How Do Incumbents Respond to the Threat of Entry? Evidence from the Major Airlines*

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Abstract

This paper examines how incumbents respond to the *threat* of entry by competitors (as distinct from how they respond to the *actual* entry of competitors). We look, specifically, at the passenger airline industry and use the evolution of Southwest Airlines' route network to identify particular routes where the probability of future entry rises abruptly. When Southwest begins operating in airports on both sides of a route but not the route itself, this dramatically raises the chance they will start flying that route in the near future. We examine the pricing of the incumbents on threatened routes in the period surrounding such events. We find that incumbents cut fares significantly when threatened by Southwest's entry but only on the threatened route itself, not on routes out of non-Southwest competing airports (e.g., Chicago Midway routes but not Chicago O'Hare routes). Over half of the total impact of Southwest on incumbents' fares occurs before Southwest starts flying. The results do not support most theories of entry deterrence as the driving explanation, however, in that the price cuts do not seem any smaller on routes where Southwest has pre-committed to enter and deterrence is moot. Similarly, there is little evidence of strategic investment in excess capacity on the routes. The results may be more consistent with incumbent accommodation and an effort to weaken Southwest's strength upon entry.

I. Introduction

In this paper we examine how incumbents respond to the threat of entry by a competitor. Though this topic has been the object of considerable theoretical and policy debate, it has received little empirical attention, mainly due to the problems of identifying the *threat* of entry separately from actual entry.

We will examine this issue in the passenger airline industry. We are able to identify discrete shifts in the threat of entry in this circumstance by using the expansion patterns of the industry's most famous potential competitor—Southwest Airlines.[1] In particular, we look at situations where Southwest begins or even announces it will begin operating in the second endpoint airport of a route (having already been operating out of the first endpoint), *but before it starts flying the route itself*. We investigate how incumbents respond to such threats.

As an illustrative example, consider Southwest's entry into Washington Dulles International Airport. On October 5, 2006, Southwest began operations at Dulles (IAD) with nonstop flights to four other cities in its network, and one-stop service to several others. One route Southwest did *not* offer service on immediately upon entering Dulles was IAD-Cleveland (CLE). Cleveland is a Southwest airport; the airline flew between CLE and other airports, just not the CLE-IAD route. But once Southwest announced and then began operating out of both endpoints on the route—CLE first and now IAD—we might expect that competitors understand that the probability that Southwest would soon start flying the route itself rose dramatically. We will document that operating in both endpoints is correlated with a probability of entering the route around 70 times higher than other routes. With that increase in probability, we can then look at, say, United and Continental Airlines' (the incumbents) fares on the CLE-IAD route

[1] Southwest's network has been expanding rapidly for some time and the impact of their actual entry on prices in a market is well documented (see, for example, Morrison, 2001).

when faced with the threat of Southwest's entry by looking at prices around the time Southwest starts operations in the second endpoint airport, but has yet to actually start flying.[2]

The paper builds on the extensive literature on airline competition, especially the work relating to airport presence and the sources of airline market power. Most of these papers have not looked at preemptive actions or the threat of entry but rather at market behaviors after entry occurs.[3] Our empirical strategy is perhaps closest to Whinston and Collins' (1992) study of the impact on incumbents' stock prices of announcements of People Express's impending (actual) entry into particular routes.

The paper provides an empirical setting for testing the considerable body of theoretical work on strategic entry deterrence and accommodation, particularly that offering rationale for preemptive action. These include, for example, Dixit's (1979) capacity commitment story, the strategic learning-by-doing of Spence (1981), cost-signaling as in Milgrom and Roberts (1982), Aghion and Bolton's (1987) long-term contracting environment, and switching costs as in Klemperer (1987) and Farrell and Klemperer (2004). These rationales were put forward to counter the traditional argument that preemptive action is irrational, either because it is not subgame perfect (in the spirit of Selten's (1978) chain-store paradox), or because costly competitive actions should be delayed until entry actually occurs.

Our primary results indicate that incumbents in the airline industry do respond to the threat of entry. Incumbents drop average fares substantially when Southwest threatens a route (before Southwest actually starts flying the route). This is true even when we compare the fare

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[2] We use the IAD example for purposes of illustration. It occurred too recently to be included in our actual sample.

[3] Examples include Reiss and Spiller (1989), Hurdle et al. (1989), Borenstein (1989, 1991, 1992), Berry (1990, 1992), Brueckner et al. (1992), Evans and Kessides (1993), Whinston and Collins (1992), Borenstein and Rose (1994), Peteraf and Reed (1994), Hendricks et al. (1997), Bamberger, Carlton, and Neumann (2001), and Mayer and Sinai (2004).

changes on threatened routes to those on incumbents' other routes out of the same airports, suggesting that shifts in airport-specific operating costs are not driving the results. The lower prices, in turn, appear to increase the number of passengers flying on the incumbents prior to entry. We also find, interestingly, that while incumbents cut fares on the directly threatened route, they do not cut prices on routes to nearby airports in the same market (e.g., no cuts on the Chicago-O'Hare route when Southwest threatens a Chicago-Midway route).

Going beyond the fact of preemptive action, we also present suggestive evidence on the explanation for preemptive fare cuts. In particular, the evidence is not strong for entry deterrence. On routes where Southwest's entry is guaranteed, the incumbents still cut prices preemptively. The results are consistent with an accommodation story where incumbents cut prices to weaken the Southwest's position once it enters. We also find little support for strategic investment/excess capacity theories of preemptive action: there is at best weak evidence that airlines add capacity in response to entry threats.

II. Data

We build the core of our sample from the U.S. Department of Transportation's DB1A files from the first quarter of 1993 through the final quarter of 2004. These data provide a 10% sample of all domestic tickets in each quarter. From these, average logged ticket prices and the logged total number of passengers within each route-carrier-quarter combination are constructed (unfortunately the data do not report specific travel dates within the quarter).[4] We define a route by its two endpoint airports and we look at so-called "direct flights" on a route. (Direct flights are predominantly nonstop flights, but technically also include itineraries where the passenger

[4] We use Severin Borenstein's cleaned files, which are already aggregated up to the route-carrier-quarter level, since this is the level of our analysis rather than the individual ticket. Note that because the DB1A data is a 10 percent random sample of all tickets, our observed passenger counts will be one-tenth that of actual traffic on average.

stops but does not change planes.) We restrict our core sample to routes between the 59 airports that Southwest ever flies any flights to in our sample.

