THE EFFECT OF THE INTERNET ON PRODUCT QUALITY IN THE AIRLINE INDUSTRY[1]

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Abstract

This paper studies the relationship between Internet access and measures of flight quality, represented by flight delays and elapsed flight times. Using flight-level data and measures of Internet penetration in U.S. metropolitan statistical areas between 1997 and 2007, we find that arrival delays are substantially longer among flights whose passengers originate from areas with greater Internet access. The increases in arrival delays occur despite increases in airlines' scheduled flight times, and are driven by longer departure delays and longer flight times. The magnitudes of these changes are larger in more competitive flight segments. These results lend support to theoretical search models that suggest that firms engaging in price competition may choose to lower the quality of the goods they offer. In addition, the results suggest that the growth of on-line distribution channels has changed how airlines compete, shifting the focus from competition on elapsed scheduled time to price competition. We provide additional evidence to support these claims.

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I. INTRODUCTION

Internet access provides consumers with information about product prices and makes it easier for them to compare prices across different merchants. The empirical literature has typically found that higher Internet usage and improvements in information lead to lower prices and exacerbate price competition among firms (e.g. Brown and Goolsbee, 2002; Jensen, 2007). This change in the competitive landscape is likely to have a negative effect on firms' margins, thereby raising the question of whether and how firms respond (Ellison and Ellison, 2009). Our paper addresses this question by exploring the effect of increased Internet usage on product quality.

The theoretical literature offers mixed predictions about the effect of lower search costs or increased Internet access on product quality. On the one hand, firms may not be able to maintain the same level of product quality as search costs diminish and margins fall. As Internet usage increases, firms begin to compete on the observable dimension of price, both at the expense of their own profits and at the expense of the less observable and less salient measures of the quality of their products (Rogerson, 1988). On the other hand, consumers who use the Internet find it easier to gather and compare information on product quality. According to a survey by Forrester Research,[2] 86% of respondents take into account product ratings and reviews when making online purchases. Thus, firms may have greater incentives to provide better quality when search costs fall (Dranove and Satterthwaite, 1992). In addition, increased competition on the price dimension might induce firms to differentiate themselves and compete on other product dimensions, including measures of product quality. This paper investigates which of these two effects dominates in the context of the U.S. airline industry. We are not aware of previous empirical studies that examine the relationship between product quality and Internet access or search costs in general.

The U.S. airline industry provides a natural setting for examining the effect of the Internet on product quality. This industry experienced dramatic changes in the past 15 years as the Internet became the most common channel for purchasing airline tickets. In 1997 only 0.5% of airline tickets were purchased online, whereas in 2007 between 50% and 60% of tickets were purchased online (Berry and Jia, 2010). Previous research has also shown that Internet usage is strongly associated with lower airfares (e.g. Orlov, 2011), and that over 35% of traditional brick-

[2] ComputerWeekly.com, November 10, 2010.

and-mortar travel agencies exited their markets between 1997 and 2003 as more air passengers began to use the Internet to purchase airline tickets (Goldmanis et al., 2010).

As Internet penetration across the U.S. has increased, statistics on flight delays and on-time performance have become more readily available to passengers through various sources, such as online media sources, online travel agencies and the U.S. Department of Transportation website.[3] Flight delays and on-time performance are considered important attributes of flight quality by passengers, regulators, industry experts and airlines. For instance, Forbes (2008) finds a positive relationship between the number of passenger complaints and the number of delays. Bowen and Headley (2011), in their "Airline Quality Rating" series, devise a quality metric composed mostly of flight delay rates and factors that are exacerbated by delayed flights (e.g., customer complaints, lost baggage). Finally, airlines acknowledge the importance of these measures, are quick to announce improvements in these areas,[4] and adopt employee bonus programs to reward on-time performance (Forbes, Lederman and Tombe, 2010). Accordingly, we adopt flight delay, i.e., the number of minutes a flight arrives after its scheduled arrival time, as a primary measure for flight quality.

We use several sources of flight-level data for the years 1997–2007 to examine whether flights on which passengers were more likely to have purchased their airfares online experienced longer or shorter delays. We exploit three main sources of variation in the data in order to identify the effect of Internet access on flight delays: (1) differences in Internet penetration over time; (2) differences in Internet penetration across geographical locations; and (3) differences in competition levels across flight segments (*flight segment* refers to a directional non-stop route between two airports). These sources of variation allow us to (a) estimate differences-in-differences regressions for the marginal effect of Internet penetration on flight delays, and (b) investigate whether the size of the effect varies across flight segments with different market structures. By incorporating various measures of congestion at the flight and the airport levels and a rich set of fixed effects, we believe that we are able to identify the impact of the Internet on the measures we use for product quality.

Airlines can reduce delays either by scheduling longer flights or, alternatively, by reducing actual flight times (i.e., the amount of time between the scheduled departure and the

[3] The U.S. Department of Transportation publishes monthly statistics on airlines' on-time performance. A flight is "on-time" if it arrives no more than 15 minutes after its scheduled arrival time.
[4] For instance, see United's press release at http://www.united.com/press/detail/0,7056,61642-1,00.html.

actual arrival), for example, by increasing the number of check-in counters, by keeping reserve aircrafts or by introducing employee incentive schemes. The richness of our data allows us to explore the sources of the changes in flight delays by investigating the relationship between Internet access and measures of both *actual* and *scheduled* flight times. We consider these measures as additional indications of flight quality.

Our findings indicate that flights with higher percentages of passengers who originated from areas with higher Internet penetration experienced substantially longer arrival delays. These flight delays occurred mainly because of longer actual flight times, primarily due to longer departure delays. We also find that airlines increased scheduled elapsed flight times (i.e., the amount of time between the scheduled departure and the scheduled arrival) for flights on which larger shares of passengers originated from areas with higher Internet penetration. This increase, however, did not fully compensate for the increase in actual flight times. Our estimates indicate that the adverse effect of the Internet on flight quality is most pronounced among competitive flight segments. For instance, we find that, *ceteris paribus*, an increase of 0.1 in Internet penetration among the passengers on a given flight (reflected in the share of households with Internet access at the areas where passengers' trips originate) is associated with increases of between 0.4 and 1 minutes in the arrival delay, and between 2.2 and 12.4 minutes in the actual flight time, depending on the level of competition in the particular flight segment.

Overall, these findings lend support to theoretical search models that show that product quality deteriorates as search costs and product prices fall. As price competition intensifies, airlines choose to cut back on costly resources, such as crew and ground employees, which are needed to obtain better flight quality. When we also include the mean airfare as a regressor, controlling for potential endogeneity, we find evidence that delays and elapsed flight times increased more as airfares fell. This finding provides additional support for these search models.

The large estimated effect of the Internet on measures of flight quality, particularly among competitive flight segments, may suggest that there is an additional channel through which the Internet affects airlines' scheduling decisions and flight delays. We propose that the rise of online distribution channels, where passengers typically sort flights based on price, and the declining role of brick-and-mortar travel agencies, where flights were typically sorted based on scheduled elapsed time, might further explain the patterns we find. In other words, the Internet has changed how airlines compete for passengers in the airline industry, shifting it from an environment in which airlines would try to appear at the top of travel agents' computer screens by scheduling the shortest flights, to an environment where price plays the dominant role in selling tickets and scheduled time is not as important. The effect of this shift is likely to be most pronounced among competitive flight segments, which is consistent with our findings. In the paper, we discuss the implications of this potential change in the "mode of competition" and provide additional supporting evidence for its existence. For example, we show that the changes in elapsed scheduled time are considerably larger for the flights with the fastest scheduled time compared to other flights on the same segment. In addition, we show that the positive relationship between Internet access and scheduled flight times exists only in segments in which no low-cost carrier operates. This may suggest that in segments in which a low-cost carrier operates, legacy carriers are not particularly concerned with achieving short scheduled times because price is already the main competitive feature.

The paper proceeds as follows. In Section II we discuss the related literature, and in Section III we discuss potential channels through which Internet access might affect our measures of flight quality. In Sections IV and V we describe our data sources and present the empirical specification and the results. In Section VI we discuss our results. We conclude in Section VII.

