Incumbent Capacity Responses to Entry: Evidence of Predation in the U.S. Airline Industry?

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Abstract

We empirically examine the post-entry price and capacity response of incumbent monopolists in 256 incumbent-entrant fights with a winner in the U.S. airline industry and find evidence of behaviour that is consistent with predation. The novelty of this paper is to use incumbent capacity to identify predatory behaviour, which helps overcome the hurdles of standard predation tests comparing price to cost. We exploit the fact that it is unprofitable to increase available capacity after entry since quantities are strategic substitutes for competitors. We show that incumbents who increase capacity after entry are more likely to eliminate competition, restore their monopoly position and exploit market power by raising prices after the exit of their rival.

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1 Introduction

"... American played by the traditional rules. It competed with the low fare carriers on their own terms. It did not price its fares below cost; it did not undercut the other carriers' fares. There is no doubt that American may be a difficult, vigorous, even brutal competitor. But here, it engaged only in bare, but not brass-knuckle competition." (United States v. AMR Corp., 2001)

Incumbents have often been accused of anti-competitive predatory behaviour in markets where they do not welcome new entry. Antitrust authorities and the judiciary have greeted such cases with skepticism. The adverse effects of market monopolization and the undermining of competition are often deemed small compared to the risk of false positives, which could "chill the very conduct the antitrust laws are designed to protect" (Matsushita Co. v. Zenith Radio Corp., 1986). The reason is that distinguishing predatory behaviour from intensified competition is a difficult task. This is evident in a well-known case against American Airlines (AA), in which the airline was accused of driving competitors out of its largest hub by undercutting fares and flooding the market with additional capacity. The case was dismissed (mainly) because AA's reaction did not display a sacrifice of short-term profit by pricing under a reasonable measure of cost. In many such cases, the identification of predation is hindered by an over-reliance on price-cost based tools and a general disregard towards non-price predation tactics (Comanor and Frech, 2015). As a consequence, empirical evidence of predation is scant despite the extensive theoretical literature that shows predation to be a rational response in certain cases of entry.

This paper fills this gap by providing empirical evidence of incumbent behaviour that is consistent with predation in a broad study of incumbent-entrant "fights" from the U.S. airline industry, where allegations of predatory conduct have been frequent. To overcome the hurdles of standard price-cost predation tests, we focus on changes in

capacity to identify predation. Adding capacity after entry is irrational for incumbent monopolists under the expectation of duopoly competition since quantities are strategic substitutes for competitors. This implies that a post-entry capacity increase can be seen as a short-term sacrifice of profit that can only be justified if firms expect future gains from the exploitation of market power after eliminating competition.

Our empirical analysis is based on 256 instances of entry in U.S. airline industry monopolies followed by a fight between the incumbent and entrant that ends with a single survivor. We focus on fights that return to monopoly to exclude growing markets that may be able to accommodate more carriers over time. We find post-entry increases in the capacity of the incumbent to positively affect the probability of the incumbent winning a fight. We also provide evidence of significantly higher revenues for incumbents that increase capacity post-entry and manage to eliminate competition (in contrast to incumbents who do not increase capacity). This can be seen as exploitation of market power and an attempt to recoup the predatory investment after the elimination of competition.

In our analysis of the incumbent winning probability, we take price changes into account and thus control for possible increases in demand driven by lower prices after entry. Our results are also robust to firm and market characteristics, such as carrier type, size and financial performance and market extent and demand, which previous literature shows to affect the reaction to entry (Simon, 2005). Finally, we empirically test several predation motives to investigate why certain incumbents react predatory and others do not, and use the identified determinants in a two-stage model that yields similar conclusions. Our study of predation motives reveals that pre-entry incumbent capacity is a key determinant of the response to entry.

The airline industry provides a good setting for studying predation. An airline ticket is a relatively homogeneous good, which restricts the types of incumbent entry

responses, and price and capacity are observable and straightforward to measure. Entry rates have been high since the deregulation of the industry in 1978, which yields a large number of fights to be examined. Moreover, firms in the airline industry simultaneously operate in multiple distinct markets and interact regularly with competitors. This allows us to observe how the same carriers react to entry in different market contexts. Finally, predation is likely to be a feasible tactic for airline monopolists. The reason is that reputation is important in the airline industry, which makes predation valuable as it both fights current entrants and creates entry barriers for potential future competitors. Predating through capacity is also likely in this context. Significant increases in capacity demonstrate a commitment to aggressive pricing in the future. Moreover, capacity adjustment is costly enough to demonstrate commitment, but cheap enough to allow reallocation after the exit of the rival, which is a unique feature of the airline industry compared to other industries with capital investment (Snider, 2008).

This paper contributes to the limited empirical literature on anti-competitive predatory behaviour (Bamberger and Carlton, 2006; Genesove and Mullin, 2006) by being the first to provide large-scale evidence for incumbent responses to entry that are consistent with predation. This fills an important gap in the predation literature, which consists of the seminal theoretical literature on the rationality of predatory behaviour (Kreps and Wilson, 1992; Milgrom and Roberts, 1982; Benoit, 1984; Fudenberg and Tirole, 1986; Poitevin, 1989) and more recent structural empirical work that focuses on a single market (Snider, 2008; Williams, 2012). Our identification strategy is novel in that it allows us to make inferences about predation by only looking at capacity responses and without the need to evaluate price reductions or estimate firm costs. This paper also extends the rich empirical literature on incumbent responses to entry (Geroski, 1995; Simon, 2005; Goolsbee and Syverson, 2008; Prince and Simon, 2014) by studying the effectiveness of different types of incumbent responses to entry. This

is a contribution to previous literature that mostly focuses on documenting the extent to which incumbent responses are aggressive or not.

Our work is also relevant from a policy perspective. Despite predatory allegations against airlines being common, they do not often make it to court and in the cases in which they did, predation did not prevail as an antitrust violation. However, this paper demonstrates that predatory tactics in the airline industry not only occur but are also effective in practice. This is an important finding for an industry with a record of high entry but low survival rates and a dramatic increase in concentration in recent years due to a series of mergers that reduced the number of network legacy carriers from eight to three (Carlton et al, 2019).

The remainder of the paper is structured as follows. In Section 2, we define predation and present a framework for identifying predatory behaviour through capacity increase. In Section 3, we introduce the data and describe the sample and methodology that is employed in our empirical analysis. In Section 4, we present the results of our main and robustness analyses. Finally, Section 5 concludes.

2 Predation and how to identify predatory behaviour

2.1 Definition and motives of predation

Predation is defined as a costly action carried out by an incumbent that leads to a short-term sacrifice of profit (the predatory "investment"), which can be rational under the expectation of eliminating competition and restoring market power (the predatory "prize"). In general, a firm will act predatory if the value of the predatory prize is greater than the cost of the investment. The predator must therefore have a reasonable expectation that the gains from exploitable market power after the elimination of competition are sufficiently large to compensate for the forgone short-term profits. We can therefore derive two necessary conditions for predation, which together are sufficient: (i) demonstration of predatory intent by means of engagement in a predatory tactic and (ii) evidence for an attempt to recoup the predatory investment by exploiting market power after successful elimination of competition.

The rationality of predation, although questioned in the past (McGee, 1958; Selten, 1978), is now largely accepted among economists. Literature provides several motivations for why predation can be a plausible strategy. One such motivation is that predation increases the exit probability of rivals by lowering their expected profits (Fudenberg and Tirole, 1986). This happens when information is imperfect and entrants are deceived into thinking they are up against a superior competitor. Another stream of literature focuses on "deep pocket" theories of predation (Benoit, 1984; Poitevin, 1