

INCUMBENT RESPONSES TO LOWER COST ENTRY: EVIDENCE FROM THE U.S. AIRLINE INDUSTRY*

HARUMI ITO[†] DARIN LEE[‡]

DECEMBER 11, 2003

Abstract

This paper analyzes the responses of incumbent hub-and-spoke carriers to low cost carrier (LCC) entry on routes served to and from their hubs over the past decade. Our analysis finds that the typical price and capacity response by incumbent hub-and-spoke carriers to LCC entry has been fairly accommodating. Moreover, our analysis also finds—somewhat surprisingly—that the likelihood of an LCC's entry into a hub market being successful is unrelated to the relative response of the incumbent.

JEL Classifications: L11, L93

Keywords: Airlines, Entry, Exit, Accommodation, Predation

*The authors thank Dan Kasper, Nick Rupp and participants of the 2003 Southern Economics Association Meetings for helpful comments. The views expressed in this paper are those of the authors and do not necessarily reflect those of LECG, LLC.

[†]Department of Economics, Box B, Brown University, Providence, Rhode Island, 02912. E-mail: Harumi_Ito@Brown.edu, Tel: (650)-329-9743, Fax: (401)-863-1970.

[‡]LECG, LLC. 350 Massachusetts Avenue, Suite 300, Cambridge, MA 02139. E-mail: darin_lee@lecg.com. Tel: (617)-761-0108, Fax: (617)-621-8018.

*“Claims of predation are more credible when they involve not only price cuts, but also significant capacity increases or other changes in network operations by Incumbent.”*¹

1 Introduction

The competitive confrontation between low cost carrier (LCCs) entrants and incumbent hub-and-spoke carriers has become a topic of widespread interest in the deregulated passenger airline industry, both in the U.S. and abroad (i.e. Morrison 2001, Dresner, Lin, and Windle 1996).² Allegations of predatory conduct by incumbent carriers have caught the eyes of both U.S. policy makers and courts, the most notable incident being the recent case brought forth by the U.S. Department of Justice (DOJ) against American Airlines.³ Moreover, in 1998, the U.S. Department of Transportation (DOT) issued tentative guidelines for evaluating whether incumbent hub-and-spoke carriers were engaged in “unfair exclusionary conducts.”⁴ In particular, the DOT statement asserted that “In recent years, when small, new-entrant carriers have instituted new low-fare service in major carriers’ local hub markets, the major carriers have increasingly responded with strategies of price reductions and capacity increases not to maximize their own profits but rather to deprive the new entrants of vital traffic and revenues.” This paper focuses on two main questions. Firstly, how aggressively have incumbent carriers responded to low-cost carrier entry over the past decade? Secondly, is there any relationship between the aggressiveness of an incumbent carrier’s response to new LCC entry and the probability that the LCC will subsequently exit the market?

From an economic policy perspective, there appear to be two primary aspects of an incumbent’s response to LCC entry that receive the majority of attention. The first area of concern revolves—not surprisingly—around the incumbent carrier’s pricing behavior following entry. It has been common practice for incumbent carriers to match the fares offered by the new entrant LCC on a portion of its seats (Transportation Research Board 1999). And while the practice of “meeting competition” has been supported by notable economists (i.e. Baumol 1998) as well as U.S. courts,⁵ others argue

¹“Predation In the Airline Industry,” Remarks by Roger W. Fones, Chief, Transportation, Energy, and Agricultural Section, Antitrust Division, U.S. Department of Justice, Before the American Bar Association Forum on Air and Space Law, Seattle, Washington June 12, 1997.

²In Canada, for example, Air Canada was recently charged by the Commissioner of Competition with predation following complaints by two low cost carriers, CanJet and WestJet. (See *Commissioner of Competition v. Air Canada*). Likewise, the Australian Competition and Consumer Commission (ACCC) recently charged Qantas with predation on the Adelaide–Brisbane route, where it faced entry by Virgin Blue. (See *Australian Competition and Consumer Commission v. Qantas Airway Limited*, In the Federal Court of Australia, New South Wales District Registry, No. N408, 2002). In Germany, the Bundeskartellamt recently issued an injunction against incumbent carrier Deutsche Lufthansa, requiring it to increase its fares on the Frankfurt-Berlin route following a price war that ensued after start-up carrier Germania entered the market. (See “Bundeskartellamt prohibits Lufthansa from hindering its rival Germania”, BundesKartellamt press release, February 19, 2000).

³See *United States v. AMR Corp., American Airlines Inc., and AMR Eagle Holding Corporation*, Civil Action No. 99-1180-JTM, May 13, 1999.

⁴Department of Transportation, Office of the Secretary, *Docket No. OST-98-3713, Notice 98-16*, April 1998.

⁵See Memorandum and Order of Judge Thomas Marten, in *United States of America vs. American Airlines*, United States District Court for the District of Kansas, No. 99-1180-JTM.

1 that the price-matching response, more often than not, results in anti-competitive consequences
2 (Edlin 2002).

3 The second primary concern revolves around the incumbent carriers' capacity decisions follow-
4 ing LCC entry (or the announcement of planned entry). It has been observed that incumbent
5 carriers often add additional flight frequencies or use larger aircraft on routes entered by low
6 cost carriers (Transportation Research Board 1999), a practice that has been highly controversial.
7 While Ordover and Willig (1998) argue that capacity additions by incumbents are economically
8 rational and can be pro-competitive, Edlin and Farrell (2002) note that in the recent U.S. DOJ
9 vs. American Airlines case, "The government claimed not that American's *prices* were predatory,
10 but that its *expansion* of flight schedules—described as 'capacity increase'—was." Likewise, some
11 industry observers in Canada (Lazar 2000) have suggested that "...Air Canada should not be al-
12 lowed to... Increase frequencies and/or use larger capacity aircraft on routes where an entrant has
13 announced an intention to start operating or has started flying."

14 In this paper, we analyze the price and capacity responses of incumbent hub-and-spoke carriers
15 to LCC entry over the past decade in the U.S. domestic airline industry. We begin by documenting
16 some stylized facts regarding the nature of LCC entry into hub markets, as well as the competitive
17 response they have evoked from incumbent carriers. Using a relatively large sample of LCC entry
18 events, we investigate how prevalent "aggressive" responses by incumbent carriers have been.
19 Finally, and perhaps most importantly, we assess the degree to which the "aggressiveness" of an
20 incumbent carrier's response impacts the probability of exit for a new entrant LCC using an probit
21 exit model.

22 "Predatory behavior" is a controversial topic, both in industrial organization theory its the
23 antitrust application. A predatory incumbent responds to an entrant by lowering its prices below
24 its costs, thus forcing the entrant to endure financial losses and eventually exit the market. The
25 source of theoretical contention often centers around the predator's rationale. The incumbent
26 suffers financially from predating, but, a well-established incumbent may be able to sustain itself
27 longer in a war of attrition if it has the a deeper purse than an entrant who may have more limited
28 financial resources. Thus, the financial loss of successful predation is compensated by higher
29 profits after the entrant exits. The promise of recoupment, however, depends on the assumption
30 that no other entrants will threatens profitability immediately after the entrant's exit. Skeptics
31 of predatory pricing date back to McGee (1958), who questioned the rationality of predatory
32 conduct in comparison to other strategies such as mergers or acquisition. Milgrom and Roberts
33 (1982) and Saloner (1987) employ models of asymmetric information where predatory action can
34 be derived as the rational behavior of incumbents. In practice, although price wars following
35 entry are commonly observed in many industries, questions often remain as to whether they reflect

1 the predatory conduct by incumbents. The Areeda and Turner (1975) Test employs a cost-based
2 definition while Ordoover and Willig (1981) propose more a general standard that takes into account
3 preconditions of market structure and profitability.

4 We emphasize that our goal is not to determine whether or not incumbent carrier responses
5 have or have not violated U.S. predatory pricing laws. Indeed, an analysis of this sort would require
6 detailed, route-level cost data that is not publicly available. Rather, our goal is to document and
7 empirically assess at more general level the patterns of incumbent capacity and price responses
8 to LCC entry to determine whether or not there have been—as many have alleged—a pattern of
9 aggressive incumbent responses to new entry over the past decade that may have hindered com-
10 petition in the industry. We believe that such exercises are useful in assessing the applicability
11 and usefulness of general rules or definitions for evaluating the “unfair exclusionary conduct” of
12 incumbent carriers in the industry.

