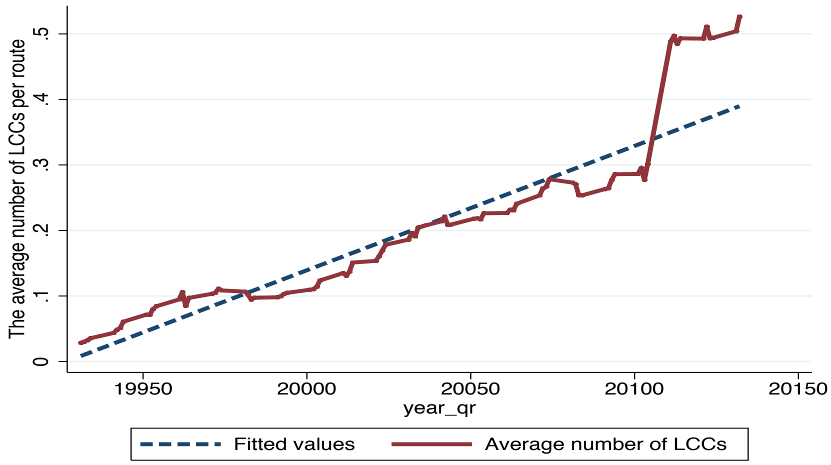


Figure 4: Industry Features: The weighted average number of all carriers vs. LCCs per route

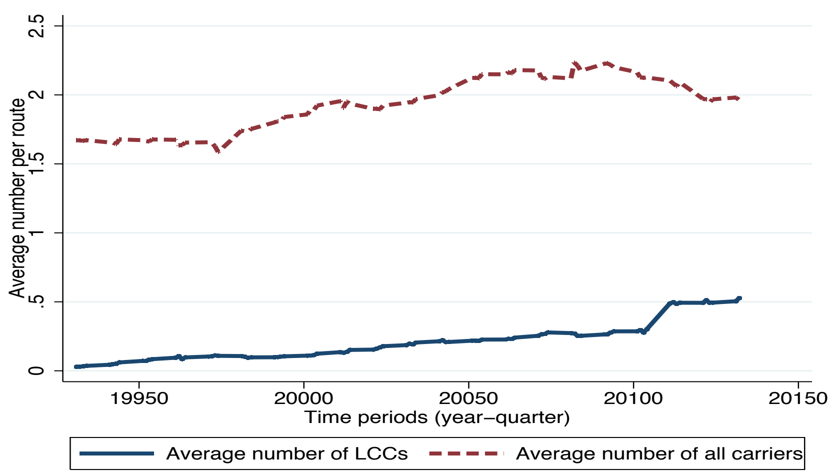


Figure 5: Industry Features: shares of routes per the number of airlines

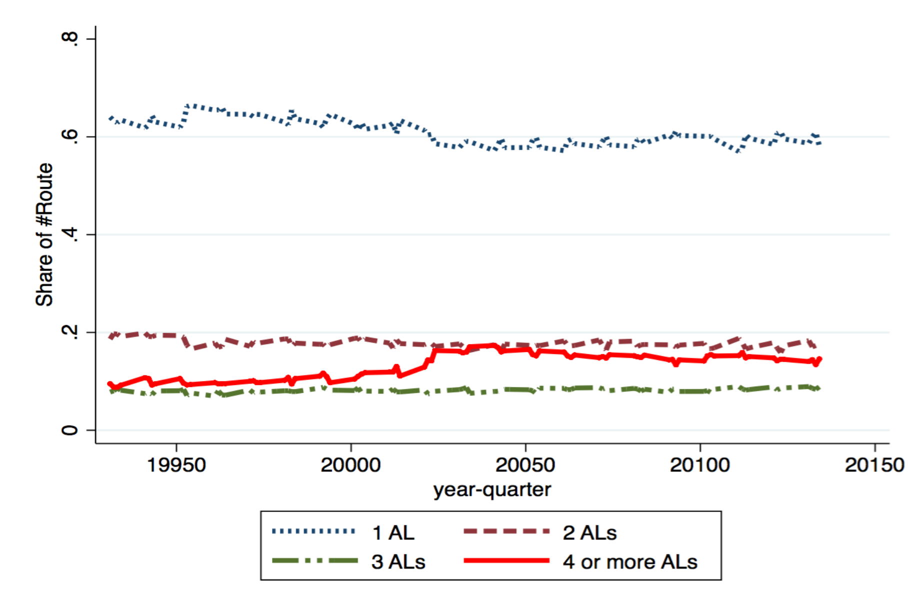


Figure 6. Entry in BC Route More Likely After United & Continental Merger

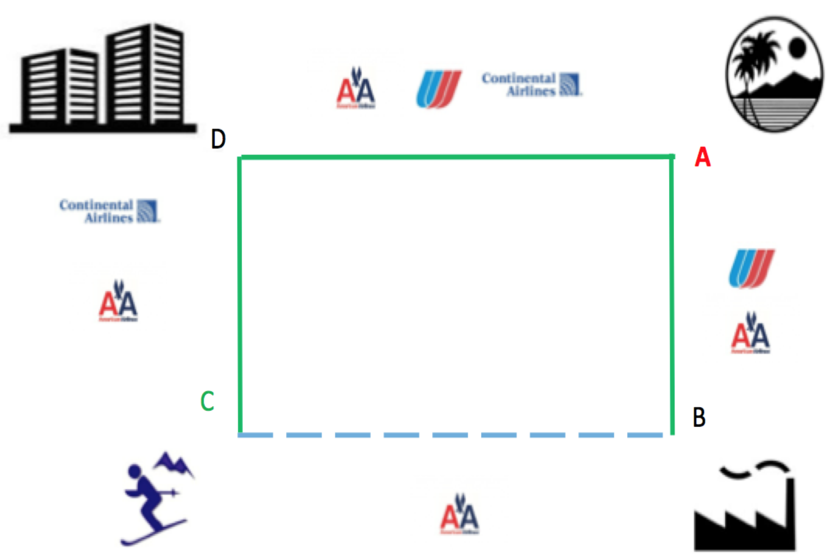
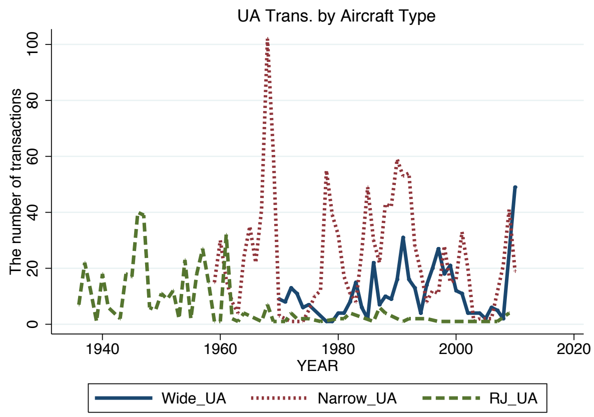
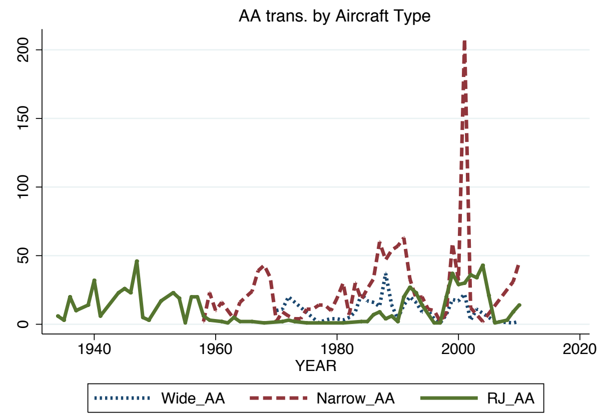