II. THE RELATED LITERATURE

Our study builds on theoretical papers that examine the relationship between search costs and product quality. These papers have shown that prices might be used to signal the quality of goods, where higher prices signal a higher quality of goods (Wolinsky, 1983; Schwartz and Wilde, 1983). Rogerson (1988) studies the effect of price advertising on service quality and shows that product quality is likely to fall once consumers' search costs for finding lower prices decrease. Dranove and Satterthwaite (1992), however, provide mixed predictions regarding the effect of lower search costs on product quality, and Spiegler (2006) shows that increased price competition as search costs fall could lead to higher product quality. Notably, we are not aware of empirical papers that examine the effect of lower search costs on product quality or, more directly, that test the relationship between Internet access and product quality.

The economic literature on the effect of the Internet on the operation of markets mainly focuses on price levels and price dispersion (Ellison and Ellison, 2005). In the context of the airline industry, Clemons, Hann and Hitt (2002) find that prices available from online travel agencies are dispersed similarly to those available from traditional offline travel agents. Sengupta and Wiggins (2007) demonstrate that tickets sold online have lower average prices and that increases in the share of tickets purchased online imply lower offline fares and lower price dispersion. Finally, Orlov(2011) shows that increases in Internet access are associated with decreases in airfares and in fare dispersion.

Only a few papers have empirically examined how firms respond to the increased capability of consumers to compare prices. Ellison and Ellison (2009) illustrate how firms adopt obfuscation strategies that frustrate consumer search, thereby reducing consumer price sensitivity for certain products. Other papers, such as those of Scott Morton (2005), Brynjolfsson, Hu and Smith (2003) and Ghose, Smith and Telang (2006), have shown that the Internet facilitates better matching between firms' products and consumer tastes.[5]

Another related strand of theoretical literature examines the relationship between product quality and the competitive structure. Swan (1970) argues that market structure and quality are unrelated. Schmalensee (1979) argues that the theoretical relationship depends on specific assumptions, and Gal-Or (1983) shows that both prices and product quality might fall as more firms enter a market. Despite these inconclusive theoretical results on the relationship between product quality and competition, the empirical evidence suggests that quality is higher in more competitive environments. A recent example is Matsa's (2011) study on the impact of competition on product quality in the supermarket industry. He finds strong evidence that stores facing more local competition, measured by the number of neighboring stores, have fewer shortfalls in product availability, the measure he uses for product quality. Other studies also found a positive relationship between product quality and competition. Olivares and Cachon (2009) find that General Motors dealers facing larger numbers of rivals carry larger inventories. Finally, in the context of the airline industry, Mazzeo (2003) and Rupp, Owens and Plumly (2006) use a cross-section of flights and find that on-time performance is better in more competitive environments.[6]

[5] Other papers that examine the effect of Internet availability on consumers and focus on non-price attributes include: Dana and Orlov (2010), who provide evidence that changes in Internet penetration can explain a large part of the significant increases in airline capacity utilization; Ghose, Telang and Krishnan (2005), who show that Internet access increases the resale value of new products; and Forman, Ghose and Goldfarb (2009), who offer evidence that use of the Internet is associated with lower consumer travel and transportation costs in traditional offline market for books, which suggests that lowering transactions costs is a big advantage of online purchases.

[6] Other related papers include: Domberger, Hall, and Li (1995), who find that increased competition pushes prices down while exerting either no effect or a positive effect on quality; Prince and Simon (2009), who show that on-time

We also find a positive relationship between product quality and the conventional measures of competition in the airline industry. Nevertheless, assuming that increased Internet usage leads to more intense price competition, we find that quality *falls* as price competition intensifies.

Finally, our findings might help explain the increase in the share of direct-flight passengers from the late 1990s to 2007 (Berry and Jia, 2010). If passengers realize that delays are more likely and that flight time will probably increase, then they may have a stronger preference for direct flights over connecting flights.

III. TERMINOLOGY AND THEORETICAL MOTIVATION

In this section we discuss how customer access to flight information on the Internet might affect flight delays and scheduled elapsed times. First, however, we present a simple example to explain the terms we are using. Assume that a flight from airport A to airport B is scheduled to depart at 10:30 a.m. and to arrive at 11:30 a.m. The *scheduled elapsed time* for this flight—i.e., the time between the scheduled departure and the scheduled arrival—is 60 minutes. Assume that the flight leaves the gate at the origin airport at 10:40 a.m. and arrives at the gate at the destination airport at 11:35 a.m. In this example, the *actual elapsed time* (i.e., the difference between the flight's actual arrival time and the scheduled departure time), the *arrival delay*, and the *departure delay* are 65 minutes, 5 minutes, and 10 minutes, respectively. Note that arrival delays and scheduled elapsed time are closely related: For a given actual flight time, a longer scheduled elapsed time results in a shorter arrival delay.

III.A. Effect of the Internet on Flight Delays

Customer access to flight information on the Internet may have either a negative or a positive effect on flight delays. The effect is negative if decreases in airlines' margins, which occur as a result of the adverse effect of the Internet on *fares*, lead airlines to allocate fewer resources, such as crew members, ticket counters, and baggage handlers, to each flight. In addition, airlines may eliminate or choose not to adopt incentive schemes that encourage employees to achieve better on-time performance. This explanation assumes that the Internet enables airlines to credibly transmit verifiable information about prices, whereas they cannot

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performance is poorer when airlines engage in multi-market contact, and Rose (1990), who finds a negative relationship between measures of airlines' profitability and their accident rates.

transmit such information about quality. Consequently, airlines may avoid costly investments in product quality and engage in "excessive" price competition.

Conversely, Internet access might have a positive effect on quality in general and on flight delays in particular. Because passengers can use the Internet to compare on-time performance across carriers, airlines might try to reduce flight delays and improve their on-time performance. Furthermore, as prices fall, airlines may try to differentiate themselves on the basis of dimensions of product quality, such as having fewer flight delays.

III.B. Effect of the Internet on Scheduled Elapsed Times

The effect of Internet access on flights' scheduled elapsed times may also be either positive or negative, irrespective of the Internet's effect on flight delays. The effect may be negative for two main reasons. First, as prices fall, airlines may not be able to provide the same level of product quality. Lower quality may entail not only longer delays but also longer scheduled elapsed times. That is, if airlines need to undertake costly investments to achieve short schedules, then as margins fall airlines may have to eliminate these investments. Second, customer access to the Internet may cause airlines to attribute less priority to minimizing scheduled flight times: In the early 1990s, brick-and-mortar travel agencies sold over 80% of airline tickets (Borenstein, 1992). These agencies received ticket information from computer reservation systems (CRSs), computer systems introduced in the 1970s to automate and control ticket distribution. Flights typically appeared in CRSs in ascending order according to their scheduled flight times or scheduled journey times (GAO, 1995).[7] Given that travel agents booked over 80% of flights from the first screen and that the majority of the tickets were sold from the first line, airlines looked for ways to reach the top of travel agents' screens (Guerin-Calvert, 1992). Therefore, airlines had strong incentives to maintain short flights, presumably incurring large operational costs to achieve these efficiencies. As Internet penetration increased and more passengers began to use online travel agencies, which typically sort tickets according to price, airlines had lower incentives to allocate substantial resources to improving and

[7] Journey time is the total time needed to get from airport A to airport B. Journey time is different from the scheduled flight time for connecting passengers because it includes scheduled flight times for both segments as well as the layover time between connecting flights.

maintaining their operational efficiency. Consequently, scheduled elapsed times may have increased as more passengers began to use the Internet.[8]

Internet access may also have a positive effect on scheduled elapsed time. Online travel agencies allow passengers to sort flights according to various flight characteristics, e.g., fare or scheduled elapsed time. Thus, if flights' scheduled elapsed times actually affect passengers' purchase decisions, then airlines may try to target and report shorter scheduled times. In this case, we can expect that airlines will report shorter scheduled elapsed times as more passengers use the Internet.