13 The paper most related to ours in the literature is that of Bamberger and Carlton (1999), which
14 (among other things) compares the success rate of new entrant LCCs to those of major carriers
15 in newly entered city-pair markets.⁶ As part of their analysis, Bamberger and Carlton (1999)
16 also examine the responses of incumbent carriers to LCC entry into hub routes and find that the
17 median response to LCC entry of the incumbents has been surprisingly modest.⁷ While many of
18 our results are consistent with those of Bamberger and Carlton (1999), our analysis differs from
19 theirs in several important respects. First, while the sample of markets used to assess incumbent
20 responses by Bamberger and Carlton (1999) was relatively small (39 suspected markets), our
21 sample contains 370 entry events.⁸ Second, whereas the response statistics reported by Bamberger
22 and Carlton (1999) are independent of the LCC’s level of entry, our results measure the level of
23 response relative to both the incumbent’s pre-entry service level as well as the LCC’s magnitude
24 of entry. This is an important distinction since a capacity response of 20% following LCC entry
25 would have different competitive implications depending on whether the entrant had entered with—
26 for example—5% of the incumbent’s original capacity versus 50%. Finally, our analysis goes one
27 step further by estimating a probit exit model to determine whether or not incumbent responses
28 can be linked to an LCC’s decision to exit a market.

29 In addition to Bamberger and Carlton (1999), there have also been a number of recent papers
30 explicitly addressing issues related to predation in the airline industry. Eckert and West (2002), for
31 example, compare the Canadian competition policy approach to predation with that of the U.S.,

⁶Other studies of incumbent responses to LCC include Dresner and Windle (1999) and Whinston and Collins (1992).

⁷For example, the authors find that incumbent carriers lowered their average fare by median value of 4.7% relative to their pre-entry levels on hub-markets entered by LCCs. Likewise, the authors found that the incumbents reduced the median number of seats offered by 1.2%.

⁸Bamberger and Carlton (1999) restrict their analysis to markets less than 750 miles that were entered by LCCs other than Southwest between May 1996 and the end of 1997.

1 while Edlin and Farrell (2002) provide a critical assessment of the recent Federal Court decision in
2 the U.S. DOJ vs. American Airlines. A somewhat different—albeit related—segment of the literature
3 analyzes the occurrence of price wars in the airline industry (Morrison and Winston 1995, Ross
4 1997, Busse 2002, Fournier and Zuehlke 2003). In general, these papers have focussed on defining
5 precisely when price wars occur and better understanding the factors (i.e., multi-market contact,
6 firm financial condition, etc.) leading to price wars.

7 In general, we find that the typical capacity response by incumbent carriers to LCC entry at
8 their hubs—measured in terms of the percentage increase in available seats and/or flights—has been
9 surprisingly modest. Indeed, in our sample of 370 hub markets entered by LCCs between 1991
10 and 2002, the incumbent introduced roughly 30% *fewer* seats and flights than the LCC entrant in
11 the four quarters following the quarter of initial entry. Likewise, while the incumbent’s average
12 fare typically drops substantially following LCC entry, it falls on average by twenty-six percentage
13 points less than the new entrant’s average fare (relative to the incumbent’s pre-entry average fare).
14 We also find that incumbent capacity responses to LCC entry have varied widely across carriers.
15 While Northwest and Alaska appear to be the most aggressive (in terms of capacity responses) to
16 LCC entry, American and Continental appear to have the most restrained responses. In fact, both
17 American and Continental reduced—on average—the number of seats offered in hub markets entered
18 by LCCs. Finally, and perhaps most importantly, we find little evidence that the response of the
19 incumbent carrier has any impact on the likelihood that an LCC’s entry proves to be successful.
20 In particular, when an LCC’s “success” in a market is defined by whether or not it eventually
21 exits that market, we find that the incumbent’s relative capacity response is not an important
22 explanatory factor. In terms of the incumbent’s price response, our analysis find that sharp price
23 cuts by the incumbent following LCC entry in fact *decrease* the probability of the LCC exiting the
24 market.

25 The remainder of this paper is organized as follows. Section 2 outlines the data used in our anal-
26 ysis and documents some stylized facts about LCC entry and the responses they have evoked from
27 incumbents over the past decade. In Section 3, we estimate LCC probit exit models. Concluding
28 remarks are provided in Section 4.

29 **2 Incumbent Responses to Low Cost Carrier Entry in the** 30 **U.S. Airline Industry**

31 Our analysis begins by documenting some stylized facts about the nature of LCC entry and the
32 responses they have evoked from incumbent hub-and-spoke carriers over the past decade in the
33 U.S. domestic airline industry.

2.1 The Data

Data on flight frequency and capacity for our analysis is taken from the U.S. DOT’s domestic T100 database, which records monthly data on all flights completed by the large certified commercial carriers. Fare and passenger data for our analysis is taken from the DOT’s OD1B database, a 10% sample of all domestic tickets.

Almost all predatory allegations involve the “hub” markets of incumbent carriers. Thus, we focus our attention on markets to and from major hub airports. More formally, our base data set is comprised of all non-directional airport-pair markets greater than 100 miles that (a) include the “hub” of at least one major hub-and-spoke carrier (Alaska, American, Continental, Delta, Northwest, United or US Airways) as one of its endpoints, and (b) were entered by one or more low cost carriers between 1991 and 2002.⁹

The set of low cost carriers we consider in our analysis are: Southwest, AirTran/ValuJet, Frontier, ATA, JetBlue, Spirit, Sun Country, Vanguard, ProAir, Western Pacific, Reno, Markair, Kiwi, Carnival, National and Air South.¹⁰ Since the use of regional code-sharing partners has become increasingly important to the major carriers’ hub-and-spoke systems over the past decade (especially following the introduction of regional jets), we also include flights operated by regional carriers that are wholly-owned or have exclusive (or near exclusive) code-sharing relationships with one of the major hub-and-spoke carriers.¹¹

Since many low cost carriers have entered certain hub markets via service to alternative airports, we group airports in Dallas, Houston, Chicago and Detroit. In each of these four cities, carriers tend to serve—almost exclusively—only one of the two large commercial airports.¹² Since relative flight frequency is likely to be an important factor influencing competition between incumbents and entrants in most markets and since it is usually not practical for travellers to depart from and

⁹The hubs included in our analysis are: Alaska (Seattle), American (Chicago, Dallas, Miami), Continental (Cleveland, Houston, Newark), Delta (Atlanta, Cincinnati, Salt Lake City), Northwest (Detroit, Memphis, Minneapolis), United (Denver, Washington-Dulles, Chicago, San Francisco), US Airways (Charlotte, Philadelphia, Pittsburgh). We exclude America West from our set of incumbent carriers since their cost structure more closely resembles that of the LCCs than other major hub-and-spoke carriers.

¹⁰Our data for AirTran includes ValuJet’s data, as AirTran was acquired by ValuJet in 1998 with ValuJet adopting AirTran’s name. It is also important to note that all of the entry events in our sample have exclusively used “mainline” (i.e., larger than 100-seat) aircraft such as the Boeing 737, McDonald Douglas DC-9, or Airbus A319/320. Recently, Atlantic Coast Airlines—a large regional carrier—announced plans to convert its business model from regional code-sharing service to a “low cost carrier” model (Independence Air) using predominantly 50-seat regional jet aircraft. Since regional jet aircraft have much higher unit operating costs than the larger, narrow-body jets traditionally used by LCCs, some of our results may not apply to Independence Air’s proposed entry.

¹¹The regional carriers we include are: American Eagle and Executive Airlines (American), Continental Express/Express Jet (Continental), Comair and Atlantic Southeast (Delta), Horizon (Alaska), Mesaba (Northwest) and Air Wisconsin (United). While we were able to include many of the largest regional codesharing carriers, we note that there are a number of regional carriers that were not required to file in the DOT’s T100 database during the period we study, such as Pinnacle Airlines (a Northwest Airlines subsidiary) or Atlantic Coast Airlines, which provides regional feed service for both Delta and United.

¹²For example, while both American and United have large hubs at Chicago’s O’Hare airport, Southwest and ATA serve the Chicago area exclusively via Chicago’s Midway airport.

1 return to different airports within the same metropolitan area, we want to ensure that we do not
2 aggregate service in city-pairs where carriers may serve multiple airport-pairs. Consequently, in
3 the other large metropolitan areas with multiple airports (i.e., Los Angeles, San Francisco, New
4 York City and Washington, D.C.), we elected not to group airports together, as many carriers
5 (both incumbent and low-cost) often serve more than one airport in the same metropolitan area.¹³

6 In our dataset, an entry event is a unique combination of market, incumbent and entrant. If
7 there are two incumbents and one entrant in one market, for example, we count two separate entry
8 events in this market so that we can observe the responses of both incumbents. Since our data set
9 encompasses thirteen years of data, it is possible for a given LCC to enter the same market more
10 than once and such re-entry is counted as a separate entry event.¹⁴

11 From our base data set, we excluded markets where there was less than four quarters of pre-
12 entry data for the incumbent carrier. Likewise, we excluded those markets in which there was
13 less than four quarters of data following the LCC's entry. We also required that a carrier serve a
14 market with at least twenty round-trips per month in order to be included. We define an entry
15 event as four or more consecutive quarters of service by an LCC following at least four quarters
16 where the LCC did not provide service in that market. While we recognize the possibility that
17 there may be a number of legitimate entries where the LCC withdrew prior to serving an entire
18 year, we wanted to minimize the impact of purely seasonal service.¹⁵

19 In total, our data set includes 370 unique entry events. Table 1 summarizes the number of entry
20 events, according to incumbent carrier and LCC. Entry events in this table often cluster between
21 specific LCCs and incumbent carriers (i.e, AirTran/Delta and Frontier/United) when these LCCs
22 have established hubs of their own at pre-existing major carrier hub airports.