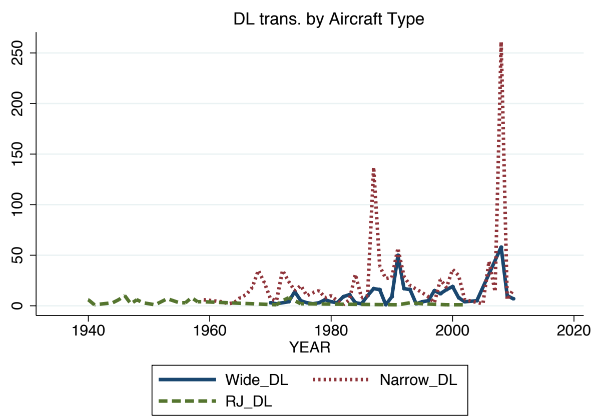
Figure 7: Transportation by Airline & Aircraft Type



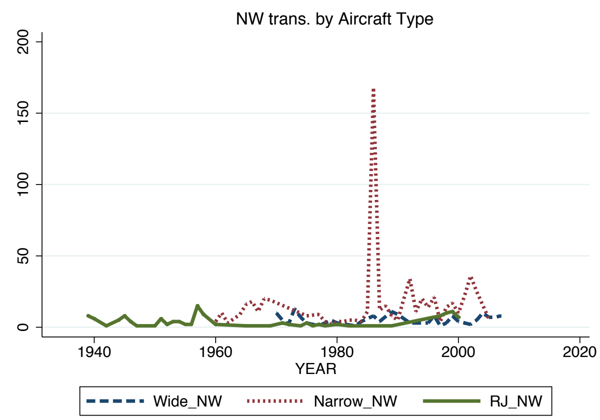
(a)



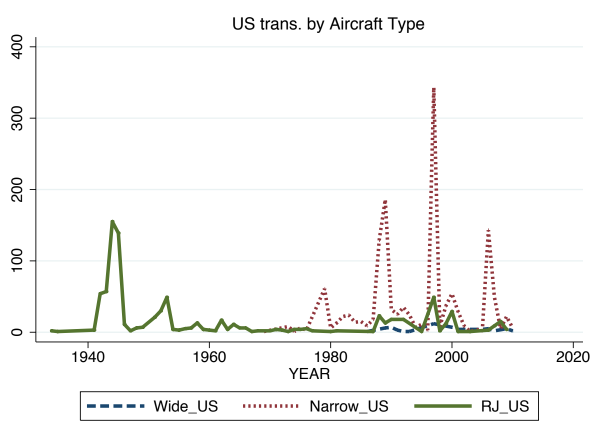
(b)



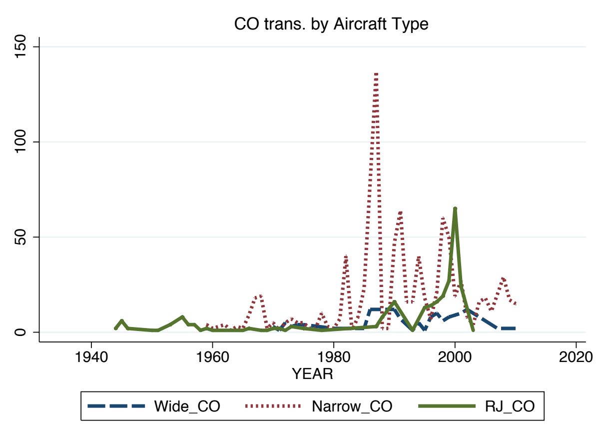
(c)



(d)



(e)



(f)

Table 1: Summary of main variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Total flights	14770	469.301	559.643	0	6847
Hubs	14770	.526	.499	0	1
Fraction of hubs	14770	.465	.0510	.291	.587
HHI	14770	.684	.242	0	1
Arrival delay	10714	5.971	6.973	-28	104
Departure delay in minute	10714	9.901	5.463	0	93.896
Arrival delay 15	10714	.204	.091	0	1
Fraction of arrival delay	10714	.207	.053	0	.313
Departure delay 15	10714	.157	.080	0	1
Fraction of departure delay	10714	.162	.0305	.095	.229
Cancellation	10714	.017	.035	0	1
Fraction of cancellation	10714	.0133	.011	0	.068

Table 2: Incumbents' response to potential entry due to mergers without slot-controlled airports, period 1993-2013