The threatened entry events we study are identified from the observed expansion patterns of Southwest Airlines. Southwest grew tremendously over our sample period, with its revenue and passenger volumes almost tripling from $2.3 to $6.5 billion and from 18.8 to 53.4 billion passenger-miles. It also added service to 22 new airports.[5]

Every time Southwest begins service in a new airport, it raises the threat that Southwest will enter routes connecting that airport with other airports in its network. We illustrate this in Figure 1. Southwest enters Washington Dulles in the fourth quarter of 2006 and immediately begins flights to Chicago Midway. Southwest is already flying out of Cleveland to other points in its network besides Dulles. Now, though, its entry into Dulles makes Southwest much more likely to start flying the IAD-CLE route in the near future.[6] Actually, even the announcement of the initial entry into Dulles ought to indicate to incumbents that the probability of future entry has risen.

Airport presence is a well known predictor of future route entry.[7] In Table 1 we present a simple probit regression of whether Southwest starts flying a route in a given quarter to verify in

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[5] Southwest exited one airport during our sample, San Francisco International (SFO), in 2001. It had operated there since before 1993.

[6] We used the local business press and press releases (via Lexis-Nexis) to confirm that Southwest did in fact start service at the airports where Southwest's entry is indicated in the DB1A data. We discovered through this search an important airport error in the DB1A data. In several quarters, the DB1A source data indicates that Southwest operated flights out of Dallas-Ft. Worth Airport (DFW) in the late 1990s for a few quarters and then exited. While the data show them flying from DFW to many different airports, the airline code for DFW must be mistaken. There is no record of Southwest operating these numerous flights out of DFW in the local business press at the time or in other Department of Transportation data such as the T-100 (see the capacity section below) and the On-Time Performance Data. We therefore dropped these DFW observations from the sample.

[7] See Bailey (1981) for a narrative of a particular episode where this idea was applied in antitrust policy toward the industry. Empirical work that has used endpoint airport presence as a potential predictor of entry (albeit in the cross section rather than within particular markets over time) includes Berry (1992) and, in a similarly themed paper to ours, Peteraf and Reed (1994).

our own sample the impact of having presence in both route endpoints on the threat of entry. This is only a descriptive exercise, of course, not an explicit model. It includes as explanatory variables only the number of endpoints at which Southwest is already operating at the beginning of the quarter and time dummies for every quarter in the sample. The results show that having a presence in one airport is correlated with a significantly higher probability of entry (the baseline probability is close to zero) but having a presence in both airports raises it by a factor of over 70—to 18.5 percent per quarter.

At any point in time in our sample, we take the existing airport service network as given and look at incumbents' fares on a route once it becomes clear that Southwest is looming as a competitor. We capture the price responses to threatened entry using dummies in the quarters surrounding Southwest's establishment of operations in both endpoint airports (but without flying the route) and control for actual entry with dummies in quarters during and after Southwest starts flying the route. We restrict our attention to the major carriers operating during our sample: American, Continental, Delta, Northwest, TWA, United, and US Airways.

We observe hundreds of routes threatened with entry over the period. In most of these, Southwest eventually starts flying the route later in our sample; in others, Southwest establishes a presence in both airports but had not yet begun flying the route by the end of our observation period (up to three years later). We exclude routes from our sample where Southwest establishes second endpoint airport presence simultaneously with actually flying the route. In such cases we do not have a clear period to identify the heightened threat of entry separately from actual entry. We will, however, look at such routes below when discussing the issue of entry deterrence.

For each route in our sample, we look at the 25-quarter window surrounding the quarter in which Southwest establishes a presence in both endpoints (three years before to three years after) and define Southwest's actual entry as occurring when it establishes direct service—i.e., flights without a change of plane—between the two airports.[8] This follows the findings from U.S. antitrust authorities that non-stop service and connecting service be considered separate markets, or at least substantially differentiated products. Our results were not sensitive to this definition, however, as we find similar results defining entry as also including change-of-plane service.

In all, we observe Southwest threatening entry into 654 routes over the sample period, 374 of which Southwest had actually entered with direct flights by the final quarter of 2004, the end of our observation period.[9] This yields just under 18,000 route-carrier-quarter observations of average logged fares and passenger counts for major airlines' direct flights on threatened routes. The standard deviation of average logged fares across observations is 0.45, and for logged passengers it is 2.01.

III. Hypotheses and Empirical Specifications

Our baseline model measures the impact of Southwest establishing a presence in both endpoints of a route by looking at the periods before, during, and after this event, while controlling for other influences—like a standard event study. The basic specification, with some slight abuse of summation notation as explained below, is as follows:

$$y_{ri,t} = \gamma_{ri} + \mu_t + \sum_{\tau=-8}^{3+} \beta_\tau (SW\_in\_both\_airports)_{r,t_0+\tau} + \sum_{\tau=0}^{3+} \delta_\tau (SW\_flying\_route)_{r,t_e+\tau} + X_{ri,t}\alpha + \varepsilon_{ri,t}, \quad (1)$$

where $y_{ri,t}$ is the outcome of interest (e.g., mean logged fares) for incumbent carrier *i* flying route

[8] Several routes are not in the sample for the full 25-quarter period, either due to truncation at the beginning of the sample—we exclude any routes that are truncated by the *end* of the sample—or because the airline does not fly them during the entire window.
[9] These numbers are somewhat smaller than those in earlier versions of this paper, as we lost a portion of our sample due to the dropping of the erroneous DFW observations discussed in section II above.

r in quarter t. $SW\_in\_both\_airports_{r,t_0+\tau}$ are time dummies surrounding the period when Southwest establishes a presence in both endpoints of a route but without flying the route. $SW\_flying\_route_{r,t_e+\tau}$ are time dummies that commence in the period Southwest actually starts flying the route. The dummies are mutually exclusive, so the implied effects on the dependent variable given by their coefficients are not additive. γ_{ri} and μ_{rt} are carrier-route and carrier-quarter fixed effects, respectively. Some specifications also include a set of controls $X_{ri,t}$.