¹³The one exception we made was with regards to JetBlue's JFK based operations. In order to study the impact of JetBlue's entry on Continental's Newark based hub markets, we recoded each of JetBlue's JFK based flights as Newark based flights. We recognize that for antitrust purposes, the appropriate market definition is usually assumed to be city-pairs rather than airport pairs. However, for the purpose of our research questions, we felt that it was more important to use a smaller set of entry events by controlling for capacity choices in the manner described above. We acknowledge, however, that our approach does not fully account for all entry in some city-pairs markets involving hub cities such as Washington-Dulles, where there has been substantial entry by LCCs at neighboring Baltimore-Washington Airport (BWI).

¹⁴To account for the large-scale exit of markets by AirTran/ValuJet following the crash of Flight 592 in May 1996 and the temporary grounding of its fleet, we exclude AirTran/ValuJet observations for the third and fourth quarters of 1996 as well as the first quarter of 1997.

¹⁵To test the sensitivity of our results, we have performed all our analysis with another data set in which we require only two quarters of service for valid LCC entries. Neither the signs nor the magnitude of the estimated probit coefficients did changed significantly.

1

Table 1: Cross Tabulation of Market Entry Events by Incumbent and LCC

	Incumbent Carriers								Total
	American	Alaska	Continental	Delta	Northwest	United	US Airways		
AirSouth*	0	0	0	5	0	0	0	0	5
AirTran	7	0	3	42	4	6	7	69	69
ATA	19	0	1	0	1	20	2	43	43
Carnival*	5	0	2	0	0	1	0	8	8
Frontier	2	0	1	2	1	29	0	35	35
JetBlue	0	0	13	1	0	1	0	15	15
Kiwi Int.*	2	0	5	4	0	4	0	15	15
MarkAir*	6	5	1	3	2	14	0	31	31
National	2	0	1	0	0	2	1	6	6
ProAir*	0	0	1	2	5	0	1	9	9
Reno [†]	0	3	0	1	0	3	0	7	7
Southwest	17	6	9	14	0	21	0	67	67
Spirit	3	0	3	0	8	4	2	20	20
Sun Country*	3	0	0	0	13	1	0	17	17
Vanguard*	6	0	0	4	1	8	2	21	21
Western Pacific*	1	0	0	0	0	1	0	2	2
Total	73	14	40	78	35	115	15	370	370

*Filed for bankruptcy protection during during sample period.

[†]Acquired by AMR Corp., the holding company of American Airline, on December 23, 1998.2
3

4 Table 2 summarizes the distribution of the entry events in our data set by year.

5

Table 2: Entry Events by Year

	Entry Year												Total
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	
JetBlue	0	0	0	0	0	0	0	0	0	9	5	1	15
MarkAir	1	5	15	10	0	0	0	0	0	0	0	0	31
Frontier	0	0	0	2	11	3	3	4	2	1	4	5	35
AirTran	0	0	8	13	14	0	2	6	4	12	7	3	69
Kiwi Int.	0	6	4	5	0	0	0	0	0	0	0	0	15
Carnival	1	2	1	2	0	0	2	0	0	0	0	0	8
National	0	0	0	0	0	0	0	0	5	1	0	0	6
Vanguard	0	0	0	3	8	0	3	1	5	1	0	0	21
Spirit	0	0	0	2	3	0	0	2	3	5	2	3	20
ProAir	0	0	0	0	0	0	3	4	2	0	0	0	9
Reno Air	0	0	1	0	1	2	1	2	0	0	0	0	7
Sun Country	0	0	0	0	0	0	0	0	12	5	0	0	17
ATA	0	0	1	6	0	0	9	6	3	9	6	3	43
Western Pacific	0	0	0	0	2	0	0	0	0	0	0	0	2
Southwest	0	7	4	15	6	3	2	2	17	2	2	7	67
AirSouth	0	0	0	3	1	1	0	0	0	0	0	0	5
Total	2	20	34	61	46	9	25	27	53	45	26	22	370

6
7

8 Eight carriers in our data set—Sun Country, Vanguard, ProAir, Western Pacific, Markair, Kiwi,
9 Carnival, and Air South—declared bankruptcy during our sample period, while another—Reno—was
10 acquired by American Airlines.¹⁶

¹⁶Sun Country has since re-emerged from bankruptcy and is once again operating flights to and from Minneapolis.

2.2 Some Stylized Facts on LCC Entry and Incumbent Responses

Our first goal is to document some stylized facts regarding the entry behavior of the different LCCs in our sample. We begin by comparing the entrant’s magnitude of entry relative to the incumbent’s pre-entry service level (i.e., capacity and prices). Similarly, we compare the post-entry response of incumbents relative their own pre-entry service offerings.

We consider two common measures of a carrier’s capacity: flight frequency and the number of available seats. In addition, we report both the average fare and the number of origin and destination (O&D) passengers as price and traffic measures.

2.2.1 Entrant’s Price and Capacity Choices

For each entry event, we begin by computing the incumbent’s pre-existing service level using data from the four quarters preceding the actual quarter of entry. We exclude data from the quarter of actual entry from this calculation since the incumbent may have already altered its service levels and fares in anticipation of entry. Next, we compute the entrant’s entry statistics using data from the four quarters directly following the quarter of entry. Again, we exclude data from the entry quarter because entry may have taken place during the middle of a quarter. For example, for an entry event that took place during the first quarter of 1996, we measure the entrant’s flight capacity choice as the percentage of the incumbent’s pre-entry flight capacity in the following way:

$$\mathcal{E}_i(\text{Flights}) = \frac{\sum_{1996qtr2}^{1997qtr1} \text{Entrant's Flights}}{\sum_{1995qtr1}^{1995qtr4} \text{Incumbent's Flights}} \quad (1)$$

Likewise, the entrant’s seat capacity and traffic are defined as:

$$\mathcal{E}_i(\text{Seats}) = \frac{\sum_{1996qtr2}^{1997qtr1} \text{Entrant's Seats}}{\sum_{1995qtr1}^{1995qtr4} \text{Incumbent's Seats}} \quad (2)$$

and

$$\mathcal{E}_i(\text{Pax}) = \frac{\sum_{1996qtr2}^{1997qtr1} \text{Entrant's Pax}}{\sum_{1995qtr1}^{1995qtr4} \text{Incumbent's Pax}} \quad (3)$$

We measure the entrant’s fare choice as the percentage price cut from the incumbent’s pre-entry average fare:

$$\mathcal{E}_i(\text{Fare}) = 1 - \frac{\sum_{1996qtr2}^{1997qtr1} \text{Entrant's Average Fare}}{\sum_{1995qtr1}^{1995qtr4} \text{Incumbent's Average Fare}} \quad (4)$$

For ease of interpretation in later sections, each of the four measures are defined so that large positive numbers indicate larger and more aggressive entry. Moreover, we average the data over four quarters to avoid seasonality.

1 2.2.2 Incumbent Responses

2 As with our entry statistics, we measure the incumbent's responses as the percentage change from
3 its pre-entry capacity and fare levels. As before, our convention is measure the change in the four
4 quarters following entry relative to the four quarters prior to entry (excluding, once again, the
5 quarter of actual entry from both the numerator and denominator). Thus, the incumbent's flight
6 capacity response to an entry event that occurred during the first quarter of 1996 is defined as:

$$\mathcal{I}_i(\text{Flights}) = 1 - \frac{\sum_{1996qtr2}^{1997qtr1} \text{Incumbent's Flights}}{\sum_{1995qtr1}^{1995qtr4} \text{Incumbent's Flights}} \quad (5)$$

7 Likewise, the incumbent's seat response and O&D passenger traffic are defined like:

$$\mathcal{I}_i(\text{Seats}) = 1 - \frac{\sum_{1996qtr2}^{1997qtr1} \text{Incumbent's Seats}}{\sum_{1995qtr1}^{1995qtr4} \text{Incumbent's Seats}} \quad (6)$$

$$\mathcal{I}_i(\text{Pax}) = 1 - \frac{\sum_{1996qtr2}^{1997qtr1} \text{Incumbent's Pax}}{\sum_{1995qtr1}^{1995qtr4} \text{Incumbent's Pax}} \quad (7)$$

8 Finally, the incumbent's fare response is also defined as the percentage decline from its original
9 average fare levels.

$$\mathcal{I}_i(\text{Fare}) = 1 - \frac{\sum_{1996qtr2}^{1997qtr1} \text{Incumbent's Fare}}{\sum_{1995qtr1}^{1995qtr4} \text{Incumbent's Fare}} \quad (8)$$

1 **2.2.3 Median Entry Style and Incumbent Responses**

2 Table 3 summarizes, by LCC, the median values of $\mathcal{E}_i(\text{Flights})$, $\mathcal{E}_i(\text{Seats})$, $\mathcal{E}_i(\text{Fare})$ and $\mathcal{E}_i(\text{Pax})$
3 across all of their respective entry events during our sample period.