VARIABLES	(1) flights	(2) flights	(3) cancel	(4) arrdelay	(5) depdelay	(6) arrival15	(7) depart15
Merger_first_aba_8_lag	0.00	-0.00	0.02	3.25***	1.73***	0.04***	0.03***
	(0.07)	(0.07)	(0.24)	(0.52)	(0.36)	(0.01)	(0.01)
Merger_first_aba_7_lag	-0.01	-0.02	0.22	2.10***	0.89**	0.03***	0.02***
	(0.08)	(0.08)	(0.28)	(0.57)	(0.42)	(0.01)	(0.01)
Merger_first_aba_6_lag	-0.05	-0.05	0.22	2.08***	0.66	0.03***	0.02**
	(0.08)	(0.08)	(0.34)	(0.58)	(0.43)	(0.01)	(0.01)
Merger_first_aba_5_lag	-0.02	-0.03	-0.24	3.30***	0.36	0.03***	0.01
	(0.08)	(0.08)	(0.34)	(0.74)	(0.61)	(0.01)	(0.01)
Merger_first_aba_4_lag	-0.01	-0.02	-0.46	1.75**	-0.62	0.01	-0.00
	(0.11)	(0.10)	(0.47)	(0.73)	(0.54)	(0.01)	(0.01)
Merger_first_aba_3_lag	0.13	0.12	-0.56	-0.15	-1.32***	-0.01	-0.02*
	(0.10)	(0.10)	(0.49)	(0.69)	(0.50)	(0.01)	(0.01)
Merger_first_aba_2_lag	0.20*	0.20*	-0.74	-0.83	-2.08***	-0.02	-0.03***
	(0.12)	(0.11)	(0.53)	(0.80)	(0.56)	(0.01)	(0.01)
Merger_first_aba_1_lag	0.22*	0.21*	-0.18	1.19	-1.01	0.00	-0.01
	(0.12)	(0.11)	(0.58)	(0.93)	(0.70)	(0.01)	(0.01)
Merger_first_announced	0.30**	0.29**	-0.08	2.73***	-0.35	0.02*	-0.00
	(0.13)	(0.13)	(0.62)	(1.04)	(0.76)	(0.01)	(0.01)
Merger_first_aba_1_forward	0.34**	0.33**	0.00	0.88	-1.71**	-0.00	-0.03*
	(0.14)	(0.14)	(0.70)	(1.14)	(0.85)	(0.01)	(0.01)
Merger_first_aba_2_forward	0.31**	0.30**	-0.27	1.14	-1.37	-0.01	-0.03**
	(0.15)	(0.15)	(0.72)	(1.20)	(0.87)	(0.02)	(0.02)
Merger_in_both_3to12	0.31**	0.31**	-0.77	-0.87	-3.46***	-0.03	-0.05***
	(0.15)	(0.15)	(0.78)	(1.41)	(1.01)	(0.02)	(0.02)
Merger_first_on_route	-0.24	-0.24	-2.17***	-3.75***	-2.13***	-0.05***	-0.04***
	(0.15)	(0.15)	(0.52)	(0.94)	(0.55)	(0.01)	(0.01)
Merger_first_on_route_1to2	-0.19*	-0.19*	-0.08	0.13	0.71	-0.01	0.00
	(0.10)	(0.10)	(0.29)	(0.68)	(0.43)	(0.01)	(0.01)
Merger_first_on_route_3to12	-0.12	-0.12	-0.38*	-0.60	-0.29	-0.01	-0.01**
	(0.07)	(0.07)	(0.20)	(0.44)	(0.29)	(0.00)	(0.00)
Observations	13,309	13,309	9,694	9,694	9,694	9,694	9,694
R-squared	0.91	0.91	1.00	0.50	0.48	0.51	0.48
Year FE	y	y	y	y	y	y	y
Carrier-Route FE	y	y	y	y	y	y	y
Carrier-Quarter FE	y	y	y	y	y	y	y
control HHI & Hub	n	y	n	n	n	n	n
Route Carrier Clustering	y	y	y	y	y	y	y

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3: Incumbents' response to potential entry due to merger using route-quarter FE, period 1993-2013

VARIABLES	(1) flight	(2) flight	(3) cancel	(4) arrdelay	(5) depdelay	(6) arrival15	(7) depdelay15
Merger_first_aba_8_lag	0.01	0.01	0.34	3.41***	1.84***	0.04***	0.02***
	(0.08)	(0.08)	(0.29)	(0.59)	(0.40)	(0.01)	(0.01)
Merger_first_aba_7_lag	0.02	0.01	0.15	2.29***	1.02**	0.04***	0.02***
	(0.08)	(0.08)	(0.37)	(0.70)	(0.51)	(0.01)	(0.01)
Merger_first_aba_6_lag	0.02	0.02	0.24	2.01***	0.73	0.03***	0.02**
	(0.09)	(0.09)	(0.38)	(0.64)	(0.45)	(0.01)	(0.01)
Merger_first_aba_5_lag	-0.00	-0.01	0.04	3.36***	0.31	0.04***	0.01
	(0.09)	(0.08)	(0.38)	(0.91)	(0.78)	(0.01)	(0.01)
Merger_first_aba_4_lag	-0.00	-0.02	0.12	1.77**	-0.54	0.01	-0.00
	(0.12)	(0.12)	(0.55)	(0.87)	(0.63)	(0.01)	(0.01)
Merger_first_aba_3_lag	0.14	0.14	-0.83	0.12	-1.05*	-0.00	-0.01
	(0.11)	(0.11)	(0.57)	(0.80)	(0.58)	(0.01)	(0.01)
Merger_first_aba_2_lag	0.25**	0.25**	-0.78	-0.54	-1.76***	-0.01	-0.02**
	(0.13)	(0.12)	(0.59)	(0.87)	(0.57)	(0.01)	(0.01)
Merger_first_aba_1_lag	0.21	0.20	0.39	1.80*	-0.64	0.02	-0.00
	(0.13)	(0.12)	(0.61)	(0.97)	(0.73)	(0.01)	(0.01)
Merger_first_announced	0.32**	0.31**	0.19	3.37***	0.23	0.04**	0.00
	(0.16)	(0.15)	(0.69)	(1.12)	(0.80)	(0.01)	(0.01)
Merger_first_aba_1_forward	0.36**	0.35**	-0.36	1.52	-1.07	0.01	-0.02
	(0.16)	(0.16)	(0.79)	(1.21)	(0.84)	(0.02)	(0.01)
Merger_first_aba_2_forward	0.36**	0.35**	-0.29	1.72	-0.88	0.00	-0.03*
	(0.17)	(0.17)	(0.78)	(1.25)	(0.86)	(0.02)	(0.02)
Merger_in_both_3to12	0.29*	0.28	-0.61	-0.14	-2.91***	-0.01	-0.04**
	(0.17)	(0.17)	(0.88)	(1.50)	(1.06)	(0.02)	(0.02)
Merger_first_on_route	-0.34**	-0.34**	-2.36***	-3.98***	-2.12***	-0.05***	-0.03***
	(0.16)	(0.16)	(0.57)	(1.08)	(0.65)	(0.01)	(0.01)
Merger_first_on_route_1to2	-0.14	-0.14	0.15	-0.41	0.27	-0.01*	-0.00
	(0.10)	(0.10)	(0.27)	(0.65)	(0.39)	(0.01)	(0.01)
Merger_first_on_route_3to12	-0.12*	-0.12*	-0.37*	-0.72	-0.34	-0.01*	-0.01**
	(0.07)	(0.07)	(0.21)	(0.48)	(0.31)	(0.01)	(0.00)
Observations	12,330	12,330	9,592	9,592	9,592	9,592	9,592
R-squared	0.91	0.91	0.99	0.57	0.56	0.57	0.56
Year FE	y	y	y	y	y	y	y
Carrier-Route FE	y	y	y	y	y	y	y
Route-Quarter FE	y	y	y	y	y	y	y
Include HHI & hub	n	y	n	n	n	n	n
Route Carrier Clustering	y	y	y	y	y	y	y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Incumbents' response to potential entry of all LCCs without slot-controlled airports, period 1993-2013

