Location Choice and Product Specification under a Threat of Entry: Evidence from the Airline Industry[*]

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Abstract

I examine how incumbent airlines adjust their departure times in response to the threat of entry by Southwest Airlines. I find that incumbents space their flights more evenly throughout the day when faced with potential entry. The reaction depends strongly on the level of the incumbent's market share and hub status at the endpoint airports of a market. The evidence suggests that incumbents' actions are designed to deter, rather than accommodate, entry. I do not find effects on flight frequency, suggesting that incumbents may rely more on the strategic choice of product attributes than on product proliferation to deter entry.

JEL Classification: L13, L93, D43.

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1 Introduction

It is well known that incumbent suppliers may alter both the prices they charge and non-price product characteristics when faced with the threat of entry. This paper empirically examines how incumbents alter their product characteristics when faced with the threat of entry by a competitor. I study this question in the context of the U.S. airline industry by analyzing how incumbent airlines adjust their flight schedules (i.e., departure times for non-stop flights) in face of potential entry by Southwest Airlines. In this case, one of the attributes of the product is a flight's departure time, and the space of this attribute on which airlines locate their flights is a circle (i.e., 24-hour clock). Passengers have a distribution of most preferred departure times around the clock, and airlines set their flight schedules (or departure times) taking into account this distribution, the schedules of competitors, and the possibility of enabling one-stop city-pair market service by creating potential connections. Passengers obtain utility from the vertical attributes of the product, but experience disutility from the price paid and the schedule delay, which is the difference between passengers' most preferred departure time and a flight's departure time.[1]

To answer the question of interest, I view a directional airport pair as a market. I also assume an entry threat occurs when Southwest establishes a presence in both endpoint airports of a market, but before it starts flying non-stop flights in the market itself.[2] Using a within-market regression model of an airline's schedule decision over time, I ask whether the distribution of departure times for non-stop flights of an incumbent airline is affected when Southwest threatens entry, and whether departure schedules are closer together or further apart under a threat of potential competition than under the absence of it. I focus my analysis on the markets between the airports out of which Southwest

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[1] Different papers have analyzed frequency or scheduling decisions by airlines within the framework of a spatial model of horizontal product differentiation. See, for example, Panzar (1979), Borenstein and Netz (1999), Brueckner and Zhang (2001), Brueckner (2004), or Brueckner and Flores-Fillol (2007).

[2] This definition of a market and entry threat is similar to the one used by Goolsbee and Syverson (2008), who previously studied incumbent airlines' responses in prices and capacities when Southwest threatens entry into a market. Goolsbee and Syverson (2008) show that Southwest's presence at both endpoint airports of a market is a strong predictor of Southwest entering the market with non-stop flights in the future. This allows us to identify preemptive actions by measuring how incumbents respond to Southwest's presence at both endpoints of the market.

operated flights at any point between January 1993 and December 2001.

I find that incumbent airlines change their departures times when Southwest threatens a market. On average, this response takes the form of flights being more evenly spaced around the clock (i.e., incumbents increase the degree of differentiation in departure times in response to the threat of entry), which is accompanied by an increase in the incumbent's range (i.e., difference between the last and first flights of the day) and interquartile range of the distribution of departure times. Perhaps surprisingly, I do not find responses in terms of flight frequency or capacity.[3] However, incumbent responses vary with the likelihood of entry by Southwest. In large markets, where Southwest's entry is likely—and consequently entry deterrence is not possible—incumbents do not significantly change their flight schedules. On the other hand, in smaller markets where entry is uncertain but probable, incumbents adjust their flight schedules. These observed preemptive actions may reflect efforts by incumbents to reduce Southwest's profitability should it enter the market, by placing flights around times that would constitute niches of the market for a potential entrant, or closer to Southwest's expected departure times. It may also reflect efforts to reduce displacement costs (i.e., the difference between departure times and passengers' most preferred departure times) among existing valuable customers, making them less likely to switch to Southwest should it enter. Consistent with the deterrence motive, I also find that the preemptive action takes the form of incumbents scheduling their flights closer together when Southwest preannounces entry into a market (instances in which Southwest's entry is guaranteed).[4] These actions may reflect attempts to differentiate in departure times and soften price competition once entry by Southwest takes place.

Finally, I analyze heterogeneities on incumbent responses by characteristics of the market and the incumbent. I find a more pronounced response in terms of changes in flight schedules when the incumbent has a higher market share. This finding may reflect the possibility that entry deterrence is a public good when there are several incumbents

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[3] This finding parallels the findings of Goolsbee and Syverson (2008).

[4] These are situations in which Southwest begins non-stop service between two endpoint airports of the market in the same month it establishes a presence in both endpoint airports of the market.

in the market, as well as the fact that a dominant incumbent is less constrained by competition and has more at stake. Having a hub at a destination airport (as opposed to flights departing from a hub) is also a strong determinant of an incumbent's response. This finding may reflect the higher costs of adjusting departures at a hub airport (as opposed to doing the same in a non-hub airport) and the fact that airport presence is an important component of product differentiation and cost structure, perhaps providing airlines with an alternative tool to deter or accommodate entry.

The empirical literature on entry deterrence has focused on different actions, including price cuts and capacity investment (e.g., Dafny (2005), Goolsbee and Syverson (2008), Tenn and Wendling (2014), and Gedge, Roberts and Sweeting (2014)), strategic alliances (e.g., Goetz and Shapiro (2012)), advertising to influence the size of the market (e.g., Ellison and Ellison (2011)), and responses of incumbent airlines in on-time performance measures (e.g., Prince and Simon (2015)).[5] The present research complements this literature by examining product design (i.e., location) choices, which typically offer a rationale for preemptive actions.[6] The paper also adds to the empirical evidence on tests of theoretical models of spatial product differentiation, as well as the literature on airline competition. Despite the importance of understanding the effects of different product positioning strategies within a market, most of the literature on airline competition has focused on other sources of market power in the industry (such as airport presence), or the effects of entry on market outcomes after entry occurs, while allowing for product

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[5] Snider (2009) studies price cuts and capacity investment as predatory behavior in a few markets in which the Department of Justice alleged predation against American Airlines in 2000. Unlike other papers that look at preemptive actions, Snider studies an incumbent's responses when a competitor enters the market. Similarly, Kwoka and Batkeyev (2019) analyze price and capacity responses by United and US Airways when confronted by entry on specific routes or by certain rivals.

[6] The literature on entry deterrence is extensive. Theoretical work on spatial preemption includes, for example, Hay (1976), Prescott and Visscher (1977), and Schmalensee (1978), whose "proliferation strategy" stories indicate that a threat of entry might induce incumbent firms to produce a greater variety of products than they would otherwise. By crowding the space of possible attributes of the product, this strategy has the effect of limiting the profitability of entry. Other theoretical work on spatial preemption includes Bonanno (1987), who shows that entry deterrence need not be achieved through product proliferation, and in some cases the incumbent firm deters entry via location choice (or product specification strategy) rather than product proliferation. Some other theoretical papers that offer a rationale for preemptive action in decisions other than location choices are Dixit's (1979) capacity commitment model, Spence's (1981) strategic learning-by-doing model, Milgrom and Roberts' (1982) cost-signaling model, Aghion and Bolton's (1987) long-term contracting model, and Klemperer's (1987) and Farrell and Klemperer's (2007) switching costs models.

differentiation.[7] To the best of my knowledge, this paper is the first to empirically detect preemptive motives behind product design choices in terms of the space of some horizontal product attribute.

The paper is organized as follows. Section 2 describes an airline's scheduling decision problem and its relationship with models of spatial horizontal differentiation. Section 3 describes the data, and Section 4 the estimation and identification strategies. Section 5 discusses the main results, and Section 6 presents evidence on the explanation for the preemptive actions. Section 7 concludes.

2 Location Choice Theory and Airlines' Scheduling Decisions

Airlines compete for passengers based on the price charged, the quality of service (e.g., airport and in-flight service amenities), products offered (e.g., restrictions on discount fare products), and other dimensions such as the frequency of service and departure schedule on each route served. Schedule development is a component of an airline's strategic plan that involves decisions on frequency plans, timetable development, and other elements such as fleet assignment and aircraft rotation planning.[8] Schedule development

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[7] Notable exceptions to this are Goolsbee and Syverson (2008), Goetz and Shapiro (2012), and Prince and Simon (2015), who study the effects of entry threats on prices, alliances, and on-time performance (a dimension of product quality for air travel, and thus a vertically differentiated feature of the product) in the airline industry, respectively. The literature on airline competition is extensive. Examples include Borenstein (1989), Reiss and Spiller (1989), Borenstein (1991), Berry (1990), Berry (1992), Peters (2006), Berry, Carnall and Spiller (1996), Ciliberto and Tamer (2009), Benkard, Bodoh-Creed and Lazarev (2010), Berry and Jia (2010), Aguirregabiria and Ho (2012), Ciliberto, Murry and Tamer (2015), and Li, Mazur, Park, Roberts, Sweeting and Zhang (2018), among others. Scheduling decisions—mostly through on-time performance metrics as a measure of quality provision—have been studied, for example, by Mayer and Sinai (2003b), Forbes, Lederman and Tombe (2015), Forbes, Lederman and Wither (2019a), and Forbes, Lederman and Yuan (2019b). The empirical evidence on tests of theoretical models of spatial product differentiation is scarce. Some exceptions are Borenstein and Netz (1999), who study the effects of actual competition in location patterns for the airline industry, Mazzeo (2002), and Seim (2006).

[8] The airline economics literature usually classifies airlines' planning and strategic decisions into five components of interacting decisions: (1) fleet planning (e.g., fleet sizing, what aircraft to acquire/retire, when and how many, etc.); (2) network structure (i.e., hub-and-spoke system or point-to-point) and route planning (e.g., hub locations and city-pairs to be served); (3) schedule development (e.g., how often, at what times, and which aircraft to operate on each route); (4) pricing; and (5) revenue management (e.g., seat allocation for each fare type). The first three are considered long-run strategic decisions. See Barnhart (2009), Belobaba (2009), and Jacobs, Garrow, Lohatepanont, Koppelman, Coldren and Purnomo (2012) for an exhaustive discussion of the airline planning and scheduling process.

is considered a long-run strategic decision, since its implementation typically requires considerable effort, investment, and careful planning in advance. The frequency of service on each route is usually established first.[9] Timetables and aircraft rotations are decided next, after frequency decisions have been made.[10] On a daily basis, airlines make decisions on prices and the number of seats available for each fare type.