In all regressions, we weight observations by the average number of passengers flying the route-carrier over the sample. This allows us to measure the "aggregate" responses to Southwest's entry (and is particularly important when looking at passenger volume responses, since logged passenger numbers are particularly volatile on low-traffic routes). We also cluster the standard errors by route-carrier to account for intertemporal correlation in the error terms.

The covariates of interest for determining the impact of threatened entry on incumbents' prices are the $SW\_in\_both\_airports_{r,t_0+\tau}$ coefficients. We include these dummies for eight quarters prior to the quarter Southwest establishes dual endpoint presence on the threatened route, and for this establishment quarter (which we denote t_0) itself. We also include dummies for the two quarters after t_0, and a single dummy for the period three or more quarters after t_0. These post-t_0 dummies only take a value of one if Southwest has not yet entered the route. Essentially, because we include route-carrier fixed effects in the regressions, reported coefficients show the relative sizes of the dependent variable in the dummy period relative to its average value in the excluded period between two and three years (that is, the 9^{th} through 12^{th} quarters) prior to t_0.

As discussed above, the conventional, static-model view of threatened entry is that incumbents should not respond until they actually face competition. This notion, in the spirit of the classic Chicago School critiques of limit pricing, is based on the seemingly simple proposition that incumbents should not cut prices before they have to. Doing so entails losing profits in the short-run and has no impact on future profits. This view implies that the coefficients on the entry threat period dummies should be zero.

For preemptive action to be rational, there needs to be some mechanism tying Southwest's actions before Southwest enters to the market in later periods. Incumbents might (as discussed in the literature cited above) be trying to deter entry or to accommodate entry but weaken the new entrant once it enters. While the difficulties of testing between various theories of strategic behavior are well known, we will have at least suggestive evidence in favor of accommodation in this case. The evidence is not overly suggestive of strategic investment in excess capacity, either.

IV. Main Results: Documenting Preemptive Action

Column 1 of Table 2 presents the results from estimating specification (1) using the average logged fares on incumbent carriers' routes faced with the threat of entry by Southwest. Incumbent fares drop significantly before Southwest begins flying the route. By the time Southwest starts operating on both sides of the route (period t_0), prices are about 15 percent lower than in the excluded period (recall that the coefficients show the value of average logged fares relative to their average over the 9th through 12th quarters before t_0. As time passes without Southwest entering, prices fall further. On routes where Southwest threatens but does not enter for at least three quarters, fares are over 20 percent below the excluded period (and significantly lower than they were at t_0).[10]

[10] This continued decline is not the subject of our analysis because it may reflect selection issues rather than strategic behavior. If Southwest waits longer to enter routes where incumbents cut fares the most, this could skew the

Prices are also lower in quarters before t_0 than in the excluded period. Imprecision in our estimates precludes pinning down an exact price breakpoint, but the patterns suggest prices begin to fall in the third to fourth quarter before t_0. A t_0-3 breakpoint is bolstered by the fact the coefficients for t_0-3 and t_0-2 are significantly different at a 5 percent level from the average coefficients for periods t_0-8, t_0-7, and t_0-6, while the t_0-4 coefficient is not. Regardless of the specific period, it is not surprising that prices begin to fall before t_0. The relevant time period should be when the incumbents first realize that Southwest's chances of entering a route have risen. Southwest announces entry months before the entry actually occurs (in order to advertise, sell tickets, hire workers, and so on). Southwest's entry into Washington Dulles, for example, was publicly announced six months before the first day of operations. (This lead time was typical of what we found in examining the business press for several such episodes in our sample.) Further, industry insiders are likely to find out about impending entries before the public announcement, as Southwest must negotiate gate leases with the airport authority and so on.[11]

Once Southwest actually enters the route at time t_e (seen in the table in the *Southwest flying route* coefficients), prices fall 18 percent below the baseline and then continue falling to over 25 percent by the end of the period. The entry-threat and actual-entry coefficients are not additive, so the price drop due to Southwest's actual entry is the difference between the preemptive 15-percent price drop and the ultimate 25 percent price drop.[12]

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coefficients negative and provide a natural alternative explanation to the strategic view that Southwest's entry hazard is increasing in the delay since entering the airport, thereby causing larger price cuts by the incumbents.

[11] This early response to impending discount carrier arrival at an airport is also supported by anecdotal evidence; Johnsson (2006) documents that the announcement that JetBlue would begin operating at Chicago O'Hare was greeted with fare cuts by American and United (the two incumbents with hubs at O'Hare) some months before JetBlue began operations.

[12] Notice that the t_e results reflect a convex combination of threatened and actual entry responses, since entry does not generally occur on the first day of the quarter. Therefore some of the underlying microdata for the quarter

The results suggest preemptive price cuts are quite important. More than half the total price effect that Southwest Airlines has on incumbents' prices takes place before Southwest ever actually starts flying the route.

We make several checks on the plausibility of these results. The first looks at the number of passengers flying on the incumbents' threatened routes during this period of preemptive price cutting. We expect the number of passengers flying on the incumbent carriers to rise in response to these lower prices. Column 2 of Table 2 presents results where the log number of passengers is the dependent variable. The estimates are imprecise, but indicate at a 10-percent significance level that passenger traffic rises on threatened routes in the period before and around Southwest enters the second endpoint airport. The timing lines up with the price changes: the first significant quantity change is two quarters before t_0. Comparing the fare and quantity changes from their baselines over the periods surrounding t_0 suggests the magnitude of the quantity response is roughly twice that of the fare changes, suggesting a demand "elasticity" of around –2.[13] We will see below that an independent data source on passenger volumes also documents similar quantity movements during the relevant time frame.

Our second check of plausibility considers the potential role of cost shocks as an alternative explanation. For example, if Southwest chooses to enter airports where operating costs are falling, this will lead to a spurious correlation between our measure of Southwest's threat of entry and the decline in incumbents' fares. To account for such cost shocks, we control

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reflect patterns prior to actual entry. Also, while all of the post-entry coefficients correspond to periods after the price drops reflected in the threat of entry coefficients, the time difference between t_0 and t_e varies across routes. Southwest actually enters some threatened routes one quarter after t_0, others several quarters after, and still others it does not enter at all (at least by the end of our three year window). The estimated impact of Southwest entry seen here is a bit smaller than that estimated in some previous work such as Morrison (2001). In that case, though, he estimates fare impacts using fare variation across routes rather than within a route across time as we do here. Our sample is also a selected one, since our results here exclude the routes that Southwest enters immediately. (We do look at these immediate entry routes below when examining *why* preemptive actions occur.)