4 **Table 3: Median Entry Statistics for Low Cost Carriers**

	$\mathcal{E}_i(\text{Flights})$	$\mathcal{E}_i(\text{Seats})$	$\mathcal{E}_i(\text{Fares})$	$\mathcal{E}_i(\text{Pax})$
AirSouth	30.4%	31.7%	61.5%	78.2%
AirTran	41.1%	34.1%	59.3%	60.4%
ATA	28.9%	27.3%	49.5%	49.4%
Carnival	23.4%	18.7%	15.0%	40.6%
Frontier	33.0%	30.0%	39.8%	42.3%
JetBlue	46.4%	53.7%	53.9%	68.7%
Kiwi Int.	34.2%	30.7%	42.4%	48.3%
MarkAir	18.2%	16.7%	47.7%	28.0%
National	51.4%	56.5%	29.9%	88.8%
ProAir	25.5%	29.1%	62.4%	24.5%
Reno Air	48.1%	48.1%	43.3%	60.2%
Southwest	48.9%	46.7%	48.0%	111.1%
Spirit	25.8%	25.1%	41.5%	44.3%
Sun Country	16.1%	24.1%	49.5%	38.6%
Vanguard	43.2%	43.5%	66.5%	101.8%
Western Pacific	62.7%	67.4%	49.6%	255.0%
Total	34.7%	32.7%	49.5%	59.8%

5
6 Table 3 demonstrates the large competitive impact that LCC entry typically has on markets. The
7 median fare reduction, relative to the incumbent’s pre-entry average price, was slightly less than
8 50%, stimulating 60% growth in O&D passengers at the median relative to the incumbent’s number
9 of pre-entry passengers. The fact that LCCs can stimulate such growth in O&D passengers by
10 adding slightly more than one-third of the incumbent carrier’s pre-entry capacity level (in terms of
11 trips or seats) reflects the fact that a substantial portion of the incumbent’s capacity is intended to
12 feed connecting traffic into its hub. For the LCC, a much larger portion (and in many cases all) of
13 its passengers are O&D passengers, since many LCCs primarily operate point-to-point, rather than
14 hub-and-spoke networks.¹⁷ Table 3 also indicates that LCCs differ significantly in their “style” of
15 entry. While Southwest and JetBlue’s median seat capacity in the first year following entry has
16 been roughly 50% of the incumbents’ pre-entry capacity, Spirit, ProAir and ATA’s median seat
17 capacity has been half of that. In terms of prices, Vanguard, ProAir, Air South and AirTran tend
18 to reduce prices the most—relative to the incumbent’s pre-entry average fares, while Frontier, Kiwi
19 and National have tended to be the least aggressive in terms of pricing. This difference in entry
20 styles is a key to understanding the nature of competition between incumbents and LCCs.

21 Table 4 summarizes the median values of $\mathcal{I}_i(\text{Flights})$, $\mathcal{I}_i(\text{Seats})$, $\mathcal{I}_i(\text{Fare})$ and $\mathcal{I}_i(\text{Pax})$ across
22 each of the markets where the respective incumbent carrier faced entry.

¹⁷The primary exceptions, in our data, are AirTran and Frontier, both of which primarily operate hub-and-spoke networks.

1 **Table 4: Median Response Statistics for Incumbents**

	$\mathcal{I}_i(\text{Flights})$	$\mathcal{I}_i(\text{Seats})$	$\mathcal{I}_i(\text{Fares})$	$\mathcal{I}_i(\text{Pax})$
American	1.3%	-0.6%	8.6%	5.4%
Alaska	11.8%	13.0%	11.6%	41.7%
Continental	-4.4%	-0.3%	14.8%	8.1%
Delta	2.3%	5.2%	25.3%	17.2%
Northwest	11.8%	10.1%	15.0%	36.8%
United	3.9%	3.0%	16.8%	17.3%
US Airways	4.9%	6.5%	20.5%	27.3%
Total	2.9%	4.0%	15.1%	16.2%

3 Table 4 indicates that—on average—incumbent carriers have responded somewhat passively to LCC
4 entry at their hubs, which is consistent with the findings of Bamberger and Carlton (1999). While
5 the median LCC entrant introduces 32.7% additional seats (relative to the incumbent’s pre-entry
6 capacity) into a hub market, the median capacity response by incumbents has only been 4.0%.
7 In terms of averages fares, the median incumbent response has been to reduce its average fares
8 by 15.1% (compared to 49.5% by the entrant).¹⁸ As was the case with Table 3, Table 4 demon-
9 strates that there are significant differences in the median response across the incumbent carriers.
10 While American and Continental have actually reduced the absolute number of available seats (on
11 average) in the hub markets where they have faced LCC entry, Northwest and Alaska have each
12 increased seat capacity by more than 10%. In terms of average fare reductions, Delta’s median
13 fare reduction relative to its pre-entry levels has been the largest (25.3%), while American’s has
14 been the smallest (8.6%).

15 **2.2.4 Relative Responses Statistics**

16 The median response statistics in Table 4 beg an obvious question: to what extent are a particular
17 incumbent’s responses in a given market a result of the magnitude of entry it faces? For example,
18 is American’s median capacity response the lowest simply because it faces the least aggressive
19 entrants? In order to shed some insight into these questions, we now turn our attention to the
20 incumbents’ responses *relative to the entry they have faced*. Define an incumbent’s relative flight
21 response to entry event i as:

$$\mathcal{R}_i(\text{Flights}) = \mathcal{I}_i(\text{Flights}) - \mathcal{E}_i(\text{Flights})$$

22 $\mathcal{R}_i(\text{Seats})$ and $\mathcal{R}_i(\text{Pax})$, $\mathcal{R}_i(\text{Fare})$ are defined analogously. Since each of our relative response
23 statistics are calculated as the difference between the incumbent’s response and the entrant, the
24 smaller its value (in absolute value), the less aggressive the incumbent’s fare response. Table 5

¹⁸It is important to note that one should not—in general—expect that the incumbent’s average fares will drop as much as the entrant’s, since the incumbent carriers typically offer both coach as well as first class service.

1 summarizes the median relative response measures for each of the incumbent carriers.

2 **Table 5: Median Relative Response Statistics for Incumbents**

	$\mathcal{R}_i(\text{Flights})$	$\mathcal{R}_i(\text{Seats})$	$\mathcal{R}_i(\text{Fares})$	$\mathcal{R}_i(\text{Pax})$
American	-33.7%	-35.9%	-28.7%	-72.9%
Alaska	-22.9%	-30.1%	-17.9%	-0.3%
Continental	-37.9%	-34.1%	-19.2%	-47.1%
Delta	-36.1%	-28.1%	-32.6%	-48.8%
Northwest	-12.1%	-13.2%	-25.6%	-0.6%
United	-32.8%	-32.3%	-25.9%	-44.9%
US Airways	-35.6%	-35.0%	-21.8%	-29.0%
3 Total	-32.7%	-29.6%	-25.8%	-43.4%

4 The first thing to notice from Table 5 is that most median relative responses statistics are strongly
5 negative. In all categories, the entrants' scale and price cuts outpace the responses of the incum-
6 bents, which confirms the passive nature of the incumbents' responses seen in Tables 3 and 4. For
7 example, American, US Airways and Continental on average tend to add the fewest additional
8 seats relative to the entrant. Indeed, Table 5 shows that American—on average—has added 35.9%
9 *fewer* seats than the LCC entrants it has faced. Northwest, on the other hand, has been the most
10 aggressive in terms of capacity responses, adding on average 13.2% fewer seats than the LCC en-
11 trant. The primary difference between Table 4 and Table 5 with respect to capacity responses is for
12 Alaska. While Table 4 indicates that Alaska tends to add the most seats of all the incumbents (its
13 median value of $\mathcal{I}_i(\text{Seats})$ is 12.9%), Table 5 shows that its median *relative* seat response (30.1%)
14 is on par with overall median (29.6%). This suggests that in the Seattle hub markets where Alaska
15 has faced LCC entry, the LCC has tended to enter with relatively high levels of capacity.

16 Turning now to the relative fare responses, Table 5 indicates that Alaska has been the most
17 aggressive—reducing its average fares by 17.9 percentage points *less than* the entrant. In contrast,
18 both Delta and American have been the least aggressive in terms of relative fare responses, reducing
19 fares—on average—by roughly thirty percentage points less than the entrant. The fact that Delta's
20 median relative fare response is the largest (in absolute value) of the incumbent carriers while its
21 absolute fare response from Table 4 was the smallest indicates that the LCCs that have entered
22 Delta's hub markets tend to do so with very large fare reductions.