IV. DATA

Our data come from several sources. The primary sources of data are the flight-level on-time performance statistics from the U.S. Bureau of Transportation Statistics. This database reports scheduled and actual flight information for all flights on each airline that is responsible for at least 1% of U.S. domestic passenger revenues. In particular, the data include measures of departure delays, arrival delays and time in the air as well as identifying information for each aircraft and flight. In Table I, we present information on on-time performance for airlines in our sample between 1997 and 2007. In the late 1990s, more than 20% of flights arrived late at their destinations. The economic slowdown of the early 2000s and the 9/11 terrorist attacks that led to capacity cuts were associated with an improvement in on-time performance, which reached its peak in 2003, when roughly only 17% of flights arrived more than 15 minutes late. After 2003, however, on-time performance deteriorated. In 2007, the last year in our sample, almost 27% of flights were considered late.

The second primary data source is the Computer Use and Ownership Supplement to the Consumer Population Survey (CPS). We use the CPS to measure Internet penetration for every major metropolitan area. The survey asks about Internet access at home, school, and business. For each metropolitan area, we compute the percentage of respondents answering "yes" to any of these Internet

[8] This explanation is corroborated by airline executives. For instance, as pointed out by American Airlines' Capacity Planning managing director: "[before the Internet] you had to be on the first screen [of the travel agent]. All the booking came off the first screen. You'd bring your airplanes in as fast as you can and you'd let them go as fast as you can." He also added that "[when most tickets are sold online] it's important still to have competitive elapsed time, because there's a point at which consumers will say no. But it isn't important to have the fastest elapsed time." (See ATW online, November 2002, at http://www.nesdb.go.th/specialWork/suvarnabhumi/ceo_talk/No%20Peaking.pdf)

access questions using sample weights provided by the CPS. The data are available for the years 1997, 1998, 2000, 2001, 2003 and 2007. Table II provides descriptive statistics for this variable.

We supplement these data with additional sources. First, we use the Origin and Destination Survey (DB1B) market database. This is a 10% sample of all passenger tickets purchased in each quarter for each year of our sample, and it includes the airline, the quarter in which the ticket was used, the fare, the number of passengers paying the fare, the origin and destination airports (for the passenger), and the itinerary (the individual flight segments flown). We use the DB1B to derive our airfare control variable. [9] In addition, we use it to calculate the weights for the Internet penetration flight variable. Importantly, the DB1B database identifies the outbound and return portions of round-trip tickets, so we can identify each passenger's home airport (and therefore the associated metropolitan area in which he or she is likely to have purchased the ticket).[10] Simply matching the flight data to the metropolitan area in which each flight's origination airport is located is inadequate. A passenger returning home on the return portion of a round-trip ticket, for example, is likely to have purchased his or her ticket at home, i.e., in the metropolitan area in which the flight's destination airport is located. Still other passengers are on the second leg of their outbound itineraries (or the first leg of their return itinerary), so the airport at which these passengers began their round-trip travel is neither the airplane's origination nor destination airport. The distinction is important because our hypothesis is that the share of passengers who buy their tickets online (or have the option of doing so) affects how an airline determines the quality of a given flight. Specifically, our weighted measure of Internet penetration is $\mathrm{IP}_{ijt} = \sum_k \omega_{ijkt} \mathrm{I}_k^m \mathrm{IP}_{mt}$, where ω_{ijkt} is the share of all passengers who fly on airline *i*'s flight serving flight segment *j* in quarter *t* who began the travel itinerary in airport *k*, IP_{mt} is the Internet penetration in metropolitan area *m*, and I_k^m is an indicator that is equal to 1 if airport *k* is located in metropolitan area *m* and 0 otherwise.[11] In the analysis we use the terms Internet access, Internet and IP interchangeably.

[9] The DB1B dataset reports airfares at the itinerary level. We use the distances of all segments of a given itinerary to allocate the corresponding airfare into segments, and then take the average of resulting airfares on a segment across itineraries that include the segment.

[10] Before 2000, Southwest Airlines reported all of its roundtrip ticket sales as two one-way tickets, so we cannot identify the home airport for these Southwest passengers, and thus we exclude Southwest Airlines from our analysis prior to 2000.

[11] The metropolitan-area traffic weights constructed from the DB1B database are equal to the fraction of each airline's passengers flying on each segment who originate their one-way or round-trip itinerary in each metropolitan area. We use the DB1B database to find all the passengers with itineraries that include the particular airline airport-pair segment and then calculate the percentage of these consumers whose itineraries originated at each airport. A

Second, we use the data published by the Official Airline Guide (OAG), which contains a complete set of scheduled non-stop flights for *all* airlines between all U.S. airports. We use these data to construct the measures of competition for each flight segment in addition to several measures of aircraft operations in each airport and at different times throughout the day. These measures enable us to control for potential changes in the number of flights and congestion patterns over time. Third, we use data from the Bureau of Economics to construct demographic and economic measures at the metropolitan-area level. These measures control for expected and unexpected demand changes that may be spuriously correlated with Internet penetration. We use the traffic weights described above to match these data to the directional flight segments. Finally, we use the T100 (Form 41) database from the Bureau of Transportation Statistics to derive a directional carrier–flight-segment load factor variable for each month in our sample.

After matching these datasets, we limit our sample to traffic during one Thursday per month in the months January, April, July and October in the following years: 1997, 1998, 2000, 2001, 2003 and 2007. In what follows, we present estimation results for nine carriers that were included in the data on on-time performance for all years between 1997 and 2007. The airlines are listed in Table III. We also limit our analysis to flight segments between the 100 airports with the highest numbers of passengers. This leaves us with 286,004 observations. The results are qualitatively similar if we do not constrain the data.

V. ESTIMATION AND RESULTS

V.A. Main Specification

To examine the relationship between Internet access and flight quality, we estimate various forms of the following reduced-form equation:

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metropolitan-area traffic weight is the sum of the airport weights across all airports located in the metropolitan area. Finally, we compute the traffic-weighted average of the metropolitan-area Internet penetration to obtain a measure of Internet penetration that is unique to each airline airport-pair segment. For example, consider a flight from airport A to airport B. Assume that 40 percent of the passengers are flying round trip from A to B (so they are on the outbound portion of their round-trip itinerary), another 35 percent of the passengers are flying round trip from B to A (so they are on the return portion of their round-trip itinerary), another 15 percent of the passengers are flying round trip from airport C to airport B with a stop each way at airport A (so they are on the second segment of the outbound portion of their round-trip itinerary), and, finally, that the remaining 10 percent are flying round trip from airport A to airport D with a stop each way at airport B (so they are on the first segment of the outbound portion of their round-trip itinerary). The weighted average Internet penetration for passengers on this particular airline's flight from airport A to airport B is equal to (0.40 + 0.10) IP_A + 0.35 IP_B + 0.15 IP_C, where IP_i denotes the Internet penetration in the metropolitan area in which airport *i* is located.

$$Y_{fijt} = \beta_I IP_{jt} + \beta_{I-MS} IP_{jt} \cdot HHI_{ijt} + \beta_{MS} HHI_{ijt} + \beta_Z Z_{fijt} + \beta_D X_{jt}^D + \beta_C X_{ijt}^C + \beta_{LF} LF_{ijt} + FE + \varepsilon_{fijt}$$

where an observation is a flight *f* of airline *i* in flight segment *j* on day *t*. We use four alternative dependent variables: a flight arrival delay, scheduled elapsed time, total actual time, and departure delay. These variables are measured in minutes, where a delay can be negative if a flight arrives or departs before its scheduled time. The primary independent variables are the traffic-weighted measure of metropolitan-area Internet penetration (*IP*) and the interaction between this measure and the competition level, measured as the HHI for the corresponding flight segment (*IP* × *HHI*). We also add the segment HHI as a separate regressor. A positive coefficient for *IP* would lend support to the argument that increases in Internet penetration among passengers lead to longer delays and, thus, to lower quality, whereas a negative coefficient would suggest that increases in Internet penetration lead to shorter delays and higher flight quality. The sign of the interaction between *IP* and HHI will be opposite to the sign of *IP* if the effect of Internet access on delays is greater on more competitive routes.