At any given price, firms have an incentive to provide departures at peak times (usually early morning and late afternoon) that are most attractive to a larger proportion of travelers in many markets.[11] However, an airline also has an incentive to set departure times that differ from the times set by rivals, in order to reduce the intensity of price competition. Different assumptions on consumers' preferences or characteristics of the demand can cause one or the other of these forces to dominate, resulting in a tendency toward either minimal or maximal differentiation.[12] Borenstein and Netz (1999) provide some suggestive evidence in this respect for the airline industry, concluding that airlines may be differentiating their departure times where possible to soften price competition.[13]

Previous studies indicate that a threat of entry might induce incumbent firms to produce a greater variety of products than they would otherwise (i.e., "proliferation strategy"),[14] or to distort the design of their products (i.e., "specification strategy") to increase

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[9] Decisions are made a year or more in advance, and are based on the routes to be flown (i.e., the airline's network), fleet capabilities, demand forecasts, competition, and the consolidation on the ratio between passengers and seats.

[10] Timetables are usually decided between 2 and 6 months in advance. The process typically continues with final revisions until the flight departs.

[11] Peak times typically vary by the characteristics of the market, such as direction of travel, distance, proportion of business travelers, etc.

[12] Smithies (1941), Eaton (1972), de Palma, Ginsburgh, Papageorgiou and Thisse (1985), Ben-Akiva, de Palma and Thisse (1989), Anderson and Engers (1994), and Irmen and Thisse (1998), for example, study the role of the elasticity or heterogeneity of demand on spatial product differentiation. See, for example, Eaton and Lipsey (1976), Neven (1986), Tabuchi and Thisse (1995), and Anderson, Goeree and Ramer (1997) for studies on the role of the distribution of consumers around the space. The role of the nature of transport costs (i.e., schedule delay costs in this case) has been studied, for instance, by Hotelling (1929), d'Aspremont, Gabszewicz and Thisse (1979), Gabszewicz and Thisse (1986), Economides (1986), Anderson (1988), and Hamilton, Macleod and Thisse (1991). Eaton and Lipsey (1975), Gabszewicz and Thisse (1986), Martinez-Giralt and Neven (1988), and Economides (1989), for example, study the role of the number of firms or outlets to be located on spatial product differentiation. Chapter 8 of Anderson, De Palma and Thisse (1992) reviews and surveys many of the theoretical models of spatial product differentiation.

[13] Borenstein and Netz (1999) study the relationship between competition in a market and the degree of product differentiation in departure times. They find that reductions in exogenous scheduling constraints increase differentiation at the market level, implying that firms may be differentiating their products where possible to soften price competition.

[14] See, for example, Hay (1976), Prescott and Visscher (1977), and Schmalensee (1978). See Loertscher

the degree of price competition faced by the entrant upon entry.[15, 16] Even though there could be different motives behind a preemptive action (i.e, deterrence or accommodation) and different means of executing a deterring strategy (i.e., product proliferation or specification), all of the location then price models on spatial preemption share a common feature: Since in the pricing stage prices are strategic complements, the number of stores and/or the locations of the stores of an incumbent firm will be different under deterrence than under accommodation.[17] One implication of this result, which I empirically test in Section 6, is that we should observe different responses by the incumbent according to, for example, different market sizes. In particular, in small markets, where entry is unlikely, we should not observe changes in departure times. In mid-size markets, where both entry and deterrence are possible, we should observe incumbents taking actions to deter entry (e.g., changes in departure times). Finally, in large markets where fixed entry costs are presumably low relative to market size and entry is likely, we should observe actions by the incumbent consistent with accommodation.[18]

Airlines, however, make scheduling (location) decisions in a much more complicated setting than the assumptions of any of the spatial models of product differentiation and spatial preemption. Air carriers not only compete on prices and departure times, but also on other dimensions (e.g., quality of service). Passengers are distributed non-uniformly in their most preferred departure times, and this distribution is expected to vary by

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and Muehlheusser (2011) for an extension of Prescott and Visscher's (1977) model to the case in which consumers are not uniformly distributed.

[15] See, for example, Bonanno (1987) for a model in which the incumbent may distort the location of its stores to deter entry. In this case, the number of stores opened by the incumbent is the same as the number of stores opened by a protected monopolist who does not face the threat of entry, but the locations of these stores are different. In Bonanno's (1987) model, when fixed entry costs (relative to market size) are "too high," entry is blockaded. When fixed entry costs (relative to market size) are in a range in which they are neither "too high" nor "too low," the incumbent may deter entry by distorting the location of its stores, moving them toward those points in the product space where there is an expectation that the entrant will place its store. When fixed entry costs are "too low," the incumbent may resort to a product proliferation strategy to deter entry, or it may accommodate entry, depending on the level of entry costs.

[16] The implicit assumption in these models is that the cost of dropping or relocating a product is sufficiently high. See Judd (1985) for more details.

[17] More specifically, if the motivation is entry deterrence, the incumbent firm will locate its stores in order to look "tough" in the pricing stage. In contrast, if the incumbent accommodates entry, it will locate its stores in order to look "soft" in the pricing stage (i.e., it will locate its stores to soften price competition should the potential entrant choose to enter the market).

[18] Theory offers similar implications in other settings (e.g., investment in capacity or advertising), which have been tested empirically in a few papers (e.g., Dafny (2005) and Ellison and Ellison (2011)).

characteristics of the market (e.g., direction of travel, distance, etc). In addition, demand is elastic, and schedule delay costs vary by customers (e.g., leisure vs business travelers). Perhaps more importantly, airlines also select schedules in order to enable one-stop city-pair market service by creating potential connections.[19] Since the value or quality of these connections is in great part described by the layover time, airlines seek to coordinate connections at their hubs at a few points in time by scheduling their flights into time periods that comprise a high number of arrivals and departures. These time periods are often referred to as "banks".[20] The fact that airlines' scheduling decisions are in part the solution of a problem in which each flight is integrated to the network adds constraints to the analysis. In particular, by scheduling many flights in banks, airlines also trade off benefits from more convenient connections against congestion costs and revenue losses from locating around times with less dense demand.[21,22] On the other hand, each flight being integrated into the network provides credibility to an entry deterrence strategy based on location choice (i.e., changes in departure times): Even though the cost of rescheduling a flight is not prohibitive, it is presumably sufficiently high given the consequential impact it has on the network.[23]

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[19] Domestic flights in the U.S. are required to allow a minimum time for connection. Additionally, the maximum connection time for two domestic flights to be eligible as a connection in a single ticket is 4 hours.

[20] The value or quality of a connection is also described by the itinerary distance relative to the non-stop distance between the origin and destination airports.

[21] See Brueckner and Lin (2016) for additional details on this trade-off. Mayer and Sinai (2003a) analyze the two commonly mentioned factors that might explain air traffic congestion: network benefits due to scheduling banks of flights and congestion externalities. They find that although both factors impact congestion, the first effect dominates empirically, implying that hub carriers incur most of the additional travel time and congestion costs from hubbing. Daniel (1995), Daniel and Harback (2008), and Molnar (2013) study other reasons an airline may find it profitable to schedule the departure and arrival of flights in short periods of time. In particular, these authors analyze the case in which an airline may find it profitable to schedule flights at a hub airport in a way that causes runway congestion if this action deters competitor entry. This airline strategy can be profitable for a carrier by deterring competitor entry by raising their costs, allowing the airline to preserve market power at the hub airport.

[22] There are other sets of factors or constraints that airlines take into account when scheduling flights, such as minimum turnaround times (i.e., minimum time required to clean and refuel the plane), time zone differences that set limits on feasible departure times, airport slot times and noise curfews that limit scheduling flexibility, or crew scheduling and routine maintenance requirements. These constraints, and the consequent schedule choices, affect airlines' operational costs, since they determine the extent of efficient utilization of fleet, crew, and ground installations.

[23] A change in the schedule of a flight is likely to involve schedule development for a higher number of flights, since typically the same plane flies multiple times per day, in many cases involving different destinations. This implies that decisions on fleet assignment across multiple markets, as well as aircraft rotation planning, may need to be reorganized, and/or that multiple arrival and departure times may need to be rearranged in order to achieve better flight schedule coordination. Moreover, additional costs

3 Data

To test whether the threats of entry in given markets are determinants of an airline's flight location (scheduling) decisions, it is necessary to measure both location decisions and threats of entry. The data come from two main sources. Domestic airline information on scheduled departure times comes from the On Time Performance (OTP) database. Certificated U.S. air carriers, which account for at least 1% of domestic scheduled passenger revenues, report air carrier scheduled and actual arrival and departure times for direct flights between airports.[24] These individual flight-level data are collected daily and reported monthly since January of 1987. I restrict the data for my analysis to Mondays, since it is typically one of the days with highest demand in a given week and an important day for business travelers who are sensitive to flight schedules.[25] Information on capacity (i.e., available seats), enplaned passengers, load factors (i.e., ratio of enplaned passengers to available seats), airport presence (i.e., total number of departures performed from an airport), and airport entry decisions come from the Air Carrier Statistics (T-100 Domestic Segment) database. These data are reported monthly since January of 1993.[26]

To select the sample for studying incumbent responses in departure times when Southwest threatens entry, I consider markets between the airports out of which Southwest operated flights at any point between January 1993 and December 2001.[27] A market in

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are likely to be incurred, since scheduling decisions also involve the consolidation and coordination of airport facilities. Rearranging gates to facilitate passenger transfers or sharing hangars and maintenance equipment, for example, typically require considerable effort and careful planning in advance.

[24] These data also provide information on the number of scheduled and actual departures, departure and arrival delays, origin and destination airports, canceled or diverted flights, taxi-out and taxi-in times, air time, and non-stop distance between airports.