[13] This is not exactly a carrier-route specific elasticity because we are not holding the prices of competitors fixed.

in the price regressions for the incumbents' fares on other routes involving the same airports on one end but non-Southwest airports on the other.

We illustrate the principle behind the routes in control groups in Figure 2. In the Washington Dulles-Cleveland example, one control is the average logged fare on (say) United's routes between IAD and airports to which Southwest doesn't fly (we restrict alternative airports to those in the top 100 to be comparable), and the second is similarly defined for routes between CLE and non-Southwest airports. These two sets of routes (referred to as the "operating cost controls" in the table) should embody any airport-specific operating cost shocks at either of the route's endpoint airports. Once they are controlled for, the observed price changes should then reflect the causal impact of Southwest's threatened and actual entry.

Column 3 of Table 2 shows the results of this specification. The cost controls have significant and positive coefficients, as one would expect. That is, when an incumbent's fares rise on non-threatened routes from an airport, its fares also rise on the threatened route out of that city. The rest of the coefficients in column 3 are slightly smaller in magnitude than in column 1, but still statistically significant and economically substantial—incumbent fares are down 12 percent from the excluded period by t_0, for example. Most of the preemptive price cuts by the incumbents therefore appear to be restricted to strictly to the threatened routes from the airport.

As a third test, we check that our results are not somehow being driven by our choice of a three year event window or by the choice of the baseline comparison period. In Table 3 we estimate a specification that expands the event window out to four years before t_0 and breaks the timing dummies out to t_0-14 (the excluded period is therefore the 15^{th} and 16^{th} quarters before t_0). The results confirm the baseline findings. There is little pattern in prices through four quarters before t_0, but prices begin to fall significantly thereafter. The magnitudes of the price drops are similar to the earlier results as well.[14]

Finally, we examine the passenger traffic when Southwest threatens entry to a metropolitan area's secondary airport (which tend to exist only in the largest markets). In such cases, the incumbents' price cuts at the directly threatened (i.e., secondary) airport ought to draw passengers away from the main airport. To examine this, we look specifically at routes flying out of LaGuardia, JFK, and Newark airports (when Southwest threatens entry into routes from Islip, Long Island), Miami (Southwest: Ft. Lauderdale), Reagan-National and Washington-Dulles (Southwest: BWI; recall that the sample ends before Southwest's entry into Dulles), Boston (Southwest: Providence and Manchester) and Chicago O'Hare (Southwest: Midway). We must exclude the Los Angeles, San Francisco, Houston and Dallas markets from this regression because, during our sample period, Southwest operates in virtually all the airports in these metro areas or else regulation prevents competition.[15]

We date the entry threat from Southwest's actions in the other airport. So, for example, when Southwest starts operations in Orlando in 1994, they were operating on both endpoints of the Orlando-Chicago Midway route without flying the route itself. Our previous results examined incumbent responses on the Orlando-Midway route; here we look at Orlando-O'Hare, even though Southwest does not fly to O'Hare.

Column 1 of Table 4 looks at the prices of incumbents on these nearby but not threatened

[14] An analogous specification using logged passenger traffic as the dependent variable gave qualitatively similar results. These estimates were less significant, however, and somewhat smaller in magnitude relative to the price results, implying price "elasticities" of around −2.

[15] Southwest operates in the four largest Los Angeles airports: Burbank, Orange County, Ontario, and LAX. Long Beach was the only neighboring airport it did not fly into and has only a tiny amount of incumbent major airline traffic in our sample. In the San Francisco Bay area, Southwest operated in the Oakland, San Jose and San Francisco airports for most of our sample (until finally exiting from SFO in 2001). Southwest operates in both Houston Hobby and Houston Intercontinental. In Dallas, flights from Love field to anywhere but Alabama, Arkansas, Kansas, Louisiana, Mississippi, New Mexico, Oklahoma, and Texas were prohibited by law during our sample, so competition with DFW is quite limited.

routes. If anything, fares *rise* in the period preceding Southwest's entry into a nearby competing route. While this result might seem surprising, it may reflect changes in the customer base on the routes in the sample. We saw above that incumbent prices fall in the airport where Southwest operates (the ‘other’ airport) and passenger traffic increases. Some of the added passengers are likely to have come from the nearby airports that we look at here. If the switchers are the more price sensitive customers, the remaining customers at the nearby airport have relatively less elastic demands, which could lead to a raise in the average fare on the route. Curiously, fare increases are not seen in the period after Southwest actually begins operations in the nearby route’s endpoint airport; there is no significant price difference between the prices during this time and the excluded period.

Column 2 of Table 4 indicates incumbents’ passenger volumes in nearby but not directly threatened airports drop when their fares rise before t_0. While the estimates are not precise, it appears that the declines remain even when the price drop is no longer significant, and further, the loss of passenger traffic appears to become larger still when Southwest actually starts operating flights on the competing route.[16]

Taken together, the results in this section suggest that incumbents do engage in preemptive price cutting when they find out Southwest is likely to enter a route in the near future. In the next section we examine some evidence regarding what they are trying to accomplish by doing so.

V. Reasons for Preemptive Action: Deterrence, Capacity, Accomodation

[16] It is worth noting that in most cases the major incumbents at the Southwest airport and at the nearby airport are not the same. In Chicago, for example, Continental and Northwest are incumbents with substantial operations at Midway while United flies exclusively out of O’Hare. So the results do not necessarily imply that the same carrier is diverting passengers from its flights at one airport to its flights at another.

The evidence documenting the existence of preemptive price cutting by incumbent airlines is much easier to establish than the reasoning behind it—especially when we lack access to important data such as the fare class of the ticket, the type of passenger, whether they are frequent flyers and so on. We can at least provide a few suggestive pieces of evidence that may indicate support for some theories at the expense of others.