We add several flight-specific control variables (*Z*). First, we include an aircraft's arrival delay (in minutes) on its previous flight. We expect this variable to be positively correlated with the current flight delay.[12] Second, we include the scheduled time (in minutes) between a given flight's scheduled departure and the scheduled time of its corresponding aircraft's previous arrival. This measure of schedule buffer represents the available scheduled time to prepare an aircraft for its next flight. Longer scheduled ground time between subsequent aircraft operations might reduce delays on an aircraft's next flight.[13] Third, we add a variable that represents the number of flights a given flight's aircraft has performed on a given day prior to the flight under consideration. The variable takes a value of 1 if the focal flight is its aircraft's first flight on a given day, a value of 2 if it is the aircraft's second flight on a given day, etc. This variable measures how long each aircraft is in service on a given day. A longer amount of time in service on a given day makes it more likely that associated delays will accumulate and lead to delays on subsequent flights. The demand controls (X^D) are metropolitan-area population, level of unemployment and average per capita income. Each

[12] This variable takes value zero for the aircraft's first flight on a given day. Airlines report that late aircraft arrival is a primary cause of flight delays. For example, according to airline reports to the DOT in 2007, more than 8% of flights were late due to late aircraft arrival.

[13] For the first aircraft's flight on a given day, we arbitrarily set the value of this variable to 240.

of these measures is matched to the segment data using the same weights used above to match the Internet penetration variable to the segment data. These variables are included in order to control for both short- and long-run variations in demand growth across airline segments and thus are constructed from the MSA data in the same way that the Internet penetration variable is constructed.

Delays, scheduled elapsed times and actual flight times are likely to be affected by the number of flights that operate in the origin and destination airports and the number of passengers on these flights. In particular, higher Internet usage and lower prices may result in more flights and fuller planes, which consequently could lead to longer actual flight times. Thus, our estimates may potentially capture the impact of the Internet on the number of aircraft operations and the number of passengers. To address this concern we use the OAG data to construct various measures of the number of flights that are scheduled to operate at the origin and destination airports at the same hour on the same day (X^C). In particular, we include the following measures: the number of flights per day on a given flight segment; the number of departures from and the number of arrivals to the flight's origin airport and, separately, the flight's destination airport on that day; the number of departures from and arrivals to the flight's origin airport within an hour of the flight's departure; the number of departures from and arrivals to the flight's destination airport within an hour of the flight's arrival; and HHI at the flight's origin airport and at the flight's destination airport. The airport HHI measures should reflect potential situations in which airlines operating in concentrated airports gain advantages in handling flight operations and avoiding delays. In addition, we also include as a separate control variable each airline's average load factor (LF)—i.e., how full that airline's flights are—on a particular flight segment in the relevant month. We expect that average load factors will have a positive effect on delays given that more passengers board each aircraft. Table IV lists descriptive statistics for each of the variables in our analysis.

Finally, we include a variety of fixed effects: segment; aircraft type; airport/carrier and carrier/day fixed effects. The directional segment fixed effects control for time-invariant metropolitan area, origin airport, destination airport, and airport-pair characteristics for each segment. Aircraft-type fixed effects account for unobservable technical differences among different aircrafts that may allow aircrafts to recover lost time differently during flight. By including the carrier/day fixed effects we capture unobservable events that might have different effects on different airlines on a given day. These fixed effects also control for time-varying characteristics that are carrier-specific, such as system-wide schedule changes (e.g., ripple effects caused by severe weather conditions in one or more airports) or the average passenger's attitude towards flight delays. The airport/carrier fixed effects should capture unobserved differences among carriers that operate in the same airport, such as the number of gates and the location of terminals. The inclusion of the set of fixed effects implies that any effects we observe come mainly from differences among flights operated by the same carrier on the same day but from different airports. Hence, we claim that differences in quality across flights occur mainly because airlines allocate fewer resources that can reduce delays to airports whose passengers are more likely to have Internet access.

Our base specification captures the relationship between Internet access and measures of flight quality. This specification, however, does not allow us to isolate the exact mechanism through which the Internet affects these measures. In particular, we cannot determine whether the effect we find arises because the Internet leads to lower prices or because of some other factor. In a separate regression we add the average airfare on a given segment as an additional control variable. The coefficient on the average airfare variable provides a direct test of our hypothesis that lower prices may have a negative effect on flight delays. Also, by adding the airfare control variable we can test whether Internet access has a direct effect on flight quality beyond its effect on prices.

V.B. Instruments

Both average airfare and average load factor variables are potentially endogenous. For example, if a flight on a certain route is more likely to be late and passengers take that into account when they purchase their airfares, then our airfare coefficient is potentially biased. Although the set of fixed effects that we use may control for this endogeneity problem, we adopt an instrumental variable approach to check whether the results change. Specifically, as instruments for the airfare we use the airline's average segment fare on all other segments of similar length (we divide segments by length into five quintiles) and the airline's rivals' average fare on the reverse segment. These instruments are similar in spirit to the instruments adopted by Nevo (2000) and other studies that use data from different geographic markets. The instruments for load factor are constructed similarly.

Below, we first report and discuss the regression results using the arrival delay measure as the dependent variable, and then turn to the results using the scheduled elapsed flight time,[14] the actual elapsed flight time and the flight departure delay as dependent variables.

V.C. Results

V.C.1. Arrival Delays. Table V shows our estimation results for flight delays, measured as the (positive or negative) difference in minutes between a flight's actual time of arrival and its scheduled time of arrival at its destination. The regression in column 1 includes the Internet penetration variable, our competition measure, the flight-segment HHI, its interaction with Internet penetration, the carrier/day and origin/carrier fixed effects, the three variables for a given flight's position relative to the previous flight on the same aircraft, and the traffic-weighted demographic control variables. The coefficient on the Internet penetration variable equals 10.6 and is highly significant. The negative and significant coefficient on the interaction term between *IP* and HHI indicates that the effect of increased Internet access is larger on competitive flight segments. The magnitude of our results implies that an increase of 0.1 in Internet penetration among the passengers on a given flight, one-half of the standard deviation for this variable, is associated with an increase of nearly 1 minute in arrival delays. This represents a 12 percent increase in arrival delay time compared with its average level. For monopolistic routes, an increase of 0.1 in Internet penetration is associated with arrival delays lasting 0.4 minutes longer. The coefficients for other variables are consistent with our expectations: a longer arrival delay for the previous flight on the same aircraft is associated with a longer delay for the given flight, while a longer scheduled time between a given flight's departure and the arrival of the previous flight on the same aircraft is associated with a shorter arrival delay for the given flight. Finally, a flight that takes place later in the day (as measured by the FLIGHT IN DAY variable) is associated with a longer arrival delay.

In column 2 of Table V, we add the entire set of congestion controls, including the load factor variable. The coefficients on our main variables of interest are qualitatively the same. In addition, the load factor variable is positive and significant, confirming our expectation that delays are affected by the number of passengers on each plane (see Ramdas and Williams, 2008, for a similar argument).

[14] In the regression with scheduled elapsed flight time as a dependent variable, we do not include a given aircraft's arrival delay on its previous flight as a control variable.

Other (non-reported) coefficients typically have the expected signs. For example, the coefficient on the number of flights that are scheduled to depart from the same origin airport in the same hour is positive and significant. The same is true for the destination airport. The total daily number of flights operating at the origin and destination airports is insignificant. The concentration level at the origin airport is negatively correlated with flight delays, suggesting that airlines at concentrated airports can better handle their operations and avoid delays. Interestingly, income per capita among passengers has a positive and significant coefficient.

In column 3 we add as an additional regressor the logarithm of carriers' average airfare on a given segment in a given quarter. The coefficient on average airfare is negative and statistically significant, suggesting that delays increase when prices fall. This finding lends additional support to our interpretation that carriers facing strong price competition degrade their product quality, as measured by flight delays. Importantly, the coefficient on the Internet penetration variable is still positive and highly significant. This could imply that the Internet has a direct effect on flight delays, and not only via its effect on airfares. The results do not change qualitatively when we account for the potential endogeneity of airfares and load factors in column 4.