[25] Results reported in the paper are robust to the selection of different days such as, for example, Fridays. These results are available from the author upon request.

[26] Both sources of data are maintained and published by the U.S. Department of Transportation (DOT).

[27] The rationale for this sample selection relies on avoiding periods in which codesharing agreements between airlines represent a significant percentage of the routes on the sample. A codesharing agreement on a particular route constitutes an alliance in which the airline that operates the flight allows the partner airline to also sell seats on their flight. Codesharing appears on a small scale in the U.S. domestic market in the late 1990s and takes off in 2004, at which time approximately 34% of the routes exhibit this type of agreement (see Ito and Lee (2007) and Goetz and Shapiro (2012) for more details about this). Goetz and Shapiro (2012) find that the probability of observing a codesharing agreement between incumbent airlines increases when Southwest threatens entry into the route. Since codesharing agreements may prompt changes in flight schedules (i.e., flight schedule coordination), to sharpen my identification strategy I restrict the sample to those periods in which codesharing is either nonexistent or an insignificant phenomenon.

this case is defined as a directional trip between an origin and destination airport.[28] Final sample selection closely follows the procedure used by Goolsbee and Syverson (2008). For each market in the sample, I look at incumbents' responses once Southwest establishes a presence in both endpoint airports of a market (i.e., threatens entry), but before it starts flying direct flights in the market itself.[29] I capture these responses using dummies in the 73-month window surrounding the month in which Southwest establishes a presence in both endpoints of a market (36 months before to 36 months after). Southwest's actual entry is defined as occurring when it establishes direct non-stop service between the two airports. I control for this event using dummies during and after Southwest starts serving the market with direct flights. The data contain 299 instances of Southwest threatening entry into markets, 140 of which Southwest had actually entered with direct flights by the end of my sample.[30]

To measure incumbent airlines' location decisions and characterize the distribution of departure times, I construct measures of differentiation in departure times for each airline-market-time, using information on scheduled departure times from the OTP database. This measure takes into account the differentiation in departures times between every pair of flights in a market owned by a given airline.[31] This statistic will not only be indicative of changes in an incumbent's flight schedules, but it will also be informative about the direction of changes in a scheduling position: whether departures schedules are

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[28] Goolsbee and Syverson (2008), who study how incumbent airlines respond on fares when Southwest threatens entry, define a market as a non-directional airport pair. In the current setting, the directionality of the market matters, since several factors that depend on the direction of travel affect the scheduling decision problem. Examples include time zones, hub or airport presence status, and airport regulations on take-offs and landings such as noise curfews, among others.

[29] Note that this definition for a threat of entry is only appropriate for low-cost carriers, due to the way in which these airlines are willing to fly routes between two non-hub airports. Goolsbee and Syverson (2008) find that when Southwest threatens a market according to this definition, it is 18.5% more likely to enter the market with a non-stop flight in the next quarter.

[30] I also follow Goolsbee and Syverson (2008) in eliminating from the sample those routes in which Southwest establishes a second endpoint airport presence simultaneously with actually flying the route, since in those cases it is not possible to identify the threat of entry separately from actual entry. Additionally, I restrict attention to those incumbents that exhibit on average, during the 73-month window, no more than 10 flights per day in the market. The rationale for this restriction relies on avoiding instances in which the space is already too crowded, making it difficult to detect spatial preemption (either through product proliferation or specification).

[31] This means, for instance, that when looking at the differentiation in departure times for airline i in market m, the measure will only contain information on the relative distance of airline i's flights in market m, telling us nothing about the distance of flights belonging to i relative to flights owned by competitor airlines in the market (if any).

becoming closer together or further apart.

To formalize this measure, consider the case of airline i in market m, with n daily departures scheduled at times $d_1, ..., d_k, ..., d_n$, and expressed as minutes after midnight. Differentiation in departure times for flight k belonging to airline i in market m is then calculated as in Borenstein and Netz (1999):

$$Diff_{imk} = \frac{1}{n-1} \sum_{l \neq k} [\min\{\mid d_l - d_k \mid, 1440 - \mid d_l - d_k \mid\}]^{\alpha}$$

where $\alpha \in (0, 1)$ is a parameter that captures the sensitivity of the differentiation index to flights that are further away.[32] I focus on the case of $\alpha = 0.5$, but also try alternative values such as 0.25 and 0.75. Note that the above index is minimized at zero, when all flights exhibit the same departure time. On the other hand, it is maximized when the n flights are equally spaced around the 24-hour clock. The number 1,440 appears in the definition of the index because I am measuring distance between flights located in a circle (i.e., 24-hour clock), and 1,440 is the number of minutes in a day.

Average differentiation in departure times for airline i in market m is

$$AvgDiff_{im} = \frac{1}{n(n-1)} \sum_{k=1}^{n} \sum_{l \neq k} [\min\{\mid d_l - d_k \mid, 1440 - \mid d_l - d_k \mid\}]^{\alpha}, \qquad 0 < \alpha < 1$$

where this index measures the average of the absolute time difference between each pair of i's flights on the market raised to the α power. I follow Borenstein and Netz (1999) and normalize the above index by the maximum possible time difference ($MaxDiff_{im}$), given the number of scheduled flights. This maximum possible time difference is simply the value of the average differentiation in departure times that would result if the flights were equally spaced around the clock. This normalization allows for comparisons of differentiation in departure times across airlines-markets-time with different numbers of scheduled flights. The measure I use to quantify the degree of differentiation in departure

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[32] When α is close to zero, this measure is more sensitive to changes in the time between flights that are close together to begin with. If α is close to 1, then this measure is equally affected by changes in the time between flights that are close together or far apart to begin with. It is also very close to the average distance between flights.

times for an incumbent airline in a market is

$$D_{im,\alpha} = \frac{AvgDif_{im}}{MaxDiff_{im}} \tag{1}$$

This variable ranges between 0 and 1, measuring the proportion of the maximum possible differentiation in departure times. The closer to 1, the closer the flights are to being evenly distributed over a 24-hour clock. I compute this index for each incumbent airline, market, and Monday observed in the data. Then, I take the average by airline, market, and month to obtain a measure of differentiation in departure times at the airline-market-month level. Since the differentiation index $D_{im,\alpha}$ is bounded between zero and one, I report my main results using as dependent variable the log-odds ratio of the index, given by $\ln\left(D^{odds}_{im,\alpha}\right) = \ln[D_{im,\alpha}/(1 - D_{im,\alpha})]$, which produces an unbounded statistic.[33]

Besides the differentiation in departure times variable, I characterize the distribution of departure times using a set of alternative measures. The list includes the departure times of the first and last flights of the day, the range (i.e., difference between the departure time of the last and first flights of the day), 25th and 75th percentiles of the distribution of departures times, and the interquartile range.

Finally, I construct other variables at the market-time level and carrier-market-time level, such as total number of passengers flying through the origin and destination airports of a market, total number of departures performed at the origin and destination airports of a market, the incumbent's market share of passengers in the market, and variables denoting the hub status of the incumbent at the endpoint airports of the market.[34] Some of these variables are then used to assess heterogeneities in the incumbent response as a function of market or incumbent characteristics.

Table 1 reports summary statistics for the final sample. The average value (standard deviation) for the log-odds ratio of the differentiation in departure times index ($\alpha = 0.5$) is 2.044 (0.940). The average of the logged number of daily departures is 1.182.

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[33] One might worry about the limited range of the differentiation index $D_{im,\alpha}$, since the assumption of a normally distributed error term may not be justifiable.

[34] For simplicity, I do not distinguish by size of the hub. I define a hub as an airport from which the incumbent airline serves at least 25 different destination airports.

4 Estimation

The empirical specification measures the impact of the threat of entry (i.e., Southwest establishing a presence in both endpoints of a market) around the time of the event (by looking at the periods before, during, and after this event), exploiting the time-series variation in flight scheduling decisions and threats of entry for a specific incumbent-market. This empirical model is similar to the one used by Goolsbee and Syverson (2008) in their study of incumbents' responses on prices under a threat of entry. The regression equation is

$$\begin{aligned} y_{imt} &= \gamma_{im} + \mu_{it} + \sum_{\tau=-8}^{3} \beta_{\tau} SW\_Threat_{m,t_0+\tau} \\ &\quad + \sum_{\tau=0}^{2} \varphi_{\tau} SW\_Entry_{m,t_e+\tau} + X'_{imt}\alpha + \epsilon_{imt} \end{aligned}$$

where y_{imt} is the outcome of interest (e.g., incumbent's degree of differentiation in departure times) for incumbent carrier i, serving market m, in month t. γ_{im} and μ_{it} are carrier-market and carrier-time fixed effects, respectively.[35] The periods in which Southwest establishes a presence in both endpoints of a route and starts flying the route are denoted by t_0 and t_e, respectively. Therefore, variables $SW\_Threat_{m,t_0+\tau}$ and $SW\_Entry_{m,t_e+\tau}$ are dummies surrounding the period when Southwest establishes a presence in both endpoints of a market but without flying the market, and dummies that begin in the period when Southwest actually starts flying the market. To measure the impact of threatened entry on incumbents' outcomes, the coefficients of interest are those corresponding to the $SW\_Threat_{m,t_0+\tau}$ dummies. These comprise eight quarterly dummies for the 24 months prior to the month in which Southwest establishes its presence at the two endpoints of the threatened market (i.e., $t_0 - 8$ to $t_0 - 1$), a dummy for the month in which Southwest establishes its presence at both endpoints of a market (i.e., t_0), two quarterly dummies for the 6 months after its presence is established (i.e., $t_0 + 1$ and $t_0 + 2$), and a single dummy for the period 7 or more months after t_0 (i.e., $t_0 + 3$). These post-establishment

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[35] To clarify this, carrier-market effects γ_{im} are fixed effects at the level of the incumbent airline and directional airport-pair. Similarly, carrier-time effects μ_{it} are represented by dummies at the airline-year-month level.

dummies take a value of one only if Southwest has not yet entered the route. I control for Southwest's actual entry into the market using the set of dummies $SW\_Entry_{m,t_e+\tau}$. This contains a dummy for the month in which Southwest starts flying the market (i.e., t_e), a dummy for the 6 months following entry into the market (i.e., $t_e + 1$), and a single dummy for 7 or more months after t_e (i.e., $t_e + 2$). Given that the regression equation includes carrier-market fixed effects, the coefficients for these dummies measure the relative size of the dependent variable in the dummy period relative to its average value in the excluded period (i.e., between 2 and 3 years prior to establishing its presence in both endpoints of a market).