A. Strategic Investment in Excess Capacity

We first test whether incumbents' actions reflect strategic investment in excess capacity, as in Dixit (1979) and others. Unfortunately, the DB1A files making up our core sample are of passenger itineraries, not flights, so they cannot speak to capacity issues like seats or flights available. We can get this type of information, however, from the T-100 data of the U.S. Department of Transportation. The T-100 contains the number of passengers, flights, and available seats by segment-carrier-month; we aggregate by route-carrier-quarter to match our DB1A-based data though there are many more missing observations in the T-100.[17]

Column 1 of table 5 shows logged passenger responses for route-carrier-quarters and although noisy, these independent data suggest the same general pattern of rising traffic around the period that the threat of entry rises. Columns 2 and 3 show two measures of incumbent capacity on threatened routes: the logged number of seats available (column 2) and the logged number of flights (column 3). We cannot definitively rule out a rise in capacity given the point estimates and the coefficients' precision, but there is no indication at conventional significance

[17] Two problems arise in comparing the T-100 data to our core sample. The first is that the T-100 data is based on segments (any airport-to-airport trip by an aircraft) rather than itineraries (defined by origin and destination city regardless of any intermediate stopovers) as in the DB1A. The T-100 will count one-stop flights with no plane change as two separate segments, while the DB1A would consider this a single, direct flight. Second, the T-100 has poor coverage of segments with few passengers. Of the 17,923 direct flight route-carrier-quarters in our DB1A sample, only 2875 have matches in the T-100. Segment traffic appears to start, stop, and start again in the T-100 even if continuous in the DB1A. This coverage gap is clearly concentrated in the smallest routes, however. While the T-100 data contain less than one-sixth of the route-carrier-quarters in our DB1A sample, they cover over 90 percent of the total passengers. Since our regressions are weighted by passenger traffic, the impact of the coverage gap should be mitigated.

levels that either available seats or the number of flights rise. Further, we look in column 4 at what happens to the log of the load factor (the share of available seats on the flights that had passengers in them). Here there is statistically significant evidence that, whatever is going on with the number of seats or flights, there are significantly more passengers *per unit of capacity* when the entry threat materializes.

B. Entry Deterrence or Accommodation?

The other basic issue we can address is whether in incumbents cut prices early to deter Southwest's entry on a route, or instead to try to soften competition once entry occurs—i.e., whether they are engaging in deterrence or accommodation.

To test this, we compare preemptive behavior on the routes in our basic sample—where Southwest's future entry behavior is unknown and could in principle be deterred—to the pricing behavior of incumbents on a set of routes where Southwest's entry is pre-announced and therefore all all but guaranteed. In the spirit of Ellison and Ellison (2000) and Dafny (2005), if entry deterrence is the motivation, we should not see price cutting where deterrence is impossible.

The routes where deterrence seems extremely unlikely are those where Southwest begins direct service between two endpoint airports in the same quarter it starts operating in the second endpoint airport. Using the example of Southwest's entry into Washington Dulles, these would be routes that Southwest immediately begins flying on October 5, 2006, like Dulles to Chicago Midway. In principle, Southwest might still be deterred from entering these routes even though they are pre-announced but we never found a single case in our sample where Southwest announced they would enter a route and did not. There are 206 such routes in our data; we observe them for roughly 6000 route-carrier-quarter observations.

The results from this no-deterrance-motive sample are shown in column 2 of Table 6. The coefficients show extremely similar behavior to the benchmark specification (shown in column 1 for comparison purposes; note that because entry is immediate in the column 2 sample, t_0 and t_e are synonymous, and the threatened entry dummies for periods after t_0 do not exist). Incumbents engage in preemptive price cutting behavior even on routes where they cannot deter entry. This suggests that firms are instead accommodating entry.[18]

The manner through which accommodative price cuts might operate is an open question. A commonly postulated mechanism through which preemptive accommodative behavior would operate involves "dynamic demand": customer loyalty or similar mechanisms that make demand today not just a function of today's prices, but previous prices as well. One plausible explanation in this vein for the observed preemptive price cutting is that it reflects efforts by incumbents to generate loyalty or lock-in among existing valuable customers, making them less likely to switch to Southwest upon entry. The consumer loyalty might be as direct as something like frequent flyer programs but it could certainly be less tangible than that; all that is required is that it can be built through price cuts.[19]

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[18] We also estimated a fully-interacted model to test for the significance of differences among the time dummy coefficients across the two samples. We could not reject equality of any common coefficients at the ten percent significance level. We note that accommodative action does not imply that the incumbent is better off with the potential entrant having entered. If it were less costly, incumbent airlines surely would prefer to keep Southwest from entering their routes. Accommodation simply implies that, given the existing cost structures, incumbents find it cheaper to take actions to improve their future prospects given that entry occurs.

[19] Discussions of the role of consumer loyalty and lock-in for the airline industry can be found in work such as Cairns and Galbraith (1990), Borenstein (1996), and Lederman (2004). As Becker, Grossman, and Murphy (1994) point out, given the complementarity between current and past consumption in dynamic demand functions, lowering prices today to stimulate current and future demand will be less effective (and even possibly entirely ineffective) if the firm cannot commit to keeping prices low in the future: consumers rationally infer that building a current consumption stock today might allow firms to extract more surplus from them tomorrow. This price commitment issue does seem to apply to the airline industry. However, it is still plausible—and the empirical evidence seems to bear this out—that the direct demand-enhancing effect outweighs consumers' wariness with respect to airlines future price commitments. Unfortunately, as stated above, conclusively testing this or any other story of dynamic demand driving preemptive fare cuts requires detailed information on passengers' histories with particular airlines, ticket

VI. Discussion and Conclusion

This paper has looked at the response of incumbent major airlines to the threat of entry by examining how the incumbents respond when Southwest starts operating in the airports on both ends of a route but before it actually starts flying that route. The nature of Southwest's network means that the likelihood of their entering such a route rises dramatically when Southwest announces operations will begin in the second endpoint airport, thus generating a discrete change in incumbents' expectations about the likelihood of new competition through entry.

The results indicate that incumbents do indeed react preemptively to Southwest's entry threat. Incumbents drop fares significantly before entry occurs. This does not appear to be driven by airport-specific cost shocks; incumbents' fares drop on threatened routes relative to their fares on other routes from the same airports. The fare declines are accompanied by an increase in passengers traffic on the incumbents' threatened routes. They do not extend to routes into neighboring airports in the same MSA where Southwest is not directly threatening entry.