V.C.2 Scheduled Flight Time Measures. We now turn to investigate whether increased Internet access has a direct effect on scheduled flight times. The analysis is important not only because scheduled flight time is likely to affect travelers' choice of flights but also because it could shed light on why delays increase as more passengers have Internet access. For example, flight delays may increase because airlines shorten scheduled elapsed times, particularly for flights on which passengers are more likely to have Internet access. This could happen if passengers who use the Internet are better informed about the scheduled elapsed times of alternative flights and, as a result, airlines compete more vigorously on this attribute.

In columns 1 and 2 of Table VI, we report the results using scheduled flight time as the dependent variable. The coefficient on the Internet in column 1 is 2.9 and is highly significant, suggesting that airlines scheduled longer rather than shorter flights as Internet access among passengers increased. Anecdotal evidence indeed suggests that scheduled time has increased dramatically over the years, sometimes by up to 39% for similar flights.[15] The increase in scheduled

[15] The Middle Seat: Why a Six-Hour Flight Now Takes Seven. Scott McCartney (2010, February 4), Wall Street Journal (Eastern Edition), p. D.1.

times partially reflects increases in congestion over the years. Nevertheless, by controlling for the level of aircraft operations at both origin and destinations airports, and including a set of fixed effects, we aim to show that the effects of Internet access are not limited to its effects on the number of flights and on the number of passengers.

The coefficient on the interaction term between Internet penetration level and HHI is negative and significant, suggesting that most of the effect of Internet penetration on scheduled elapsed time occurs on competitive routes. The combination of the Internet variable and its interaction with HHI suggests that the effect of Internet penetration on scheduled elapsed times is negligible for monopolistic flight segments. Furthermore, the coefficient on average fare is negative and significant, suggesting that scheduled time increased more on flights that experienced larger price drops.

The increase in scheduled elapsed times as more passengers have Internet access, especially in competitive environments, is also consistent with our claim that the Internet affected the mode of competition in the airline industry. As discussed above, in the pre-Internet period flights on travel agent screens were likely to be sorted based on their scheduled elapsed times. Consequently, airlines had strong incentives to keep tight schedules for their flights. As more passengers began purchasing airfares through online travel agencies such as Expedia, Orbitz and Travelocity, where flights are typically sorted according to price, the incentives of airlines to keep short schedules substantially diminished. We look for further evidence of this effect in Section V.D.

V.C.3. Actual Flight Time and Departure Delay Measures. Our results above suggest that scheduled times and flight delays increased as more passengers gained Internet access. This implies that actual flight times also rose. We now investigate this directly. In columns 1 and 2 of Table VII, we repeat our analysis using the actual flight time as the dependent variable. We compute this measure as the time elapsed between the scheduled flight departure time and the actual arrival time. In these regressions, the coefficient on the Internet penetration variable is statistically significant and, as expected, is larger in magnitude than the corresponding coefficient in the regressions in which arrival delay is the dependent variable. According to the results from column 1, an increase of 0.1 in Internet penetration is associated with an increase in actual flight time of between 2.2 and 12.5 minutes, depending on the level of competition. In addition, the coefficient on the fare variable is negative and significant, which is consistent with our claim that quality diminishes as prices fall.

Controlling for the potential endogeneity of the airfare in column 2 does not qualitatively change our results.

Next, we explore whether the increased actual time is driven by longer departure delays, measured as the elapsed time between the actual and scheduled departure times. This additional test is important because airlines are likely to have more control over delays occurring on the ground before departure compared to the flight airtime. Thus, a positive relationship between departure delays and Internet access can strengthen our interpretation that airlines chose to invest less in quality. In addition, potential changes in fuel price are less likely to affect the elapsed time an airline waits at the gate before departure. We present the results of the regressions in which the departure delay is used as the dependent variable in columns 3 and 4 of Table VII. The results show that departure delays are significantly higher for flights on segments in which larger shares of passengers have Internet access. This difference is higher on competitive routes. The magnitudes of the coefficients for Internet penetration in the regressions with departure delays as the dependent variable are smaller than the corresponding magnitudes of the coefficients in the regressions with actual flight time as the dependent variable. Nevertheless, the former coefficients amount to roughly 60% of the latter coefficients.

V.D. Additional Results on Change in Competition Mode

We claim that the effect of Internet access on scheduled elapsed flight times may depend on *how* airlines compete with each other. Our conjecture is that when most airline tickets were sold through brick-and-mortar travel agencies, airlines competed by scheduling shorter flights. However, the development of the Internet and the rise of online travel agencies where flights were typically sorted by price induced airlines to pay less attention to achieving short schedule times and to focus more on offering low prices. This argument is consistent with our findings that Internet access has a positive effect on scheduled elapsed time, particularly in competitive environments. To further explore our conjecture, we investigate the effect of the Internet on two distinct types of flights: flights that fly relatively many business passengers and flights on segments where a low-cost carrier also operates.

V.D.1 "Business" and "Non-business" Flights. We hypothesize that when flights were sorted by scheduled elapsed flight times, airlines had especially large incentives to keep scheduled flight times short for flights with many business passengers. As Internet access increased these flights became more likely to be sorted based on price, the incentives of airlines to keep short scheduled flight times for these flights diminished.

We consider two alternative definitions for business flights. First, we look at flights that depart between 6 a.m. and 9 a.m., and second we look at flights that connect the 30 largest U.S. cities to other cities.[16] We enhance the regression specification presented above by adding a dummy variable for morning flights, a dummy variable for segments from or to airports in the 30 largest cities, and their interactions with the variable for Internet penetration. Table VIII reports the estimation results. The regression results confirm our hypothesis that "business flights" are, *ceteris paribus,* shorter than "non-business flights" (the difference is nearly 1 minute), and that the effect of the Internet on scheduled elapsed time is larger for business flights than for non-business flights. These two effects are statistically different.[17]

V.D.2. Low-Cost Carrier Presence. We also compare the effect of the Internet on scheduled elapsed times for flights operated by legacy carriers in segments in which there is a low-cost carrier versus in segments in which no low-cost carrier operates. Our conjecture is that carriers are more likely to compete on scheduled elapsed time in segments where low-cost carriers do not offer service. This is because the presence of low-cost carriers already alters the nature of competition.

Specifically, we test whether scheduled elapsed times are longer for flights in segments where a low cost-carrier operates, and whether the effect of the Internet on scheduled elapsed flight times is larger for segments in which no low-cost carrier operates. Table IX reports estimation results for a regression in which we add a dummy variable for whether a low-cost carrier operates on a given segment and its interaction with the variable for Internet penetration.[18] The analysis examines how scheduled elapsed times of flights operated by legacy carriers change when a low-cost carrier offers service on the same segment. The estimation results indicate that scheduled elapsed times are indeed longer on segments where a low-cost carrier operates, and that the effect of the Internet on scheduled elapsed flight time is mostly confined to competitive segments where no

[16] The latter criterion is adopted by Gerardi and Shapiro (2009).
[17] These and other results hold if instead of Thursdays we consider Mondays or Tuesdays in each quarter in each year in our sample.
[18] The list of low-cost carriers includes Southwest Airlines, AirTran, JetBlue, Frontier, ATA Airlines, Allegiant Air, Skybus Airlines, Spirit Airlines, Sun Country Airlines, ValuJet Airlines, National Airlines, and Independence Air.

low-cost carrier operates. In other words, as more passengers began to use the Internet, legacy carriers were more likely to change scheduled flight times when they faced competition from other legacy carriers but not from low-cost carriers. Controlling for the potential endogeneity in column 2 does not qualitatively change our results.[19]

V.D.3. Changes in the Fastest Scheduled Flying Time. The estimation results, comparing business and non-business flights and segments with and without low-cost carriers, are consistent with our claim about the effect of the Internet on the form of competition between airlines. In order to provide further evidence for this effect, we also examined how the minimum scheduled flying time between airports changed over the years. An increase in the minimum flying time would be consistent with our view that the form of competition changed. Indeed, Figure I shows that the average minimum flying time has been increasing over time. Figure II, which shows how the ratio between the fastest scheduled time and the average scheduled time changed over the years, illustrates that the change in the scheduled flight time was larger for the flights with the fastest scheduled time. This suggests that the change in the form of competition was greater for the flights with the fastest scheduled time. Finally, Figure III shows, for segments that had at least five daily flights, a time series of the percentage of flights with the fastest scheduled flying time on, averaged across all segments in a given quarter. The figure illustrates that this percentage fell substantially, starting at about 33% of flights reporting the fastest scheduled time in 1997 to a level of 26% of flights with the fastest scheduled flying in 2002, and then rising slightly to 28% of flights reporting the fastest scheduled time in 2007.[20] A decrease in the share of flights with the fastest scheduled time is consistent with our view, that airlines attributed fewer resources to match each other fastest scheduled time.