I measure the impact of Southwest threatening entry on different outcomes that summarize incumbents' departure scheduling decisions. The baseline specifications use as dependent variable the log-odds ratio of the index of differentiation in departure times, where differentiation in departure times is measured by equation (1). Other specifications examine the locations of the first and last flights of the day, the range, and the interquartile range of flight locations. In most of the specifications I include in the regression equation a vector of control variables, X_{imt}, containing the (log of) total number of passengers flying through the origin and destination airports of the market, and the (log of) total number of departures performed at the origin and destination airports of the market. Finally, ϵ_{imt} is an error term. To account for intertemporal correlation in the error term, I cluster standard errors at the market-carrier level.

Identification of the effect exploits variation in scheduling decisions and threats on a given airline and market over time. Airlines schedule their flights not only in response to competing flights, but also taking into consideration the distribution of demand over the day as well as network effects (i.e., connections). Identification of airlines' motives for relocating their flights originates from the manner in which a threat will impact an airline's decision to supply flights at different departure times in a particular market at a given time. In particular, it relies on the fact that the incentive for improved connecting service or matching higher densities of demand from changes in flight schedules should not be affected one way or another by a new threat from Southwest. As the threat is generated by Southwest starting non-stop service in a market in which one of its endpoints is also the endpoint of the threatened market, the threat is unlikely to be correlated with any supply- or demand-related factors that would make it more advantageous for the incumbent airline to change the departure times of its flights in the threatened market.

There are, however, different threats to the identification strategy. The identification assumption behind any strategic effect is that the entry threats are exogenous to demand- and supply-side factors that might affect the location of flights in a given market. In other words, Southwest's decision to enter a market must be uncorrelated with cost or demand factors in the market in which the incumbent is currently operating (and shares one of its endpoints with the market Southwest enters) that would make it more suitable for the incumbent to relocate its flights. An endogeneity problem would arise if changes in the location of an incumbent's flights and initiation of a threat of entry are simply responses to changes in demand conditions (e.g., growing demand) at an endpoint airport. Similarly, responses to changes in aggregate supply at an endpoint airport (such as hubbing, de-hubbing, or changes in the level of concentration) might also confound the effects of a threat of entry. I address these issues by controlling for overall airport-level demand in the time period, as well as for the total number of departures performed at the origin and destination airports of the market. The latter helps to control for changes in hubbing behavior that may prompt changes in departure schedules in hub and non-hub (i.e., spoke) cities.

Another threat to the identification strategy may arise if both threats and schedule changes are responses made primarily to compete for passengers on one-stop service to one of the endpoint airports. For instance, consider the case in which American Airlines is offering one-stop service from Cincinnati, OH to Austin, TX through its hub in Dallas, TX. Similarly, Southwest offers non-stop service from Phoenix, AZ to Austin, TX and also from Dallas, TX to Austin, TX, and now enters the route Cincinnati, OH-Phoenix, AZ, threatening non-stop service on the route Cincinnati, OH-Dallas, TX. However, in this scenario, American and Southwest start competing over one-stop passengers in the market Austin, TX-Cincinnati, OH. Then, rather than a preemptive response to a threat of entry, the comovement between an entry threat and schedule changes may be explained by a competitive response to recently established competition for one-stop passengers. For instance, in the above example, American Airlines may change its schedule in the Dallas, TX-Cincinnati, OH market to compete with Southwest's one-stop Austin-Phoenix-Cincinnati service, by reducing its layover time for its own one-stop service from Austin to Cincinnati through Dallas.

The aforementioned type of competition would create a positive correlation between entry threats and schedule changes if Southwest's new connecting service encourages the incumbent airline to provide a different set of connecting times that it had no intention of offering before Southwest established a presence at both endpoint airports of the market. Even though competition for connecting service may be a motive for changing the location of flights in a market, I give no credence to its importance for explaining the identification of any effect. In particular, most incumbent airlines in the data are hub-and-spoke carriers, which, unlike point-to-point airlines, create one-stop service by building connections at their hub locations. The one-stop flights created by the entry threat and those belonging to incumbent airlines using the non-stop threatened market are serving completely different sets of passengers. More specifically, the threatened non-stop market can be used by passengers from many origin cities other than passengers from the origin city of the new one-stop product added by Southwest, as well as non-stop passengers. This renders it unlikely that a change in the schedule would be made primarily for the purpose of competing over a specific one-stop product that a low-cost competitor is offering. Moreover, it is unrealistic that the new one-stop Southwest product created by the entry threat is a good substitute for incumbents' service through their hubs.

5 Results

Column (1) of Table 2 reports results where the dependent variable measures the log-odds ratio of the differentiation in departure times index for the incumbent carrier in the market. The coefficients of interest for determining the impact of an entry threat on incumbents' flight schedules are the β_τ's. These are the coefficients for dummies for the 24 months prior to the month in which Southwest establishes a presence at both endpoints of the threatened market, for the establishment month (i.e., t_0) itself, for the 6 months after t_0, and a single dummy for the period 7 or more months after t_0. All of these dummies take a value of one only if Southwest has not yet entered the route. The distribution of incumbents' departure times changes significantly before Southwest begins flying the route, with incumbents shifting the distribution of flight locations toward times in which the distribution of departure times is more equally spaced around the clock. Since all specifications include market-carrier fixed effects, reported coefficients show the relative sizes of the dependent variable in the dummy period relative to its average value in the excluded period between 25 and 36 months prior to t_0. By the time Southwest establishes a presence at both endpoint airports of the market (period t_0), the odds ratio of the differentiation in departure times index is 30% higher than in the excluded period. Moreover, this variable increases slightly further as time passes without Southwest entering the market with non-stop flights. To illustrate the size of the effect, in the case of an incumbent with two flights in the market (and assuming that flight frequency does not change with the entry threat), the value of the index for the excluded period would correspond to a schedule with one departure at 8am and another departure at 4:40pm. The entry threat would imply moving the second flight to 5:34pm if the first flight remained at 8am.

The aforementioned odds ratio index is also higher in months before t_0 than in the excluded period. The patterns suggest that the odds ratio index begins to increase around 2 quarters before t_0 (i.e., between 4 and 6 months before the month in which Southwest establishes its presence in both endpoints of the market).[36] The odds ratio

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[36] As Goolsbee and Syverson (2008) note, it is not surprising to observe a preemptive action before the month in which Southwest establishes a presence at both endpoints of the market. This preemptive action should take place when incumbents realize that Southwest's chances of entering a market have risen. Since advertising, selling tickets, and hiring decisions must be made several months before the entry actually occurs, airlines typically announce entry several months in advance. Moreover, as Goolsbee and Syverson (2008) note, industry insiders are likely to find out about entries before the public announcement, as airlines must negotiate gate leases and airport facilities with the airport authority. In their study, Goolsbee and Syverson (2008) find statistically significant differences in incumbents' prices (relative to the excluded period) as far as 7 quarters before t_0.

of the differentiation in departure times index increases to 31% above the average of the baseline period once Southwest actually enters the market with non-stop flights at time t_e. This trend in the outcome variable continues in the 6 months following entry, and decreases afterward (decreasing to almost 26% above the average of the baseline period). These results indicate that preemptive actions in terms of flight location decisions are important. Essentially, all of the differentiation in the departure times effect Southwest entry has on incumbents' flight locations takes place before Southwest begins non-stop flight operations in the market itself.

Demand and supply shocks may also be an alternative explanation for the results reported in column (1). For instance, if Southwest chooses to enter airports where aggregate demand is growing faster, or de-hubbing at some of the endpoint airports of the market is taking place, this will lead to a spurious correlation between the entry threat and the change in incumbents' departure times. To account for these confounding effects, I control in the regressions for the (log of) total number of passengers flying through the origin and destination airports of the market, and the (log of) total number of departures performed at the origin and destination airports of the market. Column (2) of Table 2 reports the results of a specification that controls for the potential role of demand and supply shocks. All of these control variables are not statistically significant. Coefficients related to the threat of entry and entry variables are slightly smaller than those reported in column (1), although still statistically significant and economically substantial.

One possibility that might explain these findings is that under the threat of entry, incumbents might be adjusting the frequency of departures in the market, and consequently the changes in location patterns observed in the data might be their response to this action. This would confound the distinction between the location choice mechanism and the product proliferation strategy if, for instance, incumbents increase flight frequency under a threat of entry, and as a consequence relocate their flights more equally spaced around the clock as a response to it.[37] Columns (3) and (4) of Table 2 report results where the

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[37] In the case of the airline industry, investments in capacity might be achieved through a higher flight frequency. Therefore, in this case, a higher flight frequency may not only serve the purpose of spatial preemption (i.e., through a product proliferation strategy), but also preemption through capacity commitments. Dixit's (1979) capacity commitment model, for example, offers a rationale for investments

dependent variables are the (log of) average number of departures per day in the market and the (log of) number of seats per month, respectively. Almost all of the dummies surrounding the threat event are not statistically significant at conventional levels, and in many instances they change signs over time. This suggests, at least, that the increase in differentiation in departure times is not always accompanied by an increase in the number of flights or capacity.[38] In column (5) I run the baseline specification, including as an additional control variable the (log of) average number of departures per day in the market. The results are almost identical to those reported in column (2). This set of results would support the hypothesis that airlines use, as a preemptive action, a product specification strategy by reallocating their flights or capacity decisions across different departure times (rather than crowding the space by increasing flight frequency).