VARIABLES	(1) flight	(2) flight	(3) cancel	(4) arrdelay	(5) depdelay	(6) arrival15	(7) depart15
LCC_first_aba_8_lag	0.07	0.08	-0.00**	0.09	-0.06	0.01	0.00
	(0.06)	(0.06)	(0.00)	(0.73)	(0.52)	(0.01)	(0.01)
LCC_first_aba_7_lag	0.16**	0.18***	-0.01***	-1.13	-0.60	-0.01	-0.01
	(0.07)	(0.07)	(0.00)	(0.83)	(0.51)	(0.01)	(0.01)
LCC_first_aba_6_lag	0.15**	0.16**	-0.01***	-2.16***	-1.83***	-0.03***	-0.03***
	(0.07)	(0.07)	(0.00)	(0.66)	(0.53)	(0.01)	(0.01)
LCC_first_aba_5_lag	0.22**	0.25***	-0.00***	-1.61**	-1.37***	-0.02**	-0.02***
	(0.09)	(0.09)	(0.00)	(0.80)	(0.52)	(0.01)	(0.01)
LCC_first_aba_4_lag	0.22**	0.25**	0.00	2.10***	1.85***	0.03***	0.03***
	(0.11)	(0.11)	(0.00)	(0.77)	(0.54)	(0.01)	(0.01)
LCC_first_aba_3_lag	0.25**	0.28**	0.00	0.50	0.56	0.00	0.01
	(0.11)	(0.11)	(0.00)	(0.61)	(0.46)	(0.01)	(0.01)
LCC_first_aba_2_lag	0.38***	0.41***	-0.01***	-1.78***	-1.87***	-0.02***	-0.03***
	(0.12)	(0.12)	(0.00)	(0.54)	(0.44)	(0.01)	(0.01)
LCC_first_aba_1_lag	0.41***	0.46***	-0.00*	-2.16***	-1.80***	-0.04***	-0.03***
	(0.13)	(0.13)	(0.00)	(0.61)	(0.46)	(0.01)	(0.01)
LCC_first_at_both_airports	0.43***	0.47***	0.00	1.08	1.01*	0.02	0.02*
	(0.15)	(0.15)	(0.00)	(0.70)	(0.59)	(0.01)	(0.01)
LCC_first_aba_1_forward	0.41**	0.46***	-0.01***	-0.21	-0.35	0.00	-0.00
	(0.16)	(0.16)	(0.00)	(1.16)	(0.89)	(0.02)	(0.02)
LCC_first_aba_2_forward	0.39**	0.45**	-0.00**	-1.36	-0.77	-0.01	-0.01
	(0.17)	(0.18)	(0.00)	(0.87)	(0.60)	(0.01)	(0.01)
LCC_in_both_3to12	0.58***	0.63***	0.00	0.71	0.62	0.01	0.01
	(0.20)	(0.20)	(0.00)	(0.75)	(0.67)	(0.01)	(0.01)
LCC_first_on_route	0.09	0.07	0.00	-0.22	-0.15	-0.01	-0.00
	(0.17)	(0.17)	(0.00)	(0.51)	(0.41)	(0.01)	(0.01)
LCC_first_on_route_1to2	0.42	0.43	0.01**	-1.16	-0.97	-0.02	-0.02
	(0.28)	(0.27)	(0.00)	(0.86)	(0.66)	(0.01)	(0.01)
LCC_first_on_route_3to12	0.09	0.09	0.01**	0.80	0.12	0.01	0.00
	(0.11)	(0.11)	(0.00)	(0.98)	(0.67)	(0.01)	(0.01)
Observations	14,770	14,770	10,714	10,713	10,714	10,713	10,714
R-squared	0.91	0.91	0.28	0.36	0.33	0.36	0.35
Year FE	y	y	y	y	y	y	y
Carrier-Route FE	y	y	y	y	y	y	y
Carrier-Quarter FE	y	y	y	y	y	y	y
Include HHI & hub	n	y	n	n	n	n	n
Route Carrier Clustering	y	y	y	y	y	y	y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Incumbents' response to potential entry of LCCs using route-quarter FE, period 1993-2013