V.E Robustness

We performed several robustness checks on our results. First, we reran our regressions including all airlines that reported on-time performance statistics to the U.S. Department of Transportation (instead of including only airlines that reported the on-time performance throughout the entire

[19] We modified our definition of instruments for this regression: when calculating the airline's average segment fare on all other segments of similar length, we distinguish between segments where low-cost carriers are present from segments where low-cost carriers are not present.

[20] Note that the pattern persists when we analyze the percentage of flights corresponding to the fastest scheduled flight time in a regression framework.

period), and the results were qualitatively the same. Second, instead of restricting our analysis to the largest 100 airports, we reran our analysis focusing on the largest 50 U.S. airports, and again we obtained qualitatively similar results. Third, we split our sample into two data periods, and ran the regressions separately for earlier and later time periods. While results were qualitatively similar in both time periods, we observed that most of the effect of the Internet on flight delays took place between years 2001 and 2007. Fourth, we verified that our results remained unchanged if we used flights from other days of the week.

Finally, we verified that our results are not sensitive to the exclusion of the late arrival and the scheduled buffer variables. Inclusion of the late arrival variable might lead to serial correlation in our specification. Furthermore, one might be concerned that the scheduled buffer variable is under the control of the airline, and hence is potentially endogenous. Yet, excluding these variables does not qualitatively change our results. Furthermore, we did not find a significant relationship between our Internet access variable and the scheduled buffer variable.

VI. DISCUSSION

Following the deregulation of the U.S. airline industry in 1978, airlines began competing on price at the expense of flight quality. More than twenty years later, the U.S. airline industry experienced another dramatic change as passengers began using the Internet to search and easily compare prices across airlines. This change, together with other changes in the industry, posed great difficulties for U.S. airlines. Indeed, in the early 2000s four major airlines entered bankruptcy, and all legacy carriers reported large reductions in profits.

In the search for ways to reduce costs and address the lower margins, legacy carriers considered abandoning their traditional business model in which passengers pay more in return for better service. Our findings suggest that airlines' response involved not only price cuts but also reductions in the quality provided to consumers, especially in more competitive environments. Thus, our results suggest that the Internet, like the 1978 airline deregulation, led to lower prices and at the same time lower flight quality.

Like other products, flights have multiple dimensions of quality, such as aircraft cleanliness, food quality, the number of flight attendants and flight safety. Although our paper uses only one type of flight quality measures, anecdotal evidence suggests that flight quality decreased on other dimensions as well. A prime example is that most airlines stopped serving free meals on domestic flights.

VII. CONCLUSION

E-commerce has had a dramatic impact on several retail industries, including the airline industry. Online travel agencies, such as Orbitz, Expedia and Travelocity, have become common resources among U.S air passengers, leading to fierce price competition and lower margins. Indeed, previous studies have shown that prices in the airline industry have fallen as more passengers have gained access to online travel agencies and airline websites.

In this paper, we examined the effect of this fundamental change in the airline industry on the quality that passengers receive. The predicted effect is ambiguous. On the one hand, airlines may not be able to provide the same level of product quality as margins drop. On the other hand, online customers may find it easier to compare product quality, thereby increasing airlines' incentives to invest in product quality. Our findings, based on flight-level data and measures of Internet access between 1997 and 2007, suggest that flight quality dropped as more passengers began to use the Internet. In particular, delays, scheduled elapsed times and actual flight times increased as more passengers gained Internet access.

This paper makes two main contributions to the literature. First, to the best of our knowledge, it is the first paper that examines whether increased access to information has a predominantly positive or negative effect on product quality. Economists have long emphasized the importance of information for the efficient functioning of markets. Nevertheless, previous papers have typically explored how access to information affects prices, and generally have not investigated how firms respond to these changes. Our findings – that the Internet had a negative effect on product quality – provide one such explanation. More generally, our findings, together with previous findings that prices have fallen as Internet usage has increased, suggest that the effect of the Internet on the well-being of consumers may be ambiguous. Explicitly measuring the effect of the Internet on welfare is left for future research. Future research may also examine the effect of the Internet on other attributes of product quality, potentially distinguishing between the quality of experience and search goods.

Second, our paper contributes to the growing literature on information and communication technologies. Not surprisingly, the existing literature focused on the large benefits associated with the adoption of information and communication technologies. Our findings, however, highlight a potentially negative effect of on-line distribution channels which have indirectly reduced the incentives of airlines to compete on flight times, eventually resulting in longer flight times or lower product quality. This occurred because the reservation systems used by brick-and-mortar travel agencies typically sorted flights based on short schedules. As a result, airline operations were organized to reduce travel time. This changed as more passengers began using the Internet, where flights are typically sorted by price. Future research may further explore other implications of this shift in the nature of competition in the airline industry.

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Table I. On-Time Performance over Time

Year	Nr Carriers	Average Departure Delay	Average Arrival Delay	% On Time	% Delayed	% Cancelled
1997	9	8.29	7.59	76.4%	21.6%	1.8%
1998	9	9.02	7.59	75.7%	21.4%	2.7%
1999	9	9.40	8.37	74.4%	22.5%	2.8%
2000	9	11.39	10.56	70.7%	25.7%	3.4%
2001	9	8.09	5.39	76.0%	20.2%	3.6%
2002	9	5.53	3.10	80.8%	17.9%	1.1%
2003	9	4.80	3.03	81.8%	16.8%	1.2%
2004	9	7.86	6.67	76.9%	21.6%	1.4%
2005	9	9.09	7.30	75.5%	22.8%	1.5%
2006	8	9.67	7.77	74.4%	24.2%	1.2%
2007	8	11.36	9.82	71.3%	26.8%	1.7%

Source: U.S. Bureau of Transportation Statistics.

Note: Includes airlines that reported on-time performance statistics throughout the whole time period; the airlines are listed in Table III. America West merged with US Airways in 2005.

Table II. Internet Penetration across Metropolitan Statistical Areas (N=243)

Year	Mean	Std. Dev.	Min	Max
1997	0.194	0.074	0.043	0.489
1998	0.411	0.118	0.094	0.723
2000	0.555	0.110	0.207	0.836
2001	0.662	0.102	0.225	0.911
2003	0.698	0.100	0.323	0.923
2007	0.763	0.085	0.415	0.970

Source: Computer Use and Ownership Supplement to the Consumer Population Survey.

Table III. Differences across Airlines

	Average Scheduled Flight Time (mins)	Average Arrival Delay (mins)	Average Departure Delay (mins)
Alaska Airlines	137.0	9.8	9.2
America West	138.3	9.8	9.4
American Airlines	162.4	6.4	8.3
Continental Airlines	159.9	11.3	10.7
Delta Airlines	133.1	9.3	9.1
Northwest Airlines	135.6	8.7	8.5
Southwest Airlines	97.4	7.1	10.6
United Airlines	150.5	11.7	12.2
US Airways	116.7	9.9	9.2

Notes: Each cell contains average values over each airline's directional segments in the sample over 24 days in 24 quarters. US Airways merged with America West in 2005.