Beyond the fact of preemptive action, there is some suggestive evidence on why such action takes places. In particular, there does not seem to be much significant evidence in favor of strategic investment in excess capacity and the comparison of routes where entry deterrence is impossible suggests that they must be using the preemptive actions in an accommodative role.

This paper's findings suggest the documented powerful competitive effect Southwest

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search behaviors, or frequent flyer program status. The sensitive nature of this sort of information means it is not readily available for even an individual carrier's passengers, much less at a comprehensive, industry-wide level. A more suggestive approach we used in an earlier draft was to see how fare cuts varied between routes that are likely to have different concentrations of business travelers, who are the heaviest users of loyalty programs. We found that leisure routes, defined either via the importance of the hotel industry in the states of their endpoint airports (as in Borenstein 1989) or through temperature differences across endpoint cities (Brueckner et al. 1992), saw smaller price declines than routes likely to have higher relative levels of business traffic. While certainly not conclusive, these results are consistent with incumbents making efforts to raise loyalty among their business-travel customers in order to reduce the probability that they lose them once Southwest does enter.

Airlines has in the U.S. passenger airline industry does not operate solely through Southwest's head-to-head competition with major carriers. Merely the *threat* of competing with Southwest is enough to induce substantial fare reductions from major carriers. We have focused on this industry in particular because it offers a good setting to empirically identify the causes and effects of interest, and to therefore add to the still sparse empirical literature on the threat of entry. If the response of incumbents here is anything like the responses in other industries, the study of preemption and customer loyalty may be fruitful avenues for future empirical research.

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Figure 1. Identifying a Threatened Incumbent Route

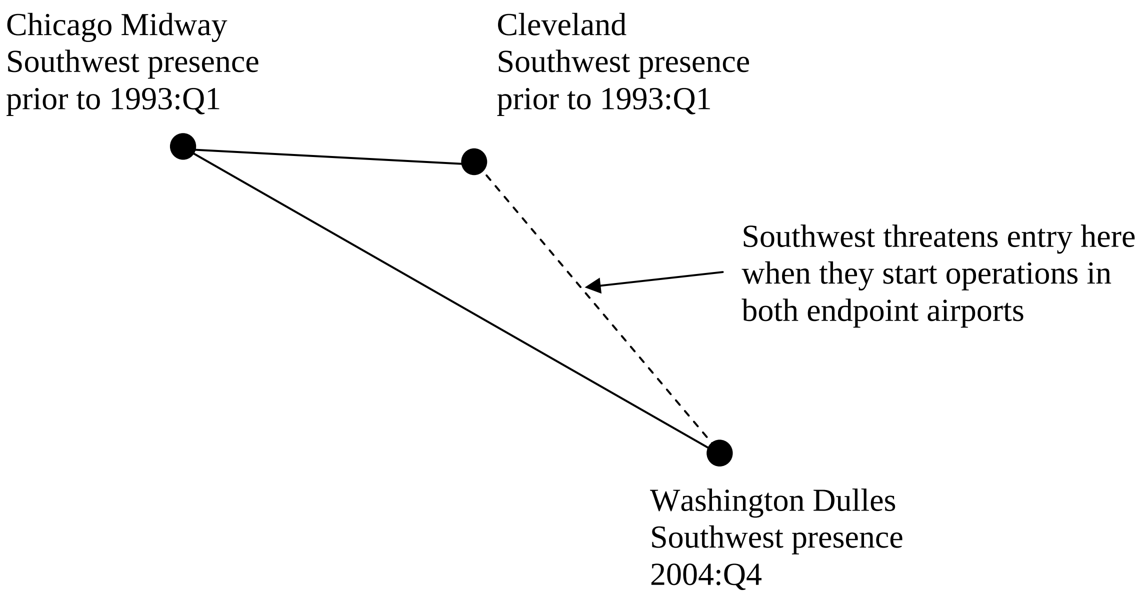

Figure 2. Comparison Routes for CLE-IAD

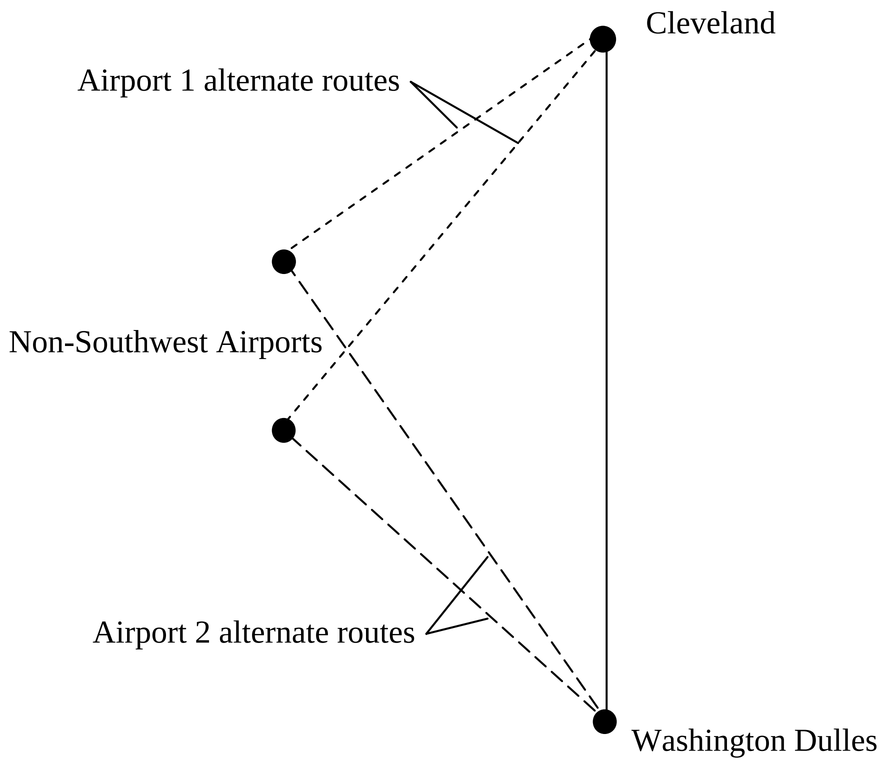

Table 1. Probability of Southwest's Entry into a Route

Southwest operates in one endpoint airport in the previous quarter (single presence)	0.0025 (0.0002)
Southwest operates in both endpoint airports in the previous quarter (dual presence)	0.1851 (0.0203)
N	163,952

Notes: The table shows estimates from a probit estimation for Southwest's entry into a route in a particular quarter, conditional on the number of the route's endpoint airports served by Southwest in the previous quarter. The excluded category includes observations where Southwest does not serve either endpoint airport in the previous quarter. Carrier-quarter fixed effects are included. Standard errors are in parentheses.