VARIABLES	(1) flight	(2) flight	(3) cancel	(4) arrdelay	(5) depdelay	(6) arrival15	(7) depart15
LCC_first_aba_8_lag	0.07	0.07	-0.00	-0.01	-0.27	0.01	-0.00
	(0.06)	(0.06)	(0.00)	(0.65)	(0.53)	(0.01)	(0.01)
LCC_first_aba_7_lag	0.16**	0.16***	-0.01***	-1.06	-0.54	-0.01	-0.01
	(0.06)	(0.06)	(0.00)	(0.84)	(0.52)	(0.01)	(0.01)
LCC_first_aba_6_lag	0.06	0.07	-0.01***	-2.20***	-1.84***	-0.03***	-0.03***
	(0.07)	(0.07)	(0.00)	(0.76)	(0.61)	(0.01)	(0.01)
LCC_first_aba_5_lag	0.18**	0.18**	-0.00**	-1.47*	-1.18**	-0.02*	-0.02***
	(0.07)	(0.07)	(0.00)	(0.80)	(0.52)	(0.01)	(0.01)
LCC_first_aba_4_lag	0.09	0.09	0.00	2.46***	2.05***	0.04***	0.03***
	(0.10)	(0.10)	(0.00)	(0.81)	(0.56)	(0.01)	(0.01)
LCC_first_aba_3_lag	0.18*	0.18*	-0.00	0.06	0.16	-0.00	0.00
	(0.09)	(0.09)	(0.00)	(0.67)	(0.51)	(0.01)	(0.01)
LCC_first_aba_2_lag	0.27***	0.27***	-0.01***	-1.85***	-2.06***	-0.02***	-0.03***
	(0.09)	(0.09)	(0.00)	(0.60)	(0.49)	(0.01)	(0.01)
LCC_first_aba_1_lag	0.29***	0.29***	-0.00	-1.99***	-1.74***	-0.04***	-0.03***
	(0.11)	(0.11)	(0.00)	(0.64)	(0.52)	(0.01)	(0.01)
LCC_first_at_both_airports	0.24**	0.24**	0.00	1.43**	1.17*	0.02**	0.02**
	(0.12)	(0.12)	(0.00)	(0.72)	(0.60)	(0.01)	(0.01)
LCC_first_aba_1_forward	0.37***	0.37***	-0.01***	-0.83	-0.62	-0.01	-0.01
	(0.13)	(0.13)	(0.00)	(1.13)	(0.82)	(0.02)	(0.01)
LCC_first_aba_2_forward	0.27**	0.27**	-0.00	-0.84	-0.22	-0.00	0.00
	(0.13)	(0.13)	(0.00)	(0.95)	(0.61)	(0.01)	(0.01)
LCC_in_both_3to12	0.49***	0.49***	0.00	0.75	0.56	0.01	0.01
	(0.17)	(0.17)	(0.00)	(0.82)	(0.74)	(0.01)	(0.01)
LCC_first_on_route	-0.18	-0.20	0.00	-0.47	-0.24	-0.01	-0.00
	(0.15)	(0.14)	(0.00)	(0.54)	(0.42)	(0.01)	(0.01)
LCC_first_on_route_1to2	0.17	0.17	0.01**	-0.33	-0.24	-0.01	-0.01
	(0.16)	(0.16)	(0.00)	(0.90)	(0.71)	(0.02)	(0.01)
LCC_first_on_route_3to12	0.06	0.06	0.01*	1.00	0.37	0.01	0.01
	(0.11)	(0.11)	(0.00)	(0.89)	(0.59)	(0.01)	(0.01)
Observations	11,375	11,375	10,677	10,676	10,677	10,676	10,677
R-squared	0.92	0.92	0.34	0.41	0.39	0.41	0.41
Year FE	y	y	y	y	y	y	y
Carrier-Route FE	y	y	y	y	y	y	y
Route-Quarter FE	y	y	y	y	y	y	y
Include HHI & hub	n	y	n	n	n	n	n
Route Carrier Clustering	y	y	y	y	y	y	y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Incumbents' response to potential entry due to mergers and of LCCs, period 1993-2013

VARIABLES	(1) ln_aveP	(2) ln_aveP	(3) ln_aveP	(4) ln_aveP
LCC_first_aba_8_lag	0.03	0.31	0.21	-0.07
	(0.04)	(0.22)	(0.16)	(0.09)
LCC_first_aba_7_lag	-0.04	-0.06	0.13	0.05
	(0.04)	(0.19)	(0.29)	(0.10)
LCC_first_aba_6_lag	0.03	-0.04	0.35	0.21**
	(0.04)	(0.22)	(0.31)	(0.10)
LCC_first_aba_5_lag	0.01	0.04	0.19	0.15
	(0.04)	(0.22)	(0.32)	(0.11)
LCC_first_aba_4_lag	-0.04	0.04	0.30	0.13
	(0.04)	(0.25)	(0.34)	(0.12)
LCC_first_aba_3_lag	0.01	-0.19	-0.05	0.11
	(0.04)	(0.25)	(0.32)	(0.13)
LCC_first_aba_2_lag	0.07	-0.13	0.14	0.11
	(0.04)	(0.27)	(0.34)	(0.15)
LCC_first_aba_1_lag	0.07	0.08	-0.12	-0.01
	(0.04)	(0.26)	(0.33)	(0.16)
LCC_first_at_both_airports	0.04	0.24	0.23	0.15
	(0.04)	(0.30)	(0.45)	(0.16)
LCC_first_aba_1_forward	0.03	0.31	0.64	0.16
	(0.04)	(0.40)	(0.47)	(0.19)
LCC_first_aba_2_forward	-0.02	-0.04	0.80	0.11
	(0.04)	(0.34)	(0.63)	(0.21)
LCC_in_both_3to12	0.02	0.31	0.71	0.18
	(0.03)	(0.42)	(0.45)	(0.24)
LCC_first_on_route	-0.01	-0.08	-0.07	-0.10
	(0.07)	(0.09)	(0.12)	(0.18)
LCC_first_on_route_1to2	-0.02	-0.15	-0.12	-0.11
	(0.04)	(0.21)	(0.13)	(0.18)
LCC_first_on_route_3to12	0.02	-0.18*	0.11	0.01
	(0.03)	(0.10)	(0.11)	(0.12)
Observations	14,276	5,718	6,504	14,225
R-squared	0.02	0.62	0.59	0.31
Year FE	y	y	y	y
Carrier-Route FE	y	y	y	y
Carrier-Quarter FE	y	y	y	y
Route Carrier Clustering	y	y	y	y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(1) Incumbents' response to potential entry due to mergers
(2) Incumbents' response to potential entry of SW
(3) Incumbents' response to potential entry of SW, JetBlue, and Spirit
(4) Incumbents' response to potential entry of all LCCs

Table 7: Incumbents' response to potential entry due to mergers and of LCCs, period 1993-2013