Table IV. Descriptive Statistics (286,004 observations)

Variable	Mean	Std. Dev.	Min	Max
SCHEDULED FLIGHT TIME	135.1	71.2	22.0	660.0
ARRIVAL DELAY	9.1	31.3	-65.0	358.0
DEPARTURE DELAY	9.7	28.0	-50.0	360.0
TOTAL ACTUAL TIME	144.2	77.5	3.0	832.0
INTERNET	0.6	0.2	0.1	0.9
Demand Variables:				
LOG (INCOME PER CAPITA)	10.4	0.1	9.9	10.9
LOG (POPULATION)	15.1	0.6	12.7	16.7
EMPLOYMENT, %	0.60	0.03	0.38	0.73
Market Structure and Additional Variables:				
HHI	0.701	0.255	0.164	1.000
LATE ARRIVAL	5.8	26.0	-65.0	797.0
SCHEDULED BUFFER	100.8	93.7	-397.0	1406.0
FLIGHT IN DAY	3.2	2.0	1.0	14.0
LOAD FACTOR	0.693	0.117	0.075	0.980
AVG. FARE	138.5	69.7	1.9	658.0
NR DEPARTURES PER HOUR, ORIGIN ARPT	33.4	24.0	1.0	122.0
NR DEPARTURES PER HOUR, DEST ARPT	28.7	22.8	0.0	122.0
NR ARRIVALS PER HOUR, DEST ARPT	32.3	24.4	1.0	171.0
NR ARRIVALS PER HOUR, ORIGIN ARPT	29.0	22.6	0.0	1.0

Table V. Regression Results: Arrival Delays

Dependent Variable:	ARRIVAL DELAY, mins			
	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	IV
INTERNET	10.585**	10.017**	9.628**	9.702**
	(4.349)	(4.292)	(4.255)	(4.261)
HHI	1.231	2.672	3.136*	3.293*
	(1.606)	(1.698)	(1.700)	(1.705)
INTERNET × HHI	-6.590***	-7.184***	-7.343***	-7.480***
	(2.333)	(2.291)	(2.287)	(2.290)
LATE ARRIVAL	.547***	.546***	.546***	.546***
	(.008)	(.008)	(.008)	(.008)
SCHEDULED BUFFER	-.016***	-.014***	-.014***	-.014***
	(.001)	(.001)	(.001)	(.001)
FLIGHT IN DAY	.522***	.395***	.397***	.402***
	(.042)	(.045)	(.045)	(.045)
LOG (LOAD FACTOR)		4.190***	3.507***	3.479***
		(.630)	(.618)	(.766)
LOG (AVG. FARE)			-2.426***	-2.803***
			(.793)	(.873)
Segment Fixed Effects	Y	Y	Y	Y
Aircraft Fixed Effects	Y	Y	Y	Y
Demographic Controls (X^D)	Y	Y	Y	Y
Congestion Controls (X^C)	N	Y	Y	Y
Carrier/Day Fixed Effects	Y	Y	Y	Y
Origin/Carrier Fixed Effects	Y	Y	Y	Y
Observations	286,004	286,004	286,004	285,509

Notes: Standard errors are in parentheses. Asterisks denote the significance level of coefficients: *** - 1 percent, ** - 5 percent, * - 10 percent. Standard errors are clustered within a segment. Additional control variables are described in the text.

Table VI. Regression Results: Scheduled Flight Time

Dependent Variable:	SCHEDULED FLIGHT TIME, mins	
	(1)	(2)
	OLS	IV
INTERNET	2.870**	2.842**
	(1.226)	(1.229)
HHI	1.501***	1.492***
	(0.500)	(0.500)
INTERNET × HHI	-3.002***	-3.000***
	(0.655)	(0.655)
LATE ARRIVAL		
SCHEDULED BUFFER	-.002***	-.002***
	(.000)	(.000)
FLIGHT IN DAY	-.049***	-.049***
	(.017)	(.017)
LOG (AVG. FARE)	-1.810***	-1.729***
	(.248)	(.271)
LOG (LOAD FACTOR)	-1.478***	-.947***
	(.273)	(.339)
Segment Fixed Effects	Y	Y
Aircraft Fixed Effects	Y	Y
Demographic Controls (X^D)	Y	Y
Additional Controls	Y	Y
Carrier/Day Fixed Effects	Y	Y
Origin/Carrier Fixed Effects	Y	Y
Observations	286,004	285,509

Notes: Standard errors are in parentheses. Asterisks denote the significance level of coefficients: *** - 1 percent, ** - 5 percent, * - 10 percent. Standard errors are clustered within a segment. Additional control variables are described in the text.

Table VII. Regression Results: Actual Elapsed Time and Departure Delays

Dependent Variable:	TOTAL ACTUAL TIME, mins		DEPARTURE DELAY, mins	
	(1)	(2)	(3)	(4)
	OLS	IV	OLS	IV
INTERNET	12.486***	12.533***	7.806**	7.736**
	(4.599)	(4.605)	(3.145)	(3.149)
HHI	4.631***	4.780***	2.679**	2.799**
	(1.806)	(1.810)	(1.168)	(1.168)
INTERNET × HHI	-10.333***	-10.468***	-6.013***	-6.096***
	(2.448)	(2.450)	(1.538)	(1.538)
LATE ARRIVAL	.548***	.547***	.559***	.559***
	(.008)	(.008)	(.008)	(.008)
SCHEDULED BUFFER	-.016***	-.017***	-.017***	-.017***
	(.001)	(.001)	(.001)	(.001)
FLIGHT IN DAY	.343***	.348***	.367***	.371***
	(.050)	(.050)	(.042)	(.042)
LOG (AVG. FARE)	-4.234***	-4.530***	-2.554***	-2.797***
	(.852)	(.939)	(.587)	(.639)
LOG (LOAD FACTOR)	2.025***	2.526***	4.163***	4.167***
	(.695)	(.858)	(.478)	(.590)
Segment Fixed Effects	Y	Y	Y	Y
Aircraft Fixed Effects	Y	Y	Y	Y
Demographic Controls (X^D)	Y	Y	Y	Y
Additional Controls	Y	Y	Y	Y
Carrier/Day Fixed Effects	Y	Y	Y	Y
Origin/Carrier Fixed Effects	Y	Y	Y	Y
Observations	286,004	285,509	286,004	285,509

Notes: Standard errors are in parentheses. Asterisks denote the significance level of coefficients: *** - 1 percent, ** - 5 percent, * - 10 percent. Standard errors are clustered within a segment. Additional control variables are described in the text.

Table VIII. Regression Results: Business vs. Non-Business Flights

Dependent Variable:	SCHEDULED FLIGHT TIME, mins	
	(1)	(2)
	OLS	IV
INTERNET	2.173*	2.158*
	(1.240)	(1.243)
MORNING	-.722***	-.729***
	(.117)	(.117)
INTERNET × MORNING	.638***	.650***
	(.121)	(.122)
INTERNET × LARGE	.831*	.814*
	(.357)	(.357)
INTERNET × LARGE × MORNING	.215	.207
	(.250)	(.250)
HHI	1.296*	1.291*
	(.514)	(.515)
INTERNET × HHI	-2.556***	-2.564***
	(.691)	(.690)
SCHEDULED BUFFER	-.002***	-.002***
	(.000)	(.000)
FLIGHT IN DAY	-.067***	-.068***
	(.018)	(.018)
LOG (AVG. FARE)	-1.749***	-1.660***
	(.245)	(.269)
LOG (LOAD FACTOR)	-1.480***	-.939***
	(.273)	(.338)
Segment Fixed Effects	Y	Y
Aircraft Fixed Effects	Y	Y
Demographic Controls (X^D)	Y	Y
Congestion Controls	Y	Y
Carrier/Day Fixed Effects	Y	Y
Origin/Carrier Fixed Effects	Y	Y
Observations	286,004	285,509