Table 2. Incumbent Responses to the Threat of Entry

	(1) ln(P)	(2) ln(Q)	(3) Cost Controls
Southwest in both airports (no flights) t_0-8	-0.019	-0.153*	-0.013
	(0.023)	(0.089)	(0.021)
Southwest in both airports (no flights) t_0-7	-0.059**	-0.112	-0.038
	(0.030)	(0.115)	(0.026)
Southwest in both airports (no flights) t_0-6	-0.057*	0.080	-0.048
	(0.034)	(0.110)	(0.032)
Southwest in both airports (no flights) t_0-5	-0.067	0.171	-0.050
	(0.041)	(0.128)	(0.039)
Southwest in both airports (no flights) t_0-4	-0.088*	0.175	-0.061
	(0.046)	(0.141)	(0.041)
Southwest in both airports (no flights) t_0-3	-0.126**	0.209	-0.102**
	(0.049)	(0.159)	(0.045)
Southwest in both airports (no flights) t_0-2	-0.113**	0.277*	-0.090*
	(0.052)	(0.168)	(0.049)
Southwest in both airports (no flights) t_0-1	-0.102*	0.358*	-0.078
	(0.058)	(0.200)	(0.053)
Southwest in both airports (no flights) t_0	-0.157**	0.395*	-0.125**
	(0.064)	(0.211)	(0.060)
Southwest in both airports (no flights) t_0+1	-0.178**	0.449*	-0.114*
	(0.064)	(0.234)	(0.061)
Southwest in both airports (no flights) t_0+2	-0.197**	0.397*	-0.149**
	(0.067)	(0.239)	(0.061)
Southwest in both airports (no flights) t_0+3 to t_0+12	-0.245**	0.463*	-0.185**
	(0.071)	(0.238)	(0.065)
Southwest flying route t_e	-0.201**	0.561**	-0.151**
	(0.068)	(0.250)	(0.065)
Southwest flying route t_e+1 to t_e+2	-0.247**	0.485**	-0.191**
	(0.077)	(0.240)	(0.072)
Southwest flying route t_e+3 to t_e+12	-0.291**	0.474	-0.237**
	(0.110)	(0.293)	(0.097)
Operating cost control, endpoint airport 1			0.405**
			(0.099)
Operating cost control, endpoint airport 2			0.219**
			(0.063)
N	17,923	17,923	17,198

Notes: The dependent variable in columns 1 and 3 is the passenger-weighted average logged fares. In column 2 it is logged total passengers. Standard errors are in parentheses and are clustered by route-carrier. The sample includes all routes where Southwest threatens entry as defined in the text. The “Southwest in both airports” dummies denote Southwest having flights involving airports on both ends of a route previous to actually flying the route. The “Southwest flying route” dummies denote Southwest actually operating flights on the route.

Table 3: Baseline Estimates with a Longer Event Window and a Finer Time Gradation

	Dependent Variable: Entry defined by:	ln(p) direct-flight
	Southwest in both airports (no flights)	
	t_0-14	-0.021 (0.024)
	t_0-13	-0.030 (0.035)
	t_0-12	-0.023 (0.037)
	t_0-11	-0.001 (0.042)
	t_0-10	-0.002 (0.043)
	t_0-9	-0.011 (0.047)
	t_0-8	-0.022 (0.051)
	t_0-7	-0.061 (0.053)
	t_0-6	-0.060 (0.059)
	t_0-5	-0.063 (0.069)
Period incumbent learns of increase in Pr(SW Entry)	**t_0-4**	-0.089 (0.071)
	t_0-3	-0.126* (0.075)
	t_0-2	-0.112 (0.079)
	t_0-1	-0.107 (0.086)
	t_0	-0.152* (0.091)
	t_0+1	-0.175* (0.091)
	t_0+2	-0.195** (0.094)
	t_0+3 to t_0+12	-0.238** (0.100)
	Southwest flying route	
	t_e	-0.198** (0.095)
	t_e+1 to t_e+2	-0.240** (0.106)
	t_e+3 to t_e+12	-0.282** (0.141)
	N	19,489

Notes: This table shows estimates from passenger-weighted average logged fares for our baseline sample, but with an expanded event window (see text for details). All regressions include route-carrier and carrier-quarter fixed effects. Standard errors are in parentheses and are clustered by route-carrier. See also Table 2 notes for variable definitions.

Table 4. Results for "Nearby" Routes

	(1) ln(p) nearby airport	(2) ln(q) nearby airport
Southwest in both airports (no flights) t_0-8	0.027 (0.023)	0.059 (0.079)
Southwest in both airports (no flights) t_0-7	0.052** (0.025)	-0.039 (0.077)
Southwest in both airports (no flights) t_0-6	0.050* (0.030)	-0.088 (0.077)
Southwest in both airports (no flights) t_0-5	0.062** (0.029)	-0.136* (0.080)
Southwest in both airports (no flights) t_0-4	0.049 (0.030)	-0.014 (0.077)
Southwest in both airports (no flights) t_0-3	0.046 (0.028)	-0.070 (0.087)
Southwest in both airports (no flights) t_0-2	0.085* (0.050)	-0.226** (0.103)
Southwest in both airports (no flights) t_0-1	0.095** (0.036)	-0.207** (0.090)
Southwest in both airports (no flights) t_0	-0.010 (0.021)	-0.159** (0.079)
Southwest in both airports (no flights) t_0+1	-0.013 (0.028)	-0.141 (0.138)
Southwest in both airports (no flights) t_0+2	-0.035 (0.026)	-0.164 (0.108)
Southwest in both airports (no flights) t_0+3 to t_0+12	-0.038 (0.026)	-0.097 (0.086)
Southwest flying route t_e	0.012 (0.033)	-0.194 (0.127)
Southwest flying route t_e+1 to t_e+2	-0.005 (0.041)	-0.163 (0.140)
Southwest flying route t_e+3 to t_e+12	0.013 (0.047)	-0.239 (0.209)
N	7155	7155

Notes: All regressions are weighted by passengers and include route-carrier and carrier-quarter fixed effects. The table shows incumbents' price and quantity responses on routes to neighboring airports to which Southwest does not fly but that are in the same market as a Southwest airport. Standard errors are in parentheses and are clustered by route-carrier. The dependent variables are route-carrier's average logged fares during the quarter in column (1) and its logged number of passengers in column (2). See also Table 2 notes for variable definitions.