I augment this analysis in several ways. First, I consider alternative measures of differentiation in departures times by taking into account different values of α, the parameter that captures the sensitivity of the differentiation index to flights that are located further away. Columns (2) and (3) of Table 3 report the results for alternative definitions of the log-odds ratio of the differentiation in departure times index, which were computed using values of α of 0.25 and 0.75, respectively. The results are qualitatively identical to those reported in column (1) for α equal to 0.5 (i.e., baseline specification). The magnitudes of the coefficients, however, are different. In particular, there is a monotonic relationship between the values of α and estimates of the coefficients associated with any of the dummy variables surrounding threat and entry events. These results might suggest that the relocation of flights takes place by rescheduling flights that are further away to begin with. Columns (4) to (6) of the table report results using as dependent variable the differentiation in departure times index described by equation (1). The results are

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in capacity as a preemptive motive. See Snider (2009) for an application of this to the airline industry in the context of predatory behavior.

[38] The result related to flight frequency is robust to other sources of data, as well as to the distinction between departures performed and scheduled. Results for departures scheduled and performed based on information from the Air Carrier Statistics (T-100 Domestic Segment) are available from the author upon request. In both cases, the results are qualitatively and quantitatively similar to those reported in column (2) of Table 2, confirming the preemptive actions by incumbent firms in terms of location decisions of flights within a market-day, instead of number of departures. The results shown in column (2) of Table 2 are also consistent with the findings reported by Goolsbee and Syverson (2008) related to flight frequency.

qualitatively similar to those reported in columns (1) to (3).

A second extension of the baseline results considers different moments of the distribution of departure times, such as the departure times of the first and last flights of the day; the range (i.e., difference between the departure times of the last flight of the day and first flight of the day); 25th and 75th percentiles of the distribution of departure times; and the interquartile range. Column (1) of Table 4 shows the estimation of the model where the dependent variable is the (log of) range. The threat of entry has a positive and significant effect on the range, increasing the time difference between the first and last flights of the day approximately 11% above the average of the baseline period. This coefficient implies an average increase in the range of approximately 57 minutes. The trend continues in the 6 months following entry and decreases slightly afterward, in which the range rises to approximately 7% above the average of the baseline period. One might wonder whether this increase in the range is a consequence of first flights of the day departing earlier, or last flights of the day departing later. Columns (2) and (3) of Table 4 show incumbents' response in terms of departure times of first and last flights of the day. The estimates are imprecise, but the point estimates suggest that on average, an incumbent's response takes the form of first and last flights of the day departing earlier and later, respectively, on threatened routes in the period before and around when Southwest enters the second endpoint airport of the market. The lack of precision of the estimates might suggest that incumbents might be rescheduling either the first or last flight of the day (but not necessarily both), depending on the characteristics of the market.[39] Columns (4), (5), and (6) report results from estimation of the model, where the dependent variables are the interquartile range of the distribution of departure times and the 25th and 75th percentiles of this distribution, respectively. The results show that the interquartile range of the distribution of departure times increases as a response to Southwest threatening entry into a market. This is explained by a decrease (increase) in the 25th (75th) percentile of the distribution. Overall, these results imply that the adjustment in the distribution of departure times and the higher levels of differentiation

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[39] An incumbent's reaction, for example, might be influenced by the relative intensities of demand in the morning and evening peak demand periods.

in this variable are not only driven by changes in schedules of flights at the extremes of the day, but also by flights located closer to the center of the distribution.

Taken together, the results suggest that incumbents do engage in preemptive scheduling behavior when Southwest threatens entry into a market. In Appendix A.1 I show that my results do not seem to be driven by a price- and cost-cutting strategy, supporting the hypothesis that incumbents' changes in flight schedules respond to a strategy rather than an efficiency motive. Appendix A.2 explores and discusses heterogeneous effects by incumbent and market characteristics. In particular, I find that the response in terms of changes in departure times is more pronounced when the incumbent has a higher market share. Having a hub at a destination airport (as opposed to flights departing from a hub) is also a strong determinant of an incumbent's response. In the next section I present some evidence regarding the motivation for these preemptive actions.

6 Entry Deterrence or Accommodation?

A natural question is whether the preemptive actions taken by incumbent airlines when Southwest threatens entry into a market represent an entry deterrence strategy or a strategy designed to soften competition once entry occurs (i.e., an accommodation strategy).

To test this, I conduct a set of different analyses. First, following the insights of Dafny (2005) and Ellison and Ellison (2011), I compare preemptive behavior in markets of different sizes. If entry deterrence is the motivation, we should not observe a preemptive action where entry is impossible or unlikely. Southwest's business model, based on aircraft productivity and density of the market, implies that market size may be a good proxy for assessing the likelihood of entry, conditional on presence at both endpoints of the market.[40] Then, we should not observe a preemptive action in very small markets, since either entry deterrence (or accommodation) is unnecessary. On the other hand, if entry deterrence is impossible in very large markets, we should observe actions consistent with accommodation in these markets. Finally, in mid-size markets, where entry is uncer-

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[40] I measure market size as the mean of the total population in 2004 of the origin and destination cities. These data come from the Population Estimates Program of the U.S. Bureau of Statistics, which produces annually population estimates based upon the last decennial census.

tain, we should observe incumbents taking actions to deter entry. Unfortunately, for the purposes of detecting the motivation behind these preemptive actions, my dataset does not contain sufficient heterogeneity in market size to make it plausible that I could find these heterogeneous responses (most of the markets in my sample are relatively large). In light of this, I attempt to test this hypothesis by dividing the sample into two mutually exclusive subsamples: (1) those markets in which market size is below the 33rd percentile of the distribution of market size, and (2) those markets in which market size is at least the 33rd percentile. Columns (2) to (3) of Table 5 report the results of the analysis, showing that the effect of a threat of entry on the log-odds ratio of the differentiation index is largest in smaller markets (i.e., those markets in the first tercile of the distribution of market size); in these instances, Southwest entry is uncertain. In instances in which the average market size is above the 33rd percentile, the effect of a threat of entry on the log-odds ratio of the differentiation index is smaller and statistically insignificant for all of the dummies. Thus, a plausible interpretation of these results would be that when there is no possibility of deterrence, as in markets in the upper two terciles, incumbents take, at best, modest actions. These results may suggest that incumbents' responses are motivated by their goal of deterring Southwest from entry.

To further investigate the strategic motives behind the preemptive actions, I follow an analysis identical to the one performed by Goolsbee and Syverson (2008) by looking at those markets in which Southwest begins direct service between two endpoint airports of the market in the same month that it starts operating in the second endpoint airport. These are instances in which entry is likely to be preannounced, and therefore the deterrence motive is very unlikely since it seems impossible to deter entry. Column (4) of Table 5 shows the results from estimation of this model. All coefficients of interest are negative and precisely estimated (statistically significant at conventional levels of significance). A negative value for the coefficients of interest implies that incumbents are adjusting their flight schedules (departure times) so that flights are closer together. If incumbents are accommodating entry when Southwest preannounces entry into a market, the fact that the response in this case is opposite to the one observed in the baseline estimation (column (1) of Table 5), in which incumbents respond by scheduling their flights more evenly spaced around the clock, may indicate that the motivation for preemptive actions is entry deterrence.

How the deterrence action (i.e., incumbents scheduling their departure times more evenly spaced around the clock) might operate is not clear. A possible mechanism involves business stealing, by placing flights around times that would constitute niches of the market for a potential entrant. Then, a plausible explanation for the observed preemptive action is that it reflects efforts by incumbents to reduce displacement costs (i.e., difference between the departure time and passengers' most preferred departure times) among existing valuable customers, making them less likely to switch to Southwest should it enter. Another possible explanation for the observed preemptive behavior is that it may reflect efforts by incumbents to place flights close to Southwest's expected departure times. The mechanism here is the same as before: business stealing effects. On the other hand, efforts to concentrate flights more closely together when Southwest preannounces entry into a market may be an attempt to differentiate in departure times and soften price competition once entry by Southwest takes place.

Overall, the findings in this section seem to support the entry deterrence story. However, the support is limited, due in part to the limited heterogeneity in market size in my sample.

7 Conclusions

I have examined whether entry threats by Southwest cause incumbent airlines to change the distribution of departure times, in an effort to either deter or accommodate entry. The results indicate that incumbents do indeed take preemptive actions as a response to Southwest's entry threat. In particular, an incumbent airline reacts by rescheduling their flights in a market, which on average takes the form of incumbents scheduling their flights more evenly spaced around the clock before entry takes place. The results also reveal that this response is typically accompanied by an increase in the incumbent's range in departure times (i.e., difference between the last and first flights of the day), as well as an increase in the interquartile range of the distribution of departure times. This preemptive action does not seem to be driven by efficiency motives or airport-specific supply or demand shocks. I also find that higher market share is a strong determinant of the strength of the carrier's response to a threat of entry by Southwest. The response in terms of changes in flight schedules is more pronounced when the incumbent has higher market share. Having a hub at a destination airport (as opposed to flights departing from a hub) is also a strong determinant of the incumbent's response.

I also found that in markets where Southwest's entry is likely—and consequently entry deterrence is not possible—incumbents seem to take modest actions and do not appear to change their flight schedules significantly. Additionally, and also consistent with the deterrence motive, I provide suggestive evidence that the preemptive action takes the form of incumbents scheduling their flights closer together when Southwest is likely to preannounce entry into a market.

Overall, the findings of the paper suggest that, in addition to pricing and quality, schedule planning is an important tool for competition in the U.S. passenger airline industry. The paper demonstrates the importance of considering the role of scheduling decisions not only in terms of integrating carriers' networks, but also as a strategic response to the competitive environment.

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A Appendix

A.1 Robustness

In this section I check whether my results are somehow being driven by a price- and cost-cutting strategy. Goolsbee and Syverson (2008) find that incumbents' market prices generally fall in the face of a threat of entry by Southwest. A concern here is that when Southwest threatens entry into a market, incumbent airlines respond not only by cutting prices, but also costs, in these markets in order to sustain profitability, and that this cost-cutting behavior is performed through scheduling decisions. The feasibility of this price- and cost-cutting strategy through scheduling decisions depends on the extent to which the scheduling of departure times impacts costs.[41] Airlines' operational costs linked to scheduling decisions are typically determined by two factors: (1) the extent of efficient utilization of fleet, crew, and ground installations (2) the costs derived from congestion.