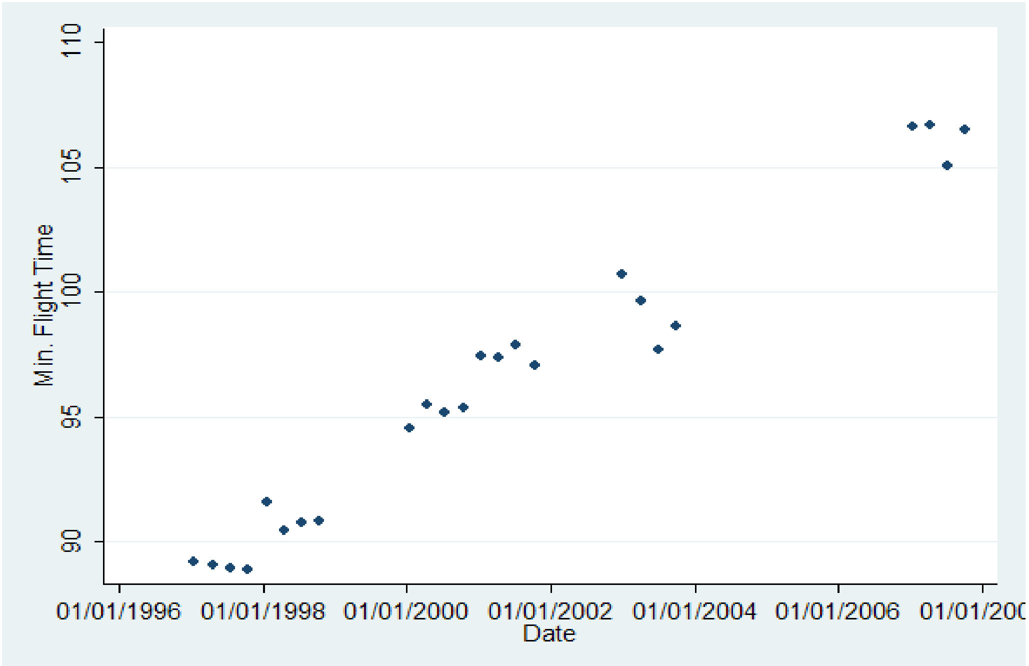
Notes: Standard errors are in parentheses. Asterisks denote the significance level of coefficients: *** - 1 percent, ** - 5 percent, * - 10 percent. Standard errors are clustered within a flight segment. Additional control variables are described in the text.

Table IX. Regression Results: Segments with and without LCC Presence

Dependent Variable:	SCHEDULED FLIGHT TIME, mins	
	(1)	(2)
	OLS	IV
INTERNET	4.069***	3.858***
	(1.433)	(1.468)
HHI	2.633***	2.610***
	(.532)	(.532)
LCC	2.251***	2.230***
	(.340)	(.342)
INTERNET × HHI	-4.267***	-4.271***
	(.727)	(.730)
INTERNET × LCC	-3.042***	-3.080***
	(.722)	(.725)
INTERNET × HHI × LCC	-.311	-.249
	(1.023)	(1.022)
SCHEDULED BUFFER	-.002***	-.002***
	(.000)	(.000)
FLIGHT IN DAY	.048**	.042*
	(.024)	(.024)
LOG (AVG. FARE)	-1.360***	-1.209***
	(.266)	(.297)
LOG (LOAD FACTOR)	-1.458***	-.785**
	(.313)	(.395)
Segment Fixed Effects	Y	Y
Aircraft Fixed Effects	Y	Y
Demographic Controls (X^D)	Y	Y
Congestion Controls	Y	Y
Carrier/Day Fixed Effects	Y	Y
Origin/Carrier Fixed Effects	Y	Y
Observations	243,113	242,605

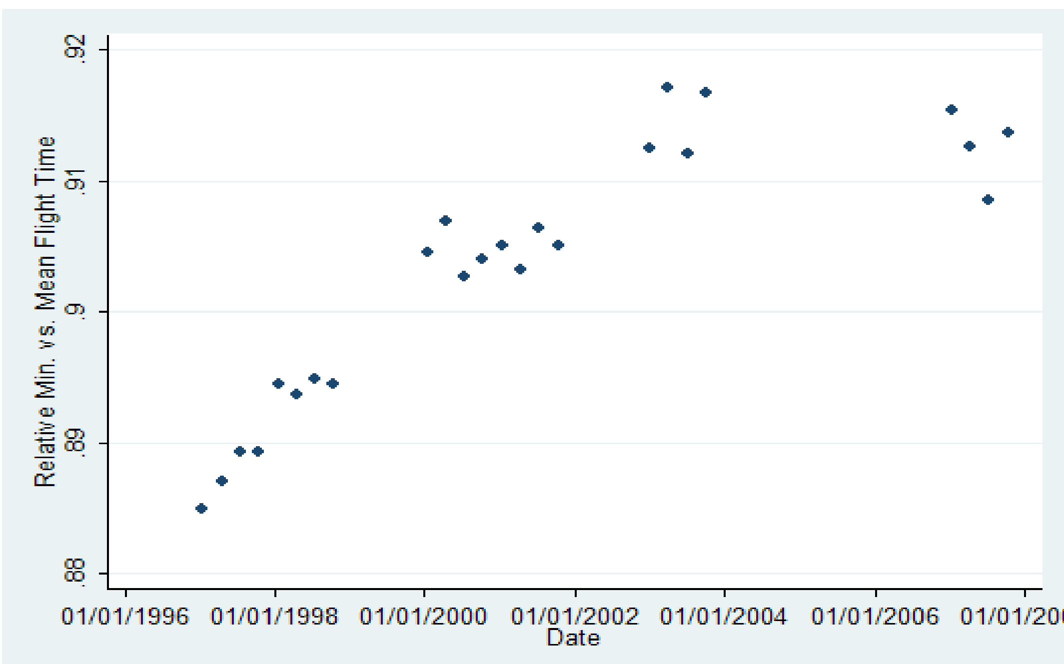
Notes: Sample excludes Southwest Airlines. Standard errors are in parentheses. Asterisks denote the significance level of coefficients: *** - 1 percent, ** - 5 percent, * - 10 percent. Standard errors are clustered within a segment. Additional control variables are described in the text.

Figure I. Average Fastest Scheduled Flying Time



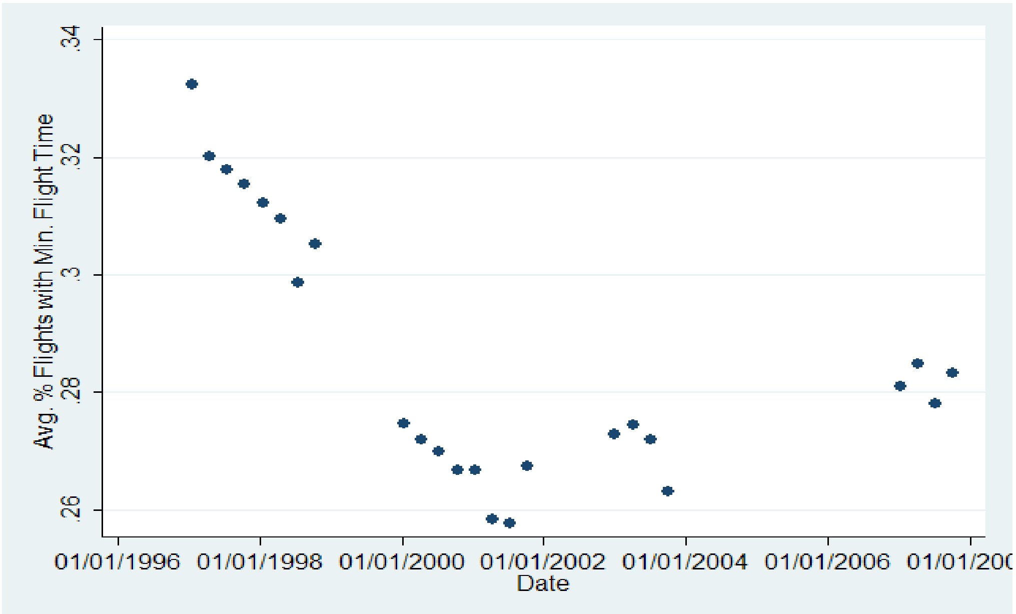
Notes: Average is calculated across directional non-stop segments that had at least five daily flights.

Figure II. Relative Change in Fastest vs. Mean Scheduled Flying Time



Notes: The figure shows the ratio between the fastest and average scheduled flying time. The sample includes directional non-stop segments that had at least five daily flights. The calculation of the average flying time excludes flights with the fastest scheduled time.

Figure III. Average Percent of Flights with the Fastest Scheduled Flying Time on a Segment



Notes: Average is calculated across directional non-stop segments that had at least five daily flights.