23 2.2.5 Capacity and Fare Interactions between Incumbents and Entrants

24 Although the relative response statistics in Table 5 are helpful in understanding the median re-
25 sponse of incumbent carriers to new entry, the numbers by themselves do not reveal much about
26 the level of post-entry competition played out between the incumbent and the entrant. For exam-
27 ple, $\mathcal{R}_i(\text{Fares}) = 0$ cannot distinguish between a simultaneous price reduction of 40% or 5%. To
28 better see the precise interactions between the incumbents and the entrants, we plot the data and
29 obtain a bird's eye view of its distribution. Among the four competitive metrics we have presented

1 (flights, fares, seats and passengers), we focus our attention on two key choice variables, fares and
2 seats, as these have been the focus of attention in the controversy surrounding incumbent responses
3 to LCC entry. While we recognize that flight frequency is also an important measure of capacity
4 as well as service quality, the flights and seats variables tend to be highly correlated in our data
5 set. Consequently, for the remainder of our analysis, we chose seats as our primary measure of
6 capacity.

7 Figure 1 plots the incumbent’s fare response $\mathcal{I}_i(\text{Fares})$ relative to the entrant’s $\mathcal{E}_i(\text{Fares})$ in
8 each of our 370 entry events. As in the previous section, the unit of observation is a market-
9 incumbent-entrant. The diagonal line in Figure 1 indicates a “perfectly matched” response by the
10 incumbent.

11 **[INSERT FIGURE 1 HERE]**

12 In general, the incumbents’ fare responses tend to be smaller than the entrants (i.e., the data
13 lie below the 45 degree line). While this may partly reflect the generally “modest” price responses
14 by incumbents, it may also reflect the limitation of using average fares. There are two reasons
15 why the average fare may not reflect the full picture of price competition. First, incumbent “full
16 service” carriers tend to have more differentiated fare structures than LCCs, as they typically offer
17 two different classes of service (first and coach). Second, when incumbents match the price cuts of
18 LCCs, they typically do so on a limited inventory basis. Nevertheless, Figure 1 clearly shows the
19 tendency for the price response of incumbent to be roughly aligned with that of the LCC entrant.

20 Figure 2 plots the capacity choices for incumbents and entrants in terms of the percentage
21 increase in quarterly seats relative to the incumbent’s pre-entry levels. Unlike the price responses
22 in Figure 1, there does not appear to be any obvious correlation between the incumbent’s and
23 entrant’s capacity choices. It is noteworthy that the majority (70%) of incumbent responses cluster
24 around $\pm 15\%$ from their pre-entry capacity level. Approximately 38% of the incumbents have zero
25 or negative capacity responses, electing a fully accommodating or complacent response to entry.
26 Strongly positive incumbent responses appear to be exceptions rather than the norm. Thus, of
27 the 370 observations, only twenty nine (or less than 8%) represent cases in which the incumbents’
28 capacity expansion outpaced that of the LCC. Moreover, almost all of those cases are between
29 relatively small scale entries and similarly small scale responses. Another observation worth noting
30 is the relatively large scale of some market entries. While many entries represent a small fraction
31 of the incumbent’s pre-existing capacity, more than one-quarter (28%) of the entries are those in
32 which the entrant chooses a capacity level of 50% or more of incumbent’s pre-entry capacity.

33 **[INSERT FIGURE 2 HERE]**

1 In summary, we find that the response of incumbent carriers to LCC entry—both in terms of
2 capacity expansion and prices reductions—tend to be much smaller than those of entrants. Although
3 incumbents show a tendency to match the entrants’ price cuts (albeit on a limited inventory basis),
4 their capacity responses are often quite modest. The entry events themselves, on the other hand,
5 tend to vary considerably, both by carrier, and often within carriers. While some LCCs such
6 as Frontier appear have adopted a “cream skimming” strategy (entering typically on a relatively
7 small scale and only moderately cutting prices), others carriers such as AirTran have tended to
8 be more aggressive, both in terms of capacity and fare reductions. Naturally, we suspect that
9 the nature of the competitive pressure facing incumbent carriers post-entry can vary significantly
10 depending on the type of entry they face. Indeed, such variation in the competitive interaction
11 between incumbents and LCCs may present some difficulty in defining “generally” applicable rules
12 for characterizing exclusionary conduct.

13 **3 Incumbent Responses and LCC Exit: Is There a Link?**

14 Numerous LCCs and some competition authorities, both in the U.S. and abroad, have alleged that
15 exclusionary conduct by incumbent carriers following entry into their hub markets have forced
16 them to exit markets they would otherwise like to serve (Transportation Research Board 1999).
17 As discussed earlier, while there is much anecdotal evidence documenting this type of behavior,
18 there have been few—if any—general conclusions regarding the impact of such alleged actions on
19 an entrant’s success. In this section, we attempt to determine the degree to which allegations of
20 exclusionary conduct are supported by the data by estimating a probit exit model.

21 **3.1 Exit Events**

22 We define an “exit” as four or more consecutive quarters of absence from a market. Since we
23 are interested in assessing the impact of incumbent responses (rather than other extraordinary
24 exogenous events) on LCC exit probability, we needed to take into consideration a number of
25 “exit” events that were primarily caused by other factors. In particular, we excluded two exit
26 events from our dataset that came as a result of American’s acquisition of Reno Air. Likewise,
27 since we excluded AirTran data for three quarters directly following the crash of one its aircraft in
28 May 1996 (which resulted in the subsequent temporary grounding of its fleet), some of the markets
29 where AirTran temporarily suspended service are not counted as formal exits.¹⁹ To minimize the
30 potential for “right censoring” in our data set, we dropped entry events from our data set that

¹⁹The markets that AirTran withdrew from for more than seven quarters were counted as exits.

1 occurred after 2000. Finally, we exclude markets that were exited as a result of the cessation of
 2 service due to bankruptcy.²⁰

3 LCC exits from markets are not an uncommon phenomena. Indeed, after modifying our entry-
 4 event data set as described above, our data set includes 265 entry events, of which 89 were exited.
 5 Table 6 summaries the exit events by entrant and incumbent and demonstrates—not surprisingly—
 6 that there are significant firm differences in terms of entry success. For example, of the 14 hub
 7 markets that JetBlue has thus far entered, none have been exited.²¹ Likewise, Southwest only
 8 exited three of sixty-seven hub markets it entered in our data set.

9 **Table 6: Cross Tabulation of Market Exits by Incumbent and LCC**

	Incumbent Carriers							Total
	American	Alaska	Continental	Delta	Northwest	United	US Airways	
AirSouth	0	0	0	2	0	0	0	2
AirTran	2	0	1	12	2	4	1	22
ATA	5	0	0	0	0	4	0	9
Carnival	2	0	1	0	0	0	0	3
Frontier	0	0	0	0	0	3	0	3
JetBlue	0	0	0	0	0	0	0	0
Kiwi Int.	1	0	2	3	0	3	0	9
MarkAir	0	1	0	0	0	1	0	2
National	0	0	0	0	0	0	0	0
Southwest	0	0	1	2	0	0	0	3
Spirit	0	0	3	0	0	0	2	5
Sun Country	3	0	0	0	12	1	0	16
Vanguard	4	0	0	3	1	6	1	15
Western Pacific	0	0	0	0	0	0	0	0
10 Total	17	1	8	22	15	22	4	89

12 3.2 Profile of Exit Events

13 Since exit from a market by an LCC is not an uncommon event, it is useful to profile some basic
 14 stylized facts of “successful” versus “unsuccessful” entry attempts. Table 7 compares the entry and
 15 response characteristics of the market events in our sample broken down by exited and non-exited
 16 events.

²⁰Note that this does *not* imply that we exclude all market exits by carriers that are now bankrupt, since markets that were exited in the years prior to bankruptcy are still included in our sample. To test the sensitivity of our results, we also performed our probit analysis including the bankruptcy events. Neither the signs nor the magnitudes of any of our estimated coefficients changed significantly.

²¹We note that JetBlue recently announced that it would exit the Atlanta-Long Beach and Atlanta-Oakland markets. Since JetBlue entered these markets in late 2002, these entry events were not part of our data set.

**Table 7: Statistical Profile of Market Entry Events
(Median Values)**

	Incumbents		Entrants	
	$\mathcal{R}_i(\text{Seats})$	$\mathcal{R}_i(\text{Fares})$	$\mathcal{E}_i(\text{Seats})$	$\mathcal{E}_i(\text{Fares})$
Non-Exits	4.5	10.8	37.3	47.3
Exits	3.5	10.7	27.7	52.2
Total	3.8	10.7	33.3	48.9

Market entry events that eventually result in exit are typically smaller scale entries. At the median, the exit events have 27.7% of the incumbent’s original capacity while the successful entries have 37.3%. The price reductions of failed entries are slightly deeper (median of 52.2%) than the successful entries (median of 47.3%). Somewhat surprisingly, the incumbents’ capacity responses tend to be slightly smaller (median of 3.5%) in exit events versus successful entries (median 4.5%). Equally surprisingly is the fact that there is no discernable difference in the incumbents’ price reductions between successful and failed LCC entries. As alluded to earlier, in light of the highly differentiated fare structures of incumbent carriers, we recognize the difficulty of determining the nature of price competition using the average fares alone. Nevertheless, it appears as though the magnitudes of the incumbents’ capacity and price cuts may not be significant factors in determining which market entries eventually fail. We investigate this possibility in the probit exit model in the following section.