Table 5. Incumbent Responses in Capacity: Passengers versus Seats, Flights, and Load Factors

	(1)	(2)	(3)	(4)
Dependent Variable:	ln(q)	ln(seats)	ln(flights)	ln(load factor)
Data Source:	T100	T100	T100	T100
Southwest in both airports (no flights)	-0.023	-0.031	-0.020	0.008
t_0-8	(0.177)	(0.159)	(0.162)	(0.045)
Southwest in both airports (no flights)	0.017	0.017	0.028	0.001
t_0-7	(0.115)	(0.100)	(0.102)	(0.039)
Southwest in both airports (no flights)	-0.012	-0.042	-0.028	0.030
t_0-6	(0.200)	(0.193)	(0.191)	(0.051)
Southwest in both airports (no flights)	-0.024	-0.024	0.004	-0.000
t_0-5	(0.202)	(0.160)	(0.156)	(0.061)
Southwest in both airports (no flights)	0.178	0.086	0.118	0.093**
t_0-4	(0.143)	(0.125)	(0.121)	(0.043)
Southwest in both airports (no flights)	0.176	0.091	0.115	0.085*
t_0-3	(0.156)	(0.135)	(0.130)	(0.044)
Southwest in both airports (no flights)	0.108	0.066	0.101	0.042
t_0-2	(0.159)	(0.137)	(0.127)	(0.047)
Southwest in both airports (no flights)	0.270	0.168	0.202	0.102**
t_0-1	(0.170)	(0.146)	(0.138)	(0.046)
Southwest in both airports (no flights)	0.307	0.159	0.198	0.148**
t_0	(0.204)	(0.179)	(0.171)	(0.052)
Southwest in both airports (no flights)	0.323	0.204	0.231	0.119**
t_0+1	(0.208)	(0.177)	(0.170)	(0.059)
Southwest in both airports (no flights)	0.336	0.160	0.198	0.176**
t_0+2	(0.208)	(0.176)	(0.173)	(0.060)
Southwest in both airports (no flights)	0.389**	0.209	0.228	0.180**
t_0+3 to t_0+12	(0.195)	(0.174)	(0.166)	(0.055)
Southwest flying route	0.475**	0.299	0.314*	0.176**
t_e	(0.219)	(0.184)	(0.179)	(0.063)
Southwest flying route	0.411*	0.236	0.253	0.174**
t_e+1 to t_e+2	(0.226)	(0.192)	(0.186)	(0.065)
Southwest flying route	0.423	0.216	0.227	0.207**
t_e+3 to t_e+12	(0.295)	(0.267)	(0.263)	(0.075)
N	2875	2875	2875	2875

Notes: All regressions are weighted by passengers and include route-carrier and carrier-quarter fixed effects. Standard errors are in parentheses and are clustered by route-carrier. The dependent variable in columns (1) and (2) is the log number of passengers. The dependent variable in (3) is the log of the total number of seats available on the route. In (4) it is the log number of flights actually flown. In (5) it is the share of the seats flown that are filled with passengers. The data set for column (1) is the DB1A whereas the data set for columns (2)-(5) is the T-100 as explained in the text. The sample in (1) is restricted to the same routes as in the T-100. See also Table 2 notes for variable definitions.

Table 6. Deterrence versus Accommodation:
Price Response on Routes Where Southwest's Entry Date is Pre-Announced

	(1) Not Certain	(2) Pre-Announced
Dependent Variable:	ln(p)	ln(p)
Southwest in both airports (no flights) t_0-8	-0.019 (0.023)	-0.027 (0.030)
Southwest in both airports (no flights) t_0-7	-0.059** (0.030)	-0.027 (0.034)
Southwest in both airports (no flights) t_0-6	-0.057* (0.034)	-0.017 (0.042)
Southwest in both airports (no flights) t_0-5	-0.067 (0.041)	-0.059 (0.038)
Southwest in both airports (no flights) t_0-4	-0.088* (0.046)	-0.086** (0.041)
Southwest in both airports (no flights) t_0-3	-0.126** (0.049)	-0.114** (0.046)
Southwest in both airports (no flights) t_0-2	-0.113** (0.052)	-0.092* (0.053)
Southwest in both airports (no flights) t_0-1	-0.102* (0.058)	-0.118* (0.070)
Southwest in both airports (no flights) t_0	-0.157** (0.064)	
Southwest in both airports (no flights) t_0+1	-0.178** (0.064)	
Southwest in both airports (no flights) t_0+2	-0.197** (0.067)	
Southwest in both airports (no flights) t_0+3 to t_0+12	-0.245** (0.071)	
Southwest flying route t_e	-0.201** (0.068)	-0.243** (0.089)
Southwest flying route t_e+1 to t_e+2	-0.247** (0.077)	-0.373** (0.101)
Southwest flying route t_e+3 to t_e+12	-0.291** (0.110)	-0.407** (0.101)
N	17,923	6054

Notes: The dependent variable in each column is the passenger-weighted average logged fares. Standard errors are in parentheses and are clustered by route-carrier. The sample in column (1) is the same as the baseline sample from table 2. The sample in column 2 includes all routes where Southwest begins flying the route simultaneously with entering the second airport. In such circumstances, of course, t_0 and t_e are the same and there are no periods after t_0 where Southwest is not yet flying the route so those coefficients are left out of the specification.