VARIABLES	(1) ln_loadfactor	(2) ln_loadfactor	(3) ln_loadfactor	(4) ln_loadfactor
LCC_first_aba_8_lag	0.12	-0.49	0.02	-0.04
	(0.11)	(0.39)	(0.26)	(0.06)
LCC_first_aba_7_lag	-0.06	-0.06	0.10	-0.03
	(0.12)	(0.55)	(0.72)	(0.07)
LCC_first_aba_6_lag	-0.25**	-0.35	0.24	-0.10
	(0.12)	(0.71)	(0.72)	(0.07)
LCC_first_aba_5_lag	-0.09	-0.18	0.11	-0.05
	(0.12)	(0.53)	(0.75)	(0.09)
LCC_first_aba_4_lag	-0.33**	-0.06	0.12	-0.18*
	(0.13)	(0.60)	(0.77)	(0.09)
LCC_first_aba_3_lag	-0.06	0.41	1.32	-0.14
	(0.12)	(0.48)	(0.83)	(0.11)
LCC_first_aba_2_lag	-0.35***	0.53	1.36	-0.25**
	(0.12)	(0.54)	(0.92)	(0.12)
LCC_first_aba_1_lag	-0.19	0.30	1.11	-0.29**
	(0.12)	(0.50)	(0.93)	(0.13)
LCC_first_at_both_airports	-0.10	0.06	1.34	-0.28**
	(0.12)	(0.57)	(0.94)	(0.14)
LCC_first_aba_1_forward	-0.42***	0.19	1.09	-0.27
	(0.12)	(0.55)	(0.98)	(0.17)
LCC_first_aba_2_forward	-0.32***	0.43	1.90	-0.26
	(0.12)	(0.74)	(1.19)	(0.18)
LCC_in_both_3to12	-0.42***	0.73	2.22*	-0.34
	(0.10)	(0.61)	(1.20)	(0.21)
LCC_first_on_route	1.04***	0.32**	0.06	-0.07
	(0.25)	(0.13)	(0.14)	(0.15)
LCC_first_on_route_1to2	0.06	-0.75***	-0.30**	-0.50**
	(0.14)	(0.17)	(0.14)	(0.26)
LCC_first_on_route_3to12	0.08	0.10	-0.03	-0.07
	(0.10)	(0.11)	(0.13)	(0.10)
Observations	14,355	6,632	7,571	14,140
R-squared	0.04	0.89	0.90	0.87
Year FE	y	y	y	y
Carrier-Route FE	y	y	y	y
Carrier-Quarter FE	y	y	y	y
Route Carrier Clustering	y	y	y	y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(1) Incumbents' response to potential entry due to mergers
(2) Incumbents' response to potential entry of SW
(3) Incumbents' response to potential entry of SW, JetBlue, and Spirit
(4) Incumbents' response to potential entry of all LCCs

Table 8: Incumbents' response to potential entry due to mergers and of LCCs, period 1993-2013

VARIABLES	(1) ln_ticketsales_r	(2) ln_ticketsales_r	(3) ln_ticketsales_r	(4) ln_ticketsales_r
LCC_first_aba_8_lag	-0.01	0.32	0.14	0.09
	(0.06)	(0.23)	(0.24)	(0.10)
LCC_first_aba_7_lag	-0.15*	0.13	-0.13	0.19*
	(0.08)	(0.41)	(0.40)	(0.11)
LCC_first_aba_6_lag	-0.15*	-0.10	-0.00	-0.02
	(0.08)	(0.42)	(0.42)	(0.11)
LCC_first_aba_5_lag	-0.12*	0.07	-0.16	-0.08
	(0.07)	(0.39)	(0.42)	(0.12)
LCC_first_aba_4_lag	-0.29***	-0.04	0.15	0.12
	(0.09)	(0.46)	(0.51)	(0.14)
LCC_first_aba_3_lag	-0.08	0.93*	0.75	0.17
	(0.09)	(0.50)	(0.58)	(0.15)
LCC_first_aba_2_lag	-0.07	0.83*	1.32**	0.07
	(0.10)	(0.49)	(0.59)	(0.16)
LCC_first_aba_1_lag	-0.04	0.27	0.69	-0.02
	(0.09)	(0.46)	(0.58)	(0.18)
LCC_first_at_both_airports	0.01	0.36	0.89	0.00
	(0.10)	(0.53)	(0.67)	(0.20)
LCC_first_aba_1_forward	-0.16	0.84	1.37	0.08
	(0.12)	(0.73)	(0.85)	(0.23)
LCC_first_aba_2_forward	-0.15	0.06	1.14	0.21
	(0.12)	(0.73)	(0.93)	(0.23)
LCC_in_both_3to12	-0.21	1.34**	2.03**	0.29
	(0.14)	(0.65)	(0.89)	(0.28)
LCC_first_on_route	-0.11	0.30***	0.11	0.26
	(0.12)	(0.11)	(0.15)	(0.16)
LCC_first_on_route_1to2	0.11	-0.02	-0.33*	-0.30*
	(0.11)	(0.17)	(0.17)	(0.17)
LCC_first_on_route_3to12	0.15*	-0.16	-0.21*	-0.22*
	(0.08)	(0.10)	(0.12)	(0.13)
Observations	10,812	6,238	7,088	10,520
R-squared	0.72	0.91	0.90	0.80
Year FE	y	y	y	y
Route-Quarter FE	y	y	y	y
Route Clustering	y	y	y	y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(1) Incumbents' response to potential entry due to mergers
(2) Incumbents' response to potential entry of SW
(3) Incumbents' response to potential entry of SW, JetBlue, and Spirit
(4) Incumbents' response to potential entry of all LCCs

Table 9A: Probability of SW's entry into a route in 1993-2013

SW in one endpoint airport in the previous quarter	SW in both endpoint airports in the previous quarter
0.0665 (0.0005)	0.3458 (0.0009)
N= 259,954	N= 259,954
including Quarter f.e.	including Quarter f.e.

Robust standard errors in parentheses
similar to the Table 1 in Goolsbee & Syverson (2008)

Table 9B: Probability of entry of SW, JetBlue, and Spirit into a route in 1993-2013

3 LCCs in one endpoint airport in the previous quarter	3 LCCs in both endpoint airports in the previous quarter
0.0203 (0.0004)	0.3156 (0.0008)
N= 312,139	N= 312,139
including Quarter f.e.	including Quarter f.e.

Robust standard errors in parentheses
similar to the Table 1 in Goolsbee & Syverson (2008)

Table 9C: Probability of all LCCs' entry into a route in 1993-2013

LCCs in one endpoint airport in the previous quarter	LCCs in both endpoint airports in the previous quarter
0.0368 (0.0003)	0.2415 (0.0005)
N= 612,273	N= 612,273
including Quarter f.e.	including Quarter f.e.