While airlines can reschedule their flights to avoid congestion and reduce costs, this strategy also involves a revenue loss. Hub carriers want to maximize the number of possible connecting markets for passengers, but also want to minimize passenger travel time spent on congestion delays or layover times. Thus, they must trade off all costs associated with congestion against the benefits of scheduling banks of flights. Although airlines can partially offset increased congestion by smoothing scheduled flight arrival times, it comes at the expense of increasing the length of layovers for some passengers (potentially decreasing profits). In fact, Mayer and Sinai (2003a) find that airlines incur most of the congestion costs from hubbing, implying that congestion is the price they are willing to pay for the network benefits associated with the hub-and-spoke system.[42] Thus, the empirical evidence does not provide support for a cost-cutting strategy motivated by lower congestion costs. In any case, I examine how fleet utilization and different variables reflecting airport congestion are affected by a threat of entry by Southwest. Columns (1) and (2) of Table 6 examine the average time elapsed by an aircraft between actual push-

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[41] It also depends on the extent to which passengers are more sensitive to price than to departure times.

[42] Brueckner and Lin (2016) also provide anecdotal evidence from practitioners in the industry supporting this view.

back from the gate and takeoff (i.e., taxi-out) and between landing and arrival at the destination airport gate (i.e., taxi-in), respectively.[43] These two variables are expected to capture runway congestion, since they include the time that the aircraft spends on the taxiway system and in runway queues. The results show that there are no significant patterns in taxi-in and taxi-out times. The coefficients tend to be small, implying average changes in elapsed times of no more than 1 minute. In all cases, the coefficients are not statistically significant, and the coefficients of the time dummies change signs over the event study. Columns (3) and (4) of Table 6 examine average departure and arrival delays, respectively.[44] The results indicate that incumbents incur in higher departure and arrival delays when faced with the threat of entry. A plausible interpretation of these results is that, instead of trying to cut costs through scheduling decisions when faced with potential competition, incumbents are willing to pay higher congestion costs because of an even higher expected revenue associated with entry deterrence or accommodation via scheduling planing. Finally, columns (5) and (6) of Table 6 study the response on utilization of the fleet. The goal is to understand whether incumbents are trying to increase aircraft productivity in threatened markets. The dependent variables I consider are the (log of) turnaround time (i.e., time required to unload an airplane after its arrival at the gate and prepare it for departure) and (log of) flight time.[45] There are no effects of the threat of entry on these variables. All coefficients are small and not statistically significant.

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[43] Information on taxi-out and taxi-in times is available since January 1995. To construct these variables I take the average across observations at the flight level by incumbent-market-month.

[44] Departure delay is defined as the difference between the scheduled departure time and the actual departure time from the origin airport gate. Arrival delay is defined as the difference between the actual arrival time and the scheduled arrival time. These two variables are equal to 0 if the flight departs or arrives earlier than planned. To construct these two variables, I average the information at the flight level by carrier-market-month.

[45] These two variables are computed at the flight level, then averaged at the carrier-market-month level. Turnaround time at the flight level is computed as the time in minutes between a flight's scheduled arrival time and its next scheduled departure time within the same day and airport (if any). Flight time at the flight level is measured as the time in minutes between a flight's scheduled arrival time at its destination airport and its scheduled departure time from its origin airport (after accounting for time zone differences).

A.2 Subsample Analysis

In this section I study how market and incumbent characteristics interact with an incumbent's response in terms of changes in departure times when Southwest threatens entry into a market. More specifically, I examine whether preemptive actions in departure times vary according to the incumbent's market power and the hub status of the endpoint airports of the market.

In the first subsample analysis, I study the incumbent's response as a function of its market share, measured in terms of passengers transported. Presumably, one should expect a stronger incumbent's response in those markets in which the incumbent has a greater market share, not only because it has more at stake, but also because it is less constrained by competition. In addition, if deterrence is the motivation behind changes in departure times, one may conjecture that entry deterrence may become a public good when there are several incumbents in the market: Since entry deterrence requires that the incumbent take a costly action, and other incumbents also benefit from an entry deterring action taken by a first incumbent, every incumbent airline would like to deter entry but would prefer not to incur the associated costs.[46] To test this hypothesis, I divide the sample into two mutually exclusive subsamples: (1) those cases in which the incumbent's average market share is below 75% and (2) those cases in which the incumbent's average market share is at least 75%.[47] Columns (1) and (2) of Table 7 report the results of the analysis, showing that the effect of a threat of entry on the log-odds ratio of the differentiation index is largest for those incumbents with an average market share of at least 75% (i.e., those instances in which the incumbent is essentially a monopolist). In instances in which the incumbent's market power is lower (those in which the average market share is below 75%), the effect of a threat of entry on the log-odds ratio of the differentiation index is negative or small, and statistically insignificant. Overall, the results seem to confirm the hypothesis that the incumbent's response is stronger in those

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[46] Gilbert and Vives (1986), for example, show that this intuition may be misleading in a model of quantity commitments under some specific conditions when incumbents move simultaneously. For more general models, the conclusions may be different. See, for instance, Waldman (1987), McLean and Riordan (1989), and Waldman (1991).

[47] The incumbent's average market share is computed over the period before Southwest establishes its presence at both endpoints of the market.

instances in which the incumbent has a large market share.

In a second subsample analysis, I divide the sample according to the hub status of the incumbent at the origin and destination airports of the market in question. Specifically, I run separate models for flights departing from a hub and flights arriving at a hub. The effect of a threat of entry on an incumbent's response as a function of the hub status at the origin or destination airport is not trivial. The literature has established that an airline's operation at a given airport significantly affects its competitive position on routes flown out of that airport.[48] The mechanisms behind this phenomenon might include greater market power—due, for example, to the control of airport facilities or the complementarity between the number of destinations served out of the airport and the use of frequent flier programs—, lower costs and better service through the use of a hub-and-spoke network, or product differentiation (e.g., airport amenities). According to this established fact, between airport presence and market dominance, we should observe a stronger incumbent's response in flights departing from a hub than in the case of flights arriving at a hub.[49] On the other hand, adjusting the schedule of departures at a hub airport seems to be a much more complicated task than doing the same at a non-hub airport, since it would involve rescheduling a higher number of flights (in order to account, for instance, for gate availability and connections). Similarly, if airport presence is an important component for product differentiation and cost structure, an incumbent airline might not need to alter location times in order to accommodate or deter entry, since alternative strategies to soften or intensify competition could potentially be achieved in different and more effective ways.[50] Columns (3) and (4) of Table 7 show the results of the hub subsample analysis. We observe that the coefficients on the threat variables are positive and statistically significant when the destination airport is a hub (as opposed to the case in which the origin airport is a hub). In the sample of markets in

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[48] See, for instance, Levine (1987); Borenstein (1989); Morrison, Winston, Bailey and Kahn (1989); Berry (1990); Berry (1992); Lederman (2007); and Lederman (2008), among others.

[49] The reasons would be the same as those previously discussed for the case of an incumbent with a high market share.

[50] For instance, when firms compete in several non-price dimensions, Irmen and Thisse (1998) show that if one dimension is sufficiently dominant, firms will maximally differentiate along that dimension and minimally differentiate along all others.

which the destination airport is a hub, the coefficient measuring the effect of a threat of entry by Southwest on the log-odds ratio of the differentiation index is 0.342 (at t_0) and statistically significant at conventional levels of significance. In contrast, this coefficient is 0.197 and statistically insignificant when the sample of markets includes only incumbents in which the origin airport is a hub. Overall, these results are indicative of an incumbent's reacting more aggressively when the origin airport of the market is not a hub, something that would be consistent with the cases of product differentiation or schedule adjustment costs at a hub described above.

A.3 Appendix of Tables

Table 1: Summary Statistics

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
$\ln(D_{0.5}^{odds})$	13,833	2.044	0.940	-2.398	6.577
$\ln(D_{0.25}^{odds})$	13,833	2.693	0.852	-0.902	7.271
$\ln(D_{0.75}^{odds})$	13,833	1.704	1.073	-3.703	6.171
$\ln(D_{0.5})$	13,837	-0.172	0.152	-2.485	0.000
$\ln(D_{0.25})$	13,837	-0.091	0.079	-1.622	0.000
$\ln(D_{0.75})$	13,837	-0.247	0.229	-3.727	0.000
ln*(number of daily departures)*	13,839	1.182	0.421	0.693	2.485
ln*(number of seats)*	13,839	9.424	0.502	6.662	10.930
ln*(range in departure times)*	13,837	6.368	0.364	1.609	7.219
ln*(interquartile range in departure times)*	13,837	6.161	0.330	1.609	7.219
ln*(departure delay)*	13,133	1.501	1.196	-3.401	5.662
ln*(arrival delay)*	13,573	1.859	1.016	-2.996	4.758
ln*(taxi-out)*	8,922	2.645	0.284	1.711	3.860
ln*(taxi-in)*	8,922	1.647	0.383	0.348	3.503
ln*(turnaround time)*	8,887	3.995	0.416	2.996	6.354
ln*(flight time)*	13,839	4.849	0.415	3.664	5.859
ln*(total passengers origin airport)*	13,839	13.133	0.787	9.609	14.601
ln*(total passengers destination airport)*	13,839	13.129	0.786	9.609	14.601
ln*(total departures from origin airport)*	13,839	8.783	0.749	5.142	11.104
ln*(total departures from destination airport)*	13,839	8.779	0.749	5.142	11.104

Note: The table reports summary statistics of variables in the final sample. Data come from the On Time Performance Database (OTP) and the Air Carrier Statistics (T-100 Domestic Segment) Database.