Table 8 compares some raw pre-entry market characteristics (O&D passengers, seats, and flights) of successful and unsuccessful market entries.²² Unsuccessful market entries typically occur in significantly “thinner” markets by all three measures. Most importantly, these markets tend to be comparatively thin in terms of pre-existing O&D passenger traffic, serving 31% fewer local passengers than those markets where entry was successful. It is possible that LCC operations that typically rely on a large base of O&D (rather than connecting) traffic were not able to sustain themselves in those markets.

**Table 8: Some Market Characteristics
(Median Quarterly Values)**

	O&D Passengers	Seats	Flights
Non-Exited Markets	80,869	303,533	2,043
Exited Markets	56,043	229,264	1,880
All Entries	68,135	265,201	1,957

3.3 Exit Probit Models

In order to determine if LCC exit choices are systematically related to the competitive behavior of incumbents prior to their exit, we estimate a basic probit model using $\mathcal{I}_i(\text{Seats})$ and $\mathcal{I}_i(\text{Fare})$ as two of our independent variables.²³ The dependent variable **D(LCC Exit)** takes the value 1

²²The figures in Table 8 are quarterly averages from the four quarters prior to the entry.

²³When calculating the incumbent’s post-entry pricing/capacity decisions, we compute the average value using quarters when the LCC is present in the market. Obviously, an LCC’s withdrawal from a market is likely to

1 if the LCC exited the market and 0 otherwise. If aggressive responses by incumbents are partly
2 responsible for the eventual withdrawal of the LCC, we expect the coefficients for these variables
3 to be strongly positive and statistically significant. Since the incumbent’s responses should be
4 measured relative to the that of the entrant, we also include the entrants’ capacity and pricing
5 choices, $\mathcal{E}_i(\text{Seats})$ and $\mathcal{E}_i(\text{Fare})$, as control variables. Moreover, we are interested in determining if
6 any particular entry style (i.e., small capacity, aggressive price cutting) contribute to higher failure
7 probabilities than others. We chose not to include the flight frequency variables ($\mathcal{E}_i(\text{Trips})$ and
8 $\mathcal{I}_i(\text{Trips})$) in our estimations since they are highly correlated with $\mathcal{E}_i(\text{Seats})$ and $\mathcal{I}_i(\text{Seats})$.

9 We perform two separate probit estimations: one with Southwest and one without Southwest.
10 As discussed earlier, Southwest is by far the largest LCC and has an extremely low exit rate.
11 By presenting two samples, we check the sensitivity of our results to the presence or absence of
12 Southwest.

13 3.4 Other Independent Variables

14 In addition to the price and capacity choices of the incumbent and entrant, we include several
15 other market characteristics that we believe may influence the success or failure of entrants. When
16 applicable, these variables are defined using the pre-entry market data averaged over the four
17 quarters prior to entry in order to account for possible effects of seasonality.

18 It is well understood that LCCs have traditionally focused on serving pre-existing high density
19 markets. Thus, we include $\ln(\text{O\&D Pax})$, the natural logarithm of quarterly O&D passengers
20 travelling in the market on all carriers as one of our independent variables. If thin O&D passenger
21 density help to explain exit, we expect this variable to have a negative coefficient. Moreover,
22 the high frequency, quick turn operational models of LCCs provide them with an even greater
23 comparative advantage (vis-à-vis their hub-and-spoke carrier counterparts) in short haul markets.
24 Furthermore, it is possible that some passengers may find the lower level of in-flight amenities
25 offered by LCCs acceptable on short-haul flights, but less acceptable on longer-haul flights. Thus,
26 we include $\ln(\text{distance})$, the natural logarithm of the market’s distance in miles.

27 It is natural to suspect that well-established LCCs with large national footprints may have
28 higher success probabilities than smaller, regional LCCs. In the long-purse story of predation, for
29 example, the more established LCC’s may have more staying power in price wars. Alternatively,
30 larger LCCs may simply enjoy high brand recognition, learning-by-doing operational experience,
31 or logistical advantages of larger networks. $\ln(\text{LCCsize})$ is the natural log of O&D passengers
32 served by the LCC in all of its markets and is a measure of the LCC’s overall size. Since entry, by

prompt some degree of fare and capacity adjustments from the incumbent, which we do not want to consider in our post-entry variables.

1 definition, occurs on an airport/city-pair basis in our model, we also include **LCC Scope**, which is
 2 defined as the mean number of destinations served by the LCC from both endpoints of the market
 3 entered.

4 We posit that variations in the pre-existing competitive environment may impact the likelihood
 5 of success for new entrants. **HHI** is the pre-entry Herfindahl index of the airport-pair market in
 6 terms of O&D passengers, while **D(Existing LCC)** is a dummy variable for markets with pre-
 7 existing LCC presence. In addition, to account for the possibility of right-censoring in our data,
 8 we include dummy variables for entry events that occurred in 1999 and 2000. Since these are the
 9 last two years in our current sample, we have a shorter window of opportunity to observe their
 10 eventual exits.

11 Finally, in order to control for systematic incumbent differences beyond those captured by our
 12 response variables $\mathcal{I}_i(\text{Seats})$ and $\mathcal{I}_i(\text{Fare})$, we include incumbent carrier dummies (with Alaska
 13 Airlines being the base case).

14 Summary statistics for our independent variables are provided in Table 9.

15 **Table 9: Summary Statistics of Probit Variables**

Variable	Entire Dataset		Without Southwest	
	Mean	Std. Dev.	Mean	Std. Dev.
D(LCC exit)	0.336	(0.473)	0.415	(0.494)
$\mathcal{I}_i(\text{Seats})$	0.060	(0.167)	0.055	(0.157)
$\mathcal{I}_i(\text{Fares})$	0.140	(0.234)	0.133	(0.221)
$\mathcal{E}_i(\text{Seats})$	0.452	(0.400)	0.389	(0.333)
$\mathcal{E}_i(\text{Fares})$	0.459	(0.197)	0.459	(0.191)
ln(Distance)	6.429	(0.614)	6.426	(0.631)
ln(O&D Pax)	11.036	(0.977)	11.067	(0.985)
ln(LCC Size)	9.444	(4.456)	8.225	(4.313)
LCC Scope	4.211	(4.754)	3.227	(3.758)
HHI	0.492	(0.182)	0.516	(0.185)
D(Existing LCC)	0.208	(0.406)	0.222	(0.417)
D(yr 1999)	0.192	(0.395)	0.164	(0.371)
D(yr 2000)	0.166	(0.373)	0.203	(0.403)
American	0.204	(0.404)	0.193	(0.396)
Continental	0.094	(0.293)	0.087	(0.282)
Delta	0.230	(0.422)	0.227	(0.420)
Northwest	0.094	(0.293)	0.121	(0.327)
United	0.298	(0.458)	0.300	(0.459)
US Airways	0.042	(0.200)	0.053	(0.225)
Obs.	N=265		N=207	

16

3.5 Estimation Results

Estimation results from our probit model are summarized in Table 10 below.

Table 10: LCC Exit Probit Results

	D(LCC exit)	
	All Entries	Excluding Southwest
$\mathcal{I}_i(\text{Seats})$	-1.122 (0.815)	-1.076 (0.883)
$\mathcal{I}_i(\text{Fares})$	-0.774 (0.554)	-1.353* (0.667)
$\mathcal{E}_i(\text{Seats})$	-1.816 [†] (0.394)	-1.441 [†] (0.454)
$\mathcal{E}_i(\text{Fares})$	0.807 (0.776)	1.684 (0.902)
ln(Distance)	-0.883 [†] (0.213)	-1.113 [†] (0.252)
ln(O&D Pax)	-0.261 (0.145)	-0.304 (0.169)
ln(LCC Size)	0.002 (0.027)	0.069* (0.034)
LCC Scope	-0.130 [†] (0.036)	-0.166 [†] (0.046)
HHI	-0.701 (0.714)	-1.409 (0.794)
D(Existing LCC)	-0.372 (0.299)	-0.664* (0.329)
D(1999)	0.313 (0.308)	0.385 (0.348)
D(2000)	-0.506 (0.357)	-0.843* (0.406)
D(American)	1.588 (0.952)	1.124 (1.690)
D(Continental)	2.266* (1.019)	2.001 (1.746)
D(Delta)	1.177 (0.946)	0.754 (1.695)
D(Northwest)	2.099* (0.985)	1.763 (1.706)
D(United)	1.213 (0.937)	0.745 (1.681)
D(US Airways)	1.75 (1.046)	1.083 (1.747)
Constant	8.015 [†] (2.444)	10.081 [†] (3.236)
Observations	265	207
Pseudo R^2	.3073	.3247
% of exits correctly predicted	59.6%	73.3%
No. of observations	265	207

[†]significant at 1%. *significant at 5%.