Robust standard errors in parentheses
similar to the Table 1 in Goolsbee & Syverson (2008)

Table 10: comparison to PS

VARIABLES	(1) arrdelay	(2) arrdelay	(3) arrdelay	(4) arrdelay	(5) arrdelay	(6) arrdelay	(7) arrdelay	(8) arrdelay
wn_both_ends_entry_fq8	1.087***	0.780*	0.690*	0.566	-1.959	-0.363	-0.207	0.093
	(0.380)	(0.401)	(0.414)	(0.616)	(1.520)	(1.066)	(0.754)	(0.732)
wn_both_ends_entry_fq7	0.975**	0.886**	0.654	1.370***	-2.125	-0.097	-1.420*	-1.129
	(0.378)	(0.445)	(0.484)	(0.482)	(1.415)	(0.817)	(0.823)	(0.825)
wn_both_ends_entry_fq6	0.789**	0.733*	0.430	1.452**	0.093	-1.910*	-1.745***	-2.163***
	(0.383)	(0.437)	(0.479)	(0.632)	(1.947)	(1.031)	(0.669)	(0.658)
wn_both_ends_entry_fq5	0.387	-0.048	-0.264	0.589	-1.649	-0.872	-1.106	-1.610**
	(0.384)	(0.439)	(0.482)	(0.642)	(1.785)	(1.045)	(0.792)	(0.799)
wn_both_ends_entry_fq4	0.627	0.345	0.168	0.969	0.722	-1.541	1.994**	2.100***
	(0.447)	(0.523)	(0.579)	(0.646)	(2.609)	(1.480)	(0.795)	(0.770)
wn_both_ends_entry_fq3	1.029*	0.636	0.404	0.285	-1.409	0.061	0.182	0.498
	(0.550)	(0.655)	(0.699)	(0.769)	(2.420)	(1.380)	(0.595)	(0.614)
wn_both_ends_entry_fq2	1.209**	1.071*	0.763	1.355*	-0.972	-1.030	-1.534***	-1.781***
	(0.570)	(0.612)	(0.642)	(0.749)	(2.831)	(1.417)	(0.524)	(0.543)
wn_both_ends_entry_fq1	1.250**	0.829	0.594	1.209	-0.599	-0.302	-1.953***	-2.157***
	(0.585)	(0.653)	(0.660)	(0.811)	(3.068)	(1.648)	(0.596)	(0.607)
wn_both_ends_entry	1.356**	0.606	0.588	1.173	0.859	-0.786	0.975	1.077
	(0.667)	(0.701)	(0.715)	(0.831)	(3.801)	(1.986)	(0.673)	(0.700)
wn_both_ends_entry_lq1	0.408	-0.131	-0.018	0.579	-0.728	-0.468	-0.120	-0.211
	(0.705)	(0.827)	(0.835)	(0.965)	(4.768)	(2.548)	(1.083)	(1.161)
wn_both_ends_entry_lq2	0.402	-0.202	-0.021	1.164	1.333	-0.983	-1.025	-1.357
	(0.726)	(0.884)	(0.916)	(1.073)	(4.764)	(2.802)	(0.836)	(0.866)
wn_both_ends_entry_lq312	1.190	0.532	0.802	1.832	0.071	-0.849	0.836	0.705
	(0.769)	(0.910)	(0.944)	(1.164)	(5.618)	(3.132)	(0.683)	(0.748)
sw_entry	1.171	0.616	0.769	1.599	-0.907	0.063	0.871	-0.224
	(0.753)	(0.856)	(0.885)	(1.010)	(1.441)	(1.191)	(0.829)	(0.510)
sw_entry_lq1	1.831**	1.293	1.427	2.117*				
	(0.787)	(0.923)	(0.937)	(1.199)				
sw_entry_lq2	1.452*	0.986	1.202	2.090				
	(0.871)	(0.954)	(0.967)	(1.491)				
sw_entry_lq1to2					1.040	0.831	-1.443	-1.159
					(1.420)	(0.969)	(0.882)	(0.855)
sw_entry_lq312	1.744*	0.916	1.264	2.435*	0.844	0.946	0.888	0.801
	(0.894)	(1.035)	(1.073)	(1.305)	(1.782)	(0.980)	(1.025)	(0.985)
load_factor	7.013***	6.559***						
	(1.231)	(1.527)						
lnflights_origin	2.044***	2.908***						
	(0.755)	(0.917)						
lnflights_dest	0.223	0.453						
	(0.779)	(0.908)						
departures_carrier_route	-0.001	-0.001						
	(0.001)	(0.002)						
Observations	4,821	3,268	3,268	3,268	1,396	1,618	7,491	10,713
R-squared	0.586	0.553	0.455	0.300	0.774	0.830	0.365	0.358
carrier_yearquarter FE	y	y	y	n	n	n	n	n
carrier_quarter FE	n	n	n	y	y	y	y	y
carrier_route FE	y	y	y	y	y	y	y	y
Year FE	n	n	n	y	y	y	y	y
Clustered s.e. carrier_route	y	y	y	y	y	y	y	y
Airlines	all	only major	only major	only major	only major	only major	only major	only major
time period	1993-2004	1993-2004	1993-2004	1993-2004	1993-2004	1993-2004	1993-2004	1993-2013

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Interaction with OTP in all connected routes of each airline