Table 2: Incumbent Response to a Threat of Entry

	(1)	(2)	(3)	(4)	(5)
Variables	$\ln(D^{odds}_{0.5})$	$\ln(D^{odds}_{0.5})$	$\ln(flights)$	$\ln(seats)$	$\ln(D^{odds}_{0.5})$
$SW\_Threat\_t_0\text{-}8$	-0.034	-0.039	-0.037**	-0.007	-0.020
	(0.068)	(0.068)	(0.016)	(0.020)	(0.067)
$SW\_Threat\_t_0\text{-}7$	0.033	0.035	-0.048***	-0.076***	0.060
	(0.070)	(0.068)	(0.018)	(0.020)	(0.067)
$SW\_Threat\_t_0\text{-}6$	0.104	0.109	-0.038*	-0.060**	0.128
	(0.088)	(0.085)	(0.021)	(0.024)	(0.083)
$SW\_Threat\_t_0\text{-}5$	0.139	0.139	-0.027	-0.049*	0.152*
	(0.095)	(0.094)	(0.024)	(0.028)	(0.091)
$SW\_Threat\_t_0\text{-}4$	0.149	0.143	-0.007	-0.039	0.147
	(0.101)	(0.101)	(0.028)	(0.033)	(0.098)
$SW\_Threat\_t_0\text{-}3$	0.184	0.183	-0.012	-0.060*	0.189*
	(0.113)	(0.112)	(0.030)	(0.035)	(0.107)
$SW\_Threat\_t_0\text{-}2$	0.244**	0.247**	0.007	-0.047	0.244**
	(0.123)	(0.120)	(0.031)	(0.037)	(0.115)
$SW\_Threat\_t_0\text{-}1$	0.277**	0.278**	0.030	-0.010	0.263**
	(0.132)	(0.129)	(0.034)	(0.040)	(0.123)
$SW\_Threat\_t_0$	0.300**	0.291**	0.024	-0.028	0.279**
	(0.143)	(0.141)	(0.038)	(0.044)	(0.135)
$SW\_Threat\_t_0+1$	0.338**	0.324**	0.035	-0.031	0.307**
	(0.150)	(0.150)	(0.040)	(0.046)	(0.144)
$SW\_Threat\_t_0+2$	0.357**	0.346**	-0.011	-0.096*	0.352**
	(0.168)	(0.167)	(0.044)	(0.051)	(0.162)
$SW\_Threat\_t_0+3$	0.378**	0.364**	-0.011	-0.077	0.369**
	(0.176)	(0.176)	(0.047)	(0.053)	(0.171)
$SW\_Entry\_t_e$	0.312*	0.296	0.007	-0.055	0.292*
	(0.182)	(0.181)	(0.049)	(0.055)	(0.176)
$SW\_Entry\_t_e+1$	0.313	0.296	0.002	-0.077	0.295
	(0.192)	(0.192)	(0.052)	(0.057)	(0.186)
$SW\_Entry\_t_e+2$	0.258	0.241	-0.023	-0.087	0.253
	(0.206)	(0.206)	(0.059)	(0.064)	(0.199)
Observations	13,833	13,833	13,839	13,839	13,833

Notes: All specifications include airline-market fixed effects and airline-time fixed effects. All specifications, except column (1), include as control variables the (log of) total number of passengers flying through the origin and destination airports of the market, and the (log of) number of total departures performed at the origin and destination airports of the market. Column (5) includes as an additional control the (log) number of flights for the carrier in the market. Standard errors are in parentheses and are clustered by market-carrier. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3: Incumbent Response to a Threat of Entry

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	$\ln(D^{odds}_{0.5})$	$\ln(D^{odds}_{0.25})$	$\ln(D^{odds}_{0.75})$	$\ln(D_{0.5})$	$\ln(D_{0.25})$	$\ln(D_{0.75})$
$SW\_Threat\_t_0$-8	-0.039	-0.032	-0.045	-0.009	-0.004	-0.014
	(0.068)	(0.060)	(0.079)	(0.012)	(0.006)	(0.019)
$SW\_Threat\_t_0$-7	0.035	0.036	0.040	0.005	0.003	0.007
	(0.068)	(0.061)	(0.078)	(0.012)	(0.006)	(0.017)
$SW\_Threat\_t_0$-6	0.109	0.105	0.118	0.021	0.010	0.031
	(0.085)	(0.076)	(0.099)	(0.016)	(0.008)	(0.024)
$SW\_Threat\_t_0$-5	0.139	0.126	0.160	0.025	0.012	0.038
	(0.094)	(0.084)	(0.110)	(0.017)	(0.008)	(0.025)
$SW\_Threat\_t_0$-4	0.143	0.121	0.175	0.036*	0.018*	0.056**
	(0.101)	(0.090)	(0.117)	(0.019)	(0.009)	(0.028)
$SW\_Threat\_t_0$-3	0.183	0.165*	0.212	0.039*	0.020**	0.058*
	(0.112)	(0.099)	(0.130)	(0.020)	(0.010)	(0.030)
$SW\_Threat\_t_0$-2	0.247**	0.224**	0.282**	0.051**	0.027**	0.076**
	(0.120)	(0.107)	(0.140)	(0.021)	(0.010)	(0.032)
$SW\_Threat\_t_0$-1	0.278**	0.252**	0.317**	0.062***	0.032***	0.091***
	(0.129)	(0.114)	(0.151)	(0.022)	(0.011)	(0.033)
$SW\_Threat\_t_0$	0.291**	0.254**	0.349**	0.058**	0.030***	0.088**
	(0.141)	(0.124)	(0.166)	(0.023)	(0.011)	(0.034)
$SW\_Threat\_t_0$+1	0.324**	0.288**	0.380**	0.068***	0.035***	0.101***
	(0.150)	(0.132)	(0.176)	(0.023)	(0.012)	(0.036)
$SW\_Threat\_t_0$+2	0.346**	0.314**	0.402**	0.061**	0.032***	0.091**
	(0.167)	(0.149)	(0.196)	(0.024)	(0.012)	(0.037)
$SW\_Threat\_t_0$+3	0.364**	0.337**	0.413**	0.061**	0.032**	0.090**
	(0.176)	(0.157)	(0.207)	(0.026)	(0.013)	(0.039)
$SW\_Entry\_t_e$	0.296	0.281*	0.321	0.063**	0.033**	0.094**
	(0.181)	(0.161)	(0.213)	(0.027)	(0.013)	(0.040)
$SW\_Entry\_t_e$+1	0.296	0.277	0.329	0.054*	0.028**	0.079*
	(0.192)	(0.171)	(0.227)	(0.028)	(0.014)	(0.042)
$SW\_Entry\_t_e$+2	0.241	0.236	0.257	0.039	0.021	0.056
	(0.206)	(0.182)	(0.242)	(0.029)	(0.014)	(0.044)
Observations	13,833	13,833	13,833	13,837	13,837	13,837

Notes: All specifications include airline-market fixed effects and airline-time fixed effects. All specifications include as control variables the (log of) total number of passengers flying through the origin and destination airports of the market, and the (log of) number of total departures performed at the origin and destination airports of the market. Standard errors are in parentheses and are clustered by market-carrier. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4: Incumbent Response to a Threat of Entry

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	$\ln(range)$	$\ln(first\ \ flight)$	$\ln(last\ \ flight)$	$\ln(iqr)$	$\ln(pctl\ \ 25th)$	$\ln(pctl\ \ 75th)$
$SW\_Threat\_t_0\text{-}8$	-0.031	0.001	-0.009	0.000	-0.020	-0.002
	(0.026)	(0.017)	(0.009)	(0.027)	(0.017)	(0.010)
$SW\_Threat\_t_0\text{-}7$	-0.016	0.005	-0.008	0.025	-0.023	0.002
	(0.025)	(0.019)	(0.010)	(0.028)	(0.020)	(0.011)
$SW\_Threat\_t_0\text{-}6$	0.021	-0.003	0.005	0.077**	-0.044*	0.019
	(0.033)	(0.023)	(0.014)	(0.035)	(0.025)	(0.014)
$SW\_Threat\_t_0\text{-}5$	0.033	-0.019	0.007	0.089**	-0.055*	0.020
	(0.035)	(0.028)	(0.014)	(0.036)	(0.030)	(0.014)
$SW\_Threat\_t_0\text{-}4$	0.065	-0.043	0.011	0.107**	-0.076**	0.020
	(0.040)	(0.033)	(0.017)	(0.042)	(0.032)	(0.018)
$SW\_Threat\_t_0\text{-}3$	0.065	-0.039	0.012	0.128***	-0.076**	0.025
	(0.042)	(0.033)	(0.020)	(0.043)	(0.036)	(0.020)
$SW\_Threat\_t_0\text{-}2$	0.092**	-0.054	0.016	0.149***	-0.092**	0.029
	(0.044)	(0.038)	(0.020)	(0.046)	(0.039)	(0.021)
$SW\_Threat\_t_0\text{-}1$	0.121***	-0.089*	0.021	0.167***	-0.114**	0.031
	(0.046)	(0.047)	(0.021)	(0.049)	(0.047)	(0.022)
$SW\_Threat\_t_0$	0.107**	-0.095*	0.019	0.161***	-0.129**	0.027
	(0.048)	(0.050)	(0.022)	(0.051)	(0.050)	(0.023)
$SW\_Threat\_t_0+1$	0.129**	-0.088*	0.031	0.182***	-0.125**	0.040*
	(0.050)	(0.050)	(0.022)	(0.053)	(0.051)	(0.023)
$SW\_Threat\_t_0+2$	0.105*	-0.074	0.025	0.195***	-0.136***	0.044*
	(0.053)	(0.050)	(0.023)	(0.054)	(0.051)	(0.023)
$SW\_Threat\_t_0+3$	0.109*	-0.079	0.033	0.186***	-0.116**	0.050**
	(0.056)	(0.056)	(0.023)	(0.057)	(0.054)	(0.024)
$SW\_Entry\_t_e$	0.110*	-0.079	0.021	0.212***	-0.152***	0.039
	(0.058)	(0.058)	(0.025)	(0.060)	(0.057)	(0.026)
$SW\_Entry\_t_e+1$	0.101*	-0.073	0.028	0.186***	-0.133**	0.047*
	(0.060)	(0.063)	(0.026)	(0.063)	(0.062)	(0.027)
$SW\_Entry\_t_e+2$	0.073	-0.084	0.017	0.145**	-0.141**	0.031
	(0.064)	(0.065)	(0.028)	(0.065)	(0.064)	(0.029)
Observations	13,837	13,839	13,839	13,837	13,839	13,839