Table 10 indicates that the incumbent's capacity response following LCC entry does not have a statistically significant impact on the LCC's failure probability—both in the full sample of markets and in those excluding Southwest. The estimated coefficients on $\mathcal{I}_i(\text{Fares})$ on the other hand, is significant at the 5% level in our sample excluding Southwest, but the coefficient, somewhat

1 surprisingly, is negative. This result may suggest that entry is often successful in markets that
2 have pre-existing higher margins where there are large numbers of “un-tapped” passengers who
3 previously had less (or no) access to the low fares offered by LCCs. In these markets, the incumbent
4 carrier may realize that once they face LCC entry, their best response is to participate in the market
5 stimulation from lower fares. Thus, the results do not support the hypothesis that aggressive price-
6 cuts or capacity expansions contributed to the LCCs exits.

7 The negative and significant estimated coefficient on $\mathcal{E}_i(\text{Seats})$ indicates that the larger the
8 initial capacity choice by the entrant, the lower the exit probability. This may reflect the scale
9 economies necessary for successful entry. Moreover, it is well known that many passengers value
10 high frequency service.

11 The estimated coefficient on $\mathcal{E}_i(\text{Fares})$ is positive, but not significant at the 5% level. The
12 positive coefficient tends to indicate, however, that the larger the initial fare reduction by the
13 LCC, the higher the probability of exit. This result may indicate that the LCC—for one reason
14 or another—was unable to attract a sufficient number of passengers at profitable fares. Alternatively,
15 larger price cuts may simply be indicative of overly aggressive (and possibly ill-conceived) entry
16 by the LCC.²⁴

17 Also noteworthy is the negative and significant estimated coefficient on $\ln(\text{distance})$. This
18 result, which is contrary to our expectation, indicates that the longer the market’s distance, the
19 lower the exit probability. We caution inferring too much from this result however, as LCC entry
20 into longer-haul markets is a rather recent phenomenon.²⁵ Moreover, the result may be related to
21 the fact that JetBlue, which has the longest average route length among all of the LCCs, did not
22 experience any exits in our data set. As expected, larger pre-existing market size measured by
23 $\ln(\text{O\&D Pax})$ reduces the probability of exit, confirming a well known result that LCCs are able
24 to leverage their comparative advantage by targeting pre-existing dense markets.

25 As expected, the larger the LCC’s absolute size and the larger the number of destinations
26 that the LCC serves at the end-point cities of a market, the smaller the probability of eventual
27 exit. However, while the estimated coefficient on **LCC Scope** is significant at the 5% level, the
28 estimated coefficient on **LCC Size** is not. This suggests that brand recognition and pre-existing
29 passenger experience with an LCC is more relevant to the eventual success of a particular market
30 entry than the firm’s overall size. Finally, there appears to be some differences (although not
31 statistically significant) in success probability depending on the particular incumbent that is faced
32 by the LCC. While LCCs appear to have had the best success facing United and Delta, they tend

²⁴For example, Australian LCC Virgin Blue stated that “The failure of Compass Airlines 1 and 2 has been attributed to shortcomings in their entry strategy, which misjudged the operational, economic and regulatory obstacles to large scale entry into the domestic market.” Source: *Virgin Blue Prospectus*, page 42.

²⁵Until recently, for example, AirTran did not possess the aircraft capable of flying from its hub in Atlanta to the West Coast.

1 to have lower entry success probabilities when facing Northwest and Continental.

2 Overall, our results indicate that aggressive responses by incumbent carriers, measured in
3 terms of percentage capacity increase or percentage price reductions, are not likely to be a general
4 explanation for LCC exit from hub markets. We should emphasize however, that our results do
5 not exclude the possibility that in some markets, the actions of incumbent carriers may have
6 influenced an LCC's exit decision. For example, in a relatively small market, the survival of a
7 small new entrant is possibly influenced by a relatively small response by an incumbent. In order
8 to explain such outcomes, however, one needs to devise a model that accounts for more subtle
9 strategic interactions between incumbents and entrants.

10 4 Conclusions

11 This paper investigates the responses of hub-and-spoke network carriers to LCC entry on their
12 hub routes. In addition to documenting some stylized facts regarding the pattern of entry and
13 response over the past decade, we examine how these responses have influenced LCC market
14 survival probabilities.

15 The responses of incumbent carriers to new entry by LCCs has been a primary focus of both
16 policy-makers and competition authorities, both in the U.S. and abroad. Indeed, numerous parties
17 have alleged that incumbent hub carriers frequently respond to LCC entry with sharp price reduc-
18 tions coupled with aggressive capacity expansion. Concerns over these types of alleged practices
19 were heightened so much during the late 1990's that the U.S. Department of Transportation is-
20 sued tentative guidelines for evaluating whether an incumbent's conduct constituted exclusionary
21 conduct.²⁶ Although anecdotal evidence of such practices is common, questions remains as to how
22 prevalent those aggressive incumbent behaviors have been. This paper attempts to provide some
23 empirical evidence to answer this question using a broad sample of market entry events.

24 We find that highly aggressive incumbent reactions are more the exception rather than the
25 rule. Moreover, we find—somewhat surprisingly—that the median response of incumbents to LCC
26 entry at their hubs has tended to be fairly accommodating. Based on our analysis of 370 market
27 entry events, we find that while the incumbent often aligns their price to that of entrant, it rarely
28 undercuts the entrant's average fares. As for the capacity response of incumbents, we find no clear
29 evidence that incumbents try to out-pace or even match the entrant's capacity choice. This is
30 contrary to the common perception that the incumbent response of aggressively expanding their
31 capacity following LCC entry is a widespread phenomena. In this sense, our results support the
32 conclusion of Bamberger and Carlton (1999) using an expanded scope of the data.

²⁶The Department eventually withdrew its proposal in favor of a case-by-case examination.

1 Perhaps the most important finding of our analysis, however, is that we found no evidence that
2 an incumbent’s capacity expansion or pricing decisions following LCC entry negatively impacts
3 the probability that the LCC exits a market. Rather, factors such as the entrant’s capacity choice,
4 pre-existing market density and the LCC’s pre-entry presence at the endpoints of a market appear
5 to be factors which contribute to an entrant’s ultimate success or failure. Thus, from a policy
6 perspective, our results suggest that rather than focussing on the nature of post-entry competition
7 between incumbents and entrants, policy-makers should be more concerned with ensuring that
8 LCCs have sufficient access to airport facilities such as gates. Indeed, LCC access to gates at some
9 highly congested hub-airports, is likely to be a topic of heated discussion in the policy arena.²⁷

10 It is important to note that the competitive confrontation between the hub-and-spoke incum-
11 bents and LCC entrants is far from over. Based on the current market capitalizations and aircraft
12 orders of LCCs such as Southwest, JetBlue, AirTran and Frontier, continued growth of LCCs is
13 likely.²⁸ Naturally, the discussion on the incumbents’ aggressive responses and their influence on
14 possible entry failures is likely to continue and expand in the future. For example, JetBlue’s CEO
15 cited intense competition from both Delta and AirTran as reasons for exiting the Atlanta-Long
16 Beach and Atlanta-Oakland markets.²⁹ The primary lesson from our analysis, however, is that a
17 cut-and-dry rule of capacity expansion or price reduction is unlikely to define—in any meaningful
18 or economically appropriate way—“predatory” or “exclusionary” conduct.

²⁷For example, Huston (1999) argue that the number of gates in the hub-airports is the key determinant of long-run equilibrium in the industry.

²⁸As of November 30, 2003 for example, Southwest’s market capitalization exceeded the sum of all other major carriers combined and JetBlue’s market capitalization exceeded that of any of the legacy hub-and-spoke carriers.

²⁹Source: “Citing competition, JetBlue will bid Atlanta farewell”, *Atlanta Journal-Constitution*, October 24, 2003.