VARIABLES	(1) cancel	(2) arrdelay	(3) depdelay	(4) arrival15	(5) depart15
LCC_first_aba_8_lag	-0.002	-0.762	-0.450	-0.004	-0.006
	(0.001)	(0.633)	(0.360)	(0.008)	(0.007)
LCC_first_aba_7_lag	-0.006***	-0.560	-0.613	-0.005	-0.007
	(0.001)	(0.765)	(0.518)	(0.011)	(0.009)
LCC_first_aba_6_lag	-0.010***	-2.157***	-2.448***	-0.034***	-0.038***
	(0.002)	(0.588)	(0.540)	(0.009)	(0.009)
LCC_first_aba_5_lag	-0.003**	-0.689	-1.228**	-0.012	-0.019**
	(0.001)	(0.729)	(0.492)	(0.010)	(0.008)
LCC_first_aba_4_lag	-0.003	-5.111***	-4.355***	-0.146***	-0.080***
	(0.002)	(1.220)	(1.152)	(0.030)	(0.017)
LCC_first_aba_3_lag	-0.006***	-3.639***	-4.886***	-0.139***	-0.090***
	(0.002)	(1.057)	(1.009)	(0.023)	(0.018)
LCC_first_aba_2_lag	-0.012***	-3.652***	-4.222***	-0.124***	-0.092***
	(0.002)	(0.900)	(0.867)	(0.026)	(0.017)
LCC_first_aba_1_lag	-0.002	-4.694***	-5.895***	-0.165***	-0.093***
	(0.002)	(0.886)	(1.041)	(0.019)	(0.018)
LCC_first_at_both_airports	-0.007*	-4.948***	-5.816***	-0.149***	-0.099***
	(0.004)	(1.241)	(1.300)	(0.030)	(0.023)
LCC_first_aba_1_forward	-0.007***	-1.932	-3.217*	-0.068**	-0.067***
	(0.002)	(1.329)	(1.828)	(0.034)	(0.026)
LCC_first_aba_2_forward	-0.004**	-5.322***	-4.787***	-0.061	-0.086***
	(0.002)	(1.422)	(1.214)	(0.039)	(0.025)
LCC_in_both_3to12	-0.005**	-6.016***	-6.344***	-0.091*	-0.098***
	(0.002)	(1.377)	(1.257)	(0.051)	(0.025)
LCC_first_on_route	-0.005***	-2.930***	-1.470	-0.049**	-0.036*
	(0.002)	(0.875)	(1.928)	(0.020)	(0.022)
LCC_first_on_route_1to2	0.007***	0.780	0.416	0.013	0.013
	(0.002)	(1.189)	(0.891)	(0.018)	(0.014)
LCC_first_on_route_3to12	-0.001	0.476	-0.184	0.016	0.002
	(0.003)	(0.984)	(0.669)	(0.015)	(0.012)
connect4lag	0.269***	0.863***	0.592***	0.777***	0.622***
	(0.091)	(0.127)	(0.111)	(0.120)	(0.088)
connect3lag	0.355**	0.690***	0.578***	0.694***	0.592***
	(0.169)	(0.139)	(0.108)	(0.105)	(0.111)
connect2lag	0.573***	0.335**	0.222**	0.547***	0.454***
	(0.138)	(0.134)	(0.100)	(0.131)	(0.132)
connect1lag	-0.072	0.588***	0.548***	0.733***	0.519***
	(0.112)	(0.114)	(0.160)	(0.088)	(0.145)
connectboth	0.447***	0.724***	0.650***	0.690***	0.641***
	(0.130)	(0.106)	(0.119)	(0.110)	(0.113)
connect1forward	-0.142	0.206	0.281	0.338*	0.422**
	(0.123)	(0.162)	(0.244)	(0.173)	(0.176)
connect2forward	0.293	0.641***	0.442***	0.262	0.509***
	(0.232)	(0.174)	(0.129)	(0.197)	(0.179)
connectboth3to12	0.511***	0.835***	0.700***	0.446**	0.652***
	(0.121)	(0.144)	(0.091)	(0.205)	(0.110)
connectentry	0.586***	0.367***	0.142	0.211**	0.228**
	(0.137)	(0.106)	(0.178)	(0.083)	(0.111)
Observations	8,504	8,503	8,504	8,503	8,504
R-squared	0.346	0.396	0.362	0.401	0.384
carrier_quarter FE	y	y	y	y	y
carrier_route FE	y	y	y	y	y
Year FE	y	y	y	y	y
Clustered s.e. carrier_route	y	y	y	y	y

*** p<0.01, ** p<0.05, * p<0.1; Only major airlines between 1993-2013

Table 12: On time performance in all connected routes of each airline with average delay variables of connecting routes as dependent variables

VARIABLES	(1) cancel	(2) arrdelay	(3) depdelay	(4) arrival15	(5) depart15
LCC_first_aba_8_lag	-0.005***	-1.230**	-0.989**	-0.013*	-0.014**
	(0.001)	(0.513)	(0.470)	(0.007)	(0.007)
LCC_first_aba_7_lag	-0.006***	-2.005**	-0.837	-0.026**	-0.014
	(0.002)	(0.842)	(0.616)	(0.012)	(0.010)
LCC_first_aba_6_lag	-0.008***	-2.435***	-2.220***	-0.035***	-0.034***
	(0.002)	(0.780)	(0.615)	(0.012)	(0.009)
LCC_first_aba_5_lag	-0.004**	-1.863**	-1.438**	-0.026**	-0.023**
	(0.002)	(0.857)	(0.653)	(0.012)	(0.009)
LCC_first_aba_4_lag	0.009***	1.628*	1.577**	0.019	0.023**
	(0.003)	(0.878)	(0.687)	(0.012)	(0.010)
LCC_first_aba_3_lag	-0.002*	0.775	0.683	-0.003	0.005
	(0.001)	(0.676)	(0.672)	(0.010)	(0.010)
LCC_first_aba_2_lag	-0.006***	-2.031**	-1.694*	-0.029**	-0.026**
	(0.002)	(0.892)	(0.980)	(0.012)	(0.012)
LCC_first_aba_1_lag	-0.000	-2.257***	-1.406**	-0.039***	-0.025***
	(0.001)	(0.648)	(0.673)	(0.010)	(0.010)
LCC_first_at_both_airports	0.005***	1.272*	1.620**	0.015	0.026**
	(0.002)	(0.753)	(0.742)	(0.011)	(0.011)
LCC_first_aba_1_forward	-0.008***	-2.007***	-1.482**	-0.028**	-0.023**
	(0.002)	(0.669)	(0.620)	(0.012)	(0.010)
LCC_first_aba_2_forward	-0.004**	-0.925	-0.709	-0.002	-0.010
	(0.002)	(0.807)	(0.705)	(0.013)	(0.011)
LCC_in_both_3to12	-0.002	0.806	0.598	0.018	0.011
	(0.002)	(0.734)	(0.848)	(0.011)	(0.011)
LCC_first_on_route	0.001	-0.841	-0.750	0.003	0.001
	(0.001)	(0.546)	(0.518)	(0.009)	(0.006)
LCC_first_on_route_1to2	0.011***	-0.086	-0.724	0.006	-0.007
	(0.002)	(1.222)	(1.009)	(0.021)	(0.018)
LCC_first_on_route_3to12	0.010*	0.657	-0.318	0.005	-0.003
	(0.005)	(0.977)	(0.854)	(0.014)	(0.013)
Observations	8,504	8,503	8,504	8,503	8,504
R-squared	0.352	0.414	0.378	0.399	0.409
carrier_quarter FE	y	y	y	y	y
carrier_route FE	y	y	y	y	y
Year FE	y	y	y	y	y
Clustered s.e. carrier_route	y	y	y	y	y
Airlines	Major ALs	Major ALs	Major ALs	Major ALs	Major ALs
time period	1993-2013	1993-2013	1993-2013	1993-2013	1993-2013

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1