Notes: All specifications include airline-market fixed effects and airline-time fixed effects. All specifications include as control variables the (log of) total number of passengers flying through the origin and destination airports of the market, and the (log of) number of total departures performed at the origin and destination airports of the market. Standard errors are in parentheses and are clustered by market-carrier. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5: Incumbent Response to a Threat of Entry

	(1) $\ln(D_{0.5}^{odds})$	(2) $\ln(D_{0.5}^{odds})$	(3) $\ln(D_{0.5}^{odds})$	(4) $\ln(D_{0.5}^{odds})$
Variables	*Baseline*	*Mid-Size Markets*	*Large Markets*	*Preannounced*
$SW\_Threat\_t_0$-*8*	-0.039	0.010	-0.075	-0.254***
	(0.068)	(0.161)	(0.080)	(0.081)
$SW\_Threat\_t_0$-*7*	0.035	0.104	-0.009	-0.499***
	(0.068)	(0.125)	(0.083)	(0.113)
$SW\_Threat\_t_0$-*6*	0.109	0.250	0.063	-0.525***
	(0.085)	(0.174)	(0.095)	(0.131)
$SW\_Threat\_t_0$-*5*	0.139	0.308	0.068	-0.520***
	(0.094)	(0.199)	(0.105)	(0.150)
$SW\_Threat\_t_0$-*4*	0.143	0.435**	0.075	-0.616***
	(0.101)	(0.214)	(0.110)	(0.168)
$SW\_Threat\_t_0$-*3*	0.183	0.579**	0.041	-0.711***
	(0.112)	(0.244)	(0.109)	(0.196)
$SW\_Threat\_t_0$-*2*	0.247**	0.578**	0.130	-0.875***
	(0.120)	(0.286)	(0.115)	(0.218)
$SW\_Threat\_t_0$-*1*	0.278**	0.568*	0.138	-0.987***
	(0.129)	(0.304)	(0.129)	(0.233)
$SW\_Threat\_t_0$	0.291**	0.603*	0.185	
	(0.141)	(0.331)	(0.139)	
$SW\_Threat\_t_0$+*1*	0.324**	0.760**	0.196	
	(0.150)	(0.332)	(0.149)	
$SW\_Threat\_t_0$+*2*	0.346**	0.844**	0.182	
	(0.167)	(0.358)	(0.166)	
$SW\_Threat\_t_0$+*3*	0.364**	0.848**	0.198	
	(0.176)	(0.360)	(0.187)	
$SW\_Entry\_t_e$	0.296	0.853**	0.097	-1.041***
	(0.181)	(0.375)	(0.182)	(0.254)
$SW\_Entry\_t_e$+*1*	0.296	0.876**	0.073	-1.042***
	(0.192)	(0.392)	(0.196)	(0.271)
$SW\_Entry\_t_e$+*2*	0.241	0.714*	0.053	-0.967***
	(0.206)	(0.421)	(0.218)	(0.288)
Observations	13,833	4,305	9,528	6,082

Notes: All specifications include airline-market fixed effects and airline-time fixed effects. All specifications include as control variables the (log of) total number of passengers flying through the origin and destination airports of the market, and the (log of) number of total departures performed by the incumbent airline at the origin and destination airports of the market. Standard errors are in parentheses and are clustered by market-carrier. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 6: Incumbent Response to a Threat of Entry

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	ln*(taxi-out)*	ln*(taxi-in)*	ln*(dep. delay)*	ln*(arrival delay)*	ln*(turnaround)*	ln*(flight time)*
$SW\_Threat\_t_0$-8	0.012	0.014	0.024	0.239***	-0.008	-0.003
	(0.021)	(0.022)	(0.091)	(0.069)	(0.050)	(0.003)
$SW\_Threat\_t_0$-7	0.016	0.015	0.035	0.197**	0.089	-0.002
	(0.022)	(0.023)	(0.086)	(0.088)	(0.059)	(0.003)
$SW\_Threat\_t_0$-6	0.028	0.029	0.031	0.158**	0.158***	-0.002
	(0.021)	(0.019)	(0.093)	(0.075)	(0.056)	(0.003)
$SW\_Threat\_t_0$-5	0.001	-0.010	-0.003	0.182**	0.062	-0.003
	(0.021)	(0.025)	(0.093)	(0.079)	(0.046)	(0.004)
$SW\_Threat\_t_0$-4	0.032	0.010	0.142	0.293***	0.058	0.003
	(0.023)	(0.024)	(0.098)	(0.081)	(0.051)	(0.003)
$SW\_Threat\_t_0$-3	0.041	0.041*	0.178*	0.291***	0.061	0.005
	(0.026)	(0.025)	(0.095)	(0.079)	(0.056)	(0.004)
$SW\_Threat\_t_0$-2	0.005	0.019	0.188*	0.324***	0.071	-0.001
	(0.026)	(0.025)	(0.097)	(0.086)	(0.059)	(0.004)
$SW\_Threat\_t_0$-1	0.031	0.008	0.217**	0.413***	0.056	-0.001
	(0.025)	(0.023)	(0.109)	(0.086)	(0.057)	(0.004)
$SW\_Threat\_t_0$	0.034	0.020	0.156	0.344***	0.050	-0.001
	(0.026)	(0.027)	(0.116)	(0.101)	(0.060)	(0.004)
$SW\_Threat\_t_0$+1	0.026	-0.001	0.215*	0.317***	0.044	0.001
	(0.028)	(0.024)	(0.111)	(0.094)	(0.061)	(0.004)
$SW\_Threat\_t_0$+2	-0.012	-0.023	0.157	0.299***	0.022	0.002
	(0.027)	(0.027)	(0.118)	(0.100)	(0.058)	(0.004)
$SW\_Threat\_t_0$+3	0.014	0.010	0.252*	0.452***	0.075	-0.001
	(0.030)	(0.030)	(0.129)	(0.108)	(0.067)	(0.005)
$SW\_Entry\_t_e$	-0.007	0.010	0.337**	0.485***	-0.029	0.005
	(0.038)	(0.040)	(0.157)	(0.118)	(0.077)	(0.005)
$SW\_Entry\_t_e$+1	0.009	-0.006	0.315**	0.441***	0.033	0.002
	(0.036)	(0.035)	(0.131)	(0.110)	(0.076)	(0.005)
$SW\_Entry\_t_e$+2	-0.003	-0.009	0.291**	0.438***	0.049	0.005
	(0.038)	(0.039)	(0.142)	(0.121)	(0.079)	(0.006)
Observations	8,922	8,922	13,133	13,573	8,887	13,839

Notes: All specifications include airline-market fixed effects and airline-time fixed effects. All specifications include as control variables the (log of) total number of passengers flying through the origin and destination airports of the market, and the (log of) number of total departures performed at the origin and destination airports of the market. Standard errors are in parentheses and are clustered by market-carrier. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 7: Incumbent Response to a Threat of Entry

	(1)	(2)	(3)	(4)
	$\ln(D_{0.5}^{odds})$	$\ln(D_{0.5}^{odds})$	$\ln(D_{0.5}^{odds})$	$\ln(D_{0.5}^{odds})$
Variables	*Avg. Mkt. Share <75%*	*Avg. Mkt. Share ≥75%*	*To Hub*	*From Hub*
$SW\_Threat\_t_0$-8	0.044	-0.036	0.030	0.008
	(0.254)	(0.068)	(0.085)	(0.109)
$SW\_Threat\_t_0$-7	-0.138	0.036	0.022	0.092
	(0.297)	(0.068)	(0.086)	(0.107)
$SW\_Threat\_t_0$-6	-0.220	0.102	0.164	0.092
	(0.318)	(0.088)	(0.114)	(0.129)
$SW\_Threat\_t_0$-5	-0.195	0.115	0.212	0.043
	(0.324)	(0.099)	(0.134)	(0.146)
$SW\_Threat\_t_0$-4	-0.204	0.133	0.152	0.092
	(0.328)	(0.104)	(0.133)	(0.166)
$SW\_Threat\_t_0$-3	-0.229	0.148	0.109	0.057
	(0.333)	(0.119)	(0.131)	(0.169)
$SW\_Threat\_t_0$-2	-0.210	0.233*	0.269**	0.091
	(0.332)	(0.127)	(0.134)	(0.173)
$SW\_Threat\_t_0$-1	-0.151	0.262*	0.339**	0.143
	(0.341)	(0.133)	(0.145)	(0.192)
$SW\_Threat\_t_0$	-0.140	0.279*	0.342**	0.197
	(0.342)	(0.149)	(0.172)	(0.206)
$SW\_Threat\_t_0$+1	-0.117	0.322**	0.404**	0.212
	(0.347)	(0.157)	(0.188)	(0.213)
$SW\_Threat\_t_0$+2	-0.174	0.369**	0.446**	0.152
	(0.366)	(0.177)	(0.206)	(0.238)
$SW\_Threat\_t_0$+3	-0.047	0.351*	0.369*	0.174
	(0.386)	(0.186)	(0.192)	(0.253)
$SW\_Entry\_t_e$	-0.186	0.194	0.372*	0.004
	(0.376)	(0.205)	(0.206)	(0.269)
$SW\_Entry\_t_e$+1	-0.225	0.293	0.428**	0.019
	(0.385)	(0.225)	(0.210)	(0.280)
$SW\_Entry\_t_e$+2	-0.203	0.239	0.306	-0.007
	(0.425)	(0.235)	(0.232)	(0.318)
Observations	4,048	9,785	4,390	4,436

Notes: All specifications include airline-market fixed effects and airline-time fixed effects. All specifications include as control variables the (log of) total number of passengers flying through the origin and destination airports of the market, and the (log of) number of total departures performed at the origin and destination airports of the market. Standard errors are in parentheses and are clustered by market-carrier. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.