Figure 1: Fare Responses of Incumbent Carriers

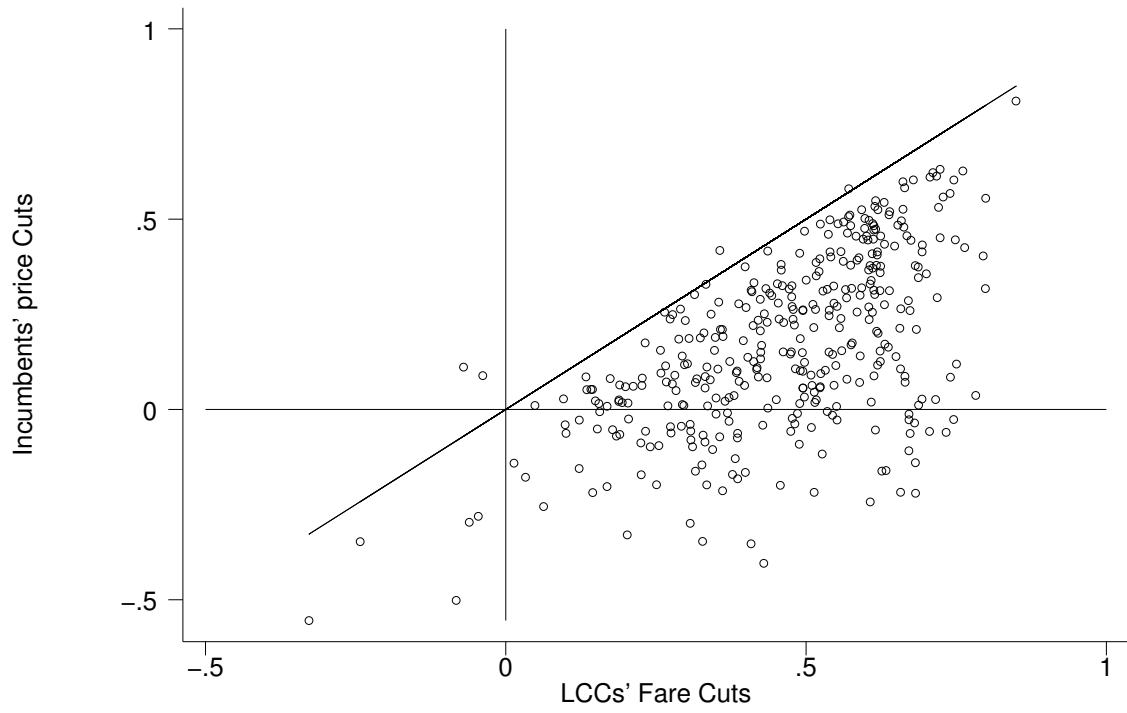
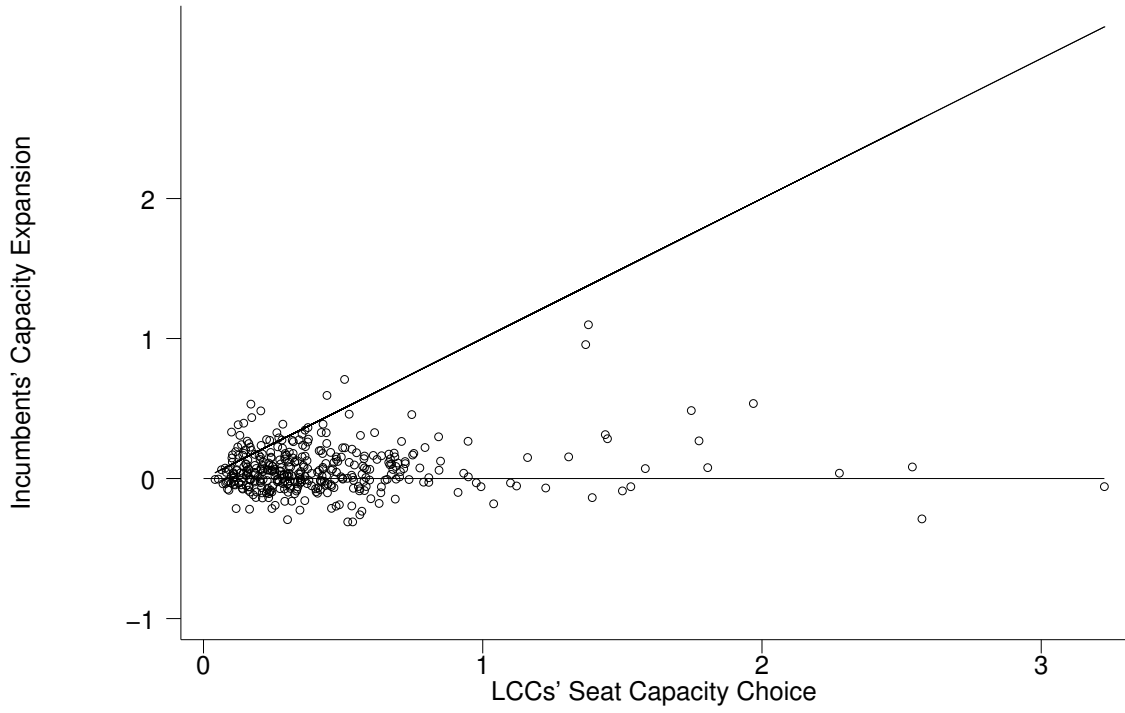


Figure 2: Capacity Responses of Incumbent Carriers



1 References

- 2 AREEDA, P., AND D. TURNER (1975): "Predatory Pricing and Related Practices under Section 2
3 of the Sherman Act," *Harvard Law Review*, 88, 697–733.
- 4 BAMBERGER, G., AND D. CARLTON (1999): "An Empirical Assessment of Predation in the Airline
5 Industry," Unpublished Manuscript, Lexecon, Inc., October 12, 1999.
- 6 BAUMOL, W. J. (1998): "Declaration of Professor William J. Baumol," In *Re Enforcement Policy*
7 *Regarding Unfair Exclusionary Conduction in the Air Transportation Industry*.
- 8 BUSSE, M. (2002): "Firm Financial Condition and Airline Price Wars," *Rand Journal of Eco-*
9 *nomics*, 33, 298–318.
- 10 DRESNER, M., J.-S. C. LIN, AND R. WINDLE (1996): "The Impact of Low-Cost Carriers on
11 Airport and Route Competition," *Journal of Transport Economics and Policy*, 30, 309–328.
- 12 DRESNER, M., AND R. WINDLE (1999): "Competitive Responses to Low Cost Carrier Entry,"
13 *Transportation Research Part E*, 35, 59–75.
- 14 ECKERT, A., AND D. WEST (2002): "Predation in the airline industry: the Canadian antitrust
15 approach," *The Antitrust Bulletin*, pp. 217–242.
- 16 EDLIN, A., AND J. FARRELL (2002): "The American Airlines Case: A Chance to Clarify Predation
17 Policy," Unpublished Manuscript, University of California–Berkeley.
- 18 EDLIN, A. S. (2002): "Stopping Above-Cost Predatory Pricing," *Yale Law Journal*, 111, 941–991.
- 19 FOURNIER, G., AND T. ZUEHLKE (2003): "Airline price wars with multi-market carrier contacts
20 and low-cost carrier entrants," Unpublished Manuscript, Department of Economics, Florida
21 State University, March 2003.
- 22 HUSTON, R. B. J. (1999): "The Measing of Size: Output? Scope? Capacity? The Case of Airline
23 Hubs," *Review of Industrial Organization*, 14, 51–64.
- 24 LAZAR, F. (2000): "Why an Air Canada Monopoly is Bad for Air Business," *Canadian Business*
25 *Economics*, (February), 3–5.
- 26 MCGEE, J. (1958): "Predatory Price Cutting: the Standard Oil (N.J.) Case," *Journal of Law and*
27 *Economics*, 1, 137–69.
- 28 MILGROM, P., AND J. ROBERTS (1982): "Limit Pricing adn Entry Under Incomplete Information:
29 an Equilibrium Analysis," *Econometrica*, 50, 443–60.

- 1 MORRISON, S., AND C. WINSTON (1995): *The Evolution of the Airline Industry*. The Brookings
2 Institution, Washington, D.C.
- 3 MORRISON, S. A. (2001): “Actual, Adjacent and Potential Competition: Estimating the Full
4 Effect of Southwest Airlines,” *Journal of Transport Economics and Policy*, 35, 239–256.
- 5 ORDOVER, J., AND R. WILLIG (1981): “An Economic Definition of Predation: Pricing and Prod-
6 uct Innovation,” *Yale Law Journal*, 91, 8–53.
- 7 ——— (1998): “Statement of Professor Professor Janusz A. Ordover and Professor Robert
8 D. Willig,” In *Re Enforcement Policy Regarding Unfair Exclusionary Conduction in the Air*
9 *Transportation Industry*.
- 10 ROSS, L. (1997): “When will an Airline Stand its Ground? An Analysis of Fare Wars,” *Interna-*
11 *tional Journal of the Economics of Business*, 4, 109–127.
- 12 SALONAR, G. (1987): “Predation, Mergers and Incomplete Information,” *Rand Journal of Eco-*
13 *nomics*, 18, 165–86.
- 14 TRANSPORTATION RESEARCH BOARD (1999): “Entry and Competition in the U.S. Airline Indus-
- 15 try: Issues and Opportunities,” National Research Council, Special Report 255, Washington,
16 D.C.
- 17 WHINSTON, M., AND S. COLLINS (1992): “Entry and Competitive Structure in Deregulated Airline
18 Markets: An Event Study Analysis of People Express,” *Rand Journal of Economics*, 23, 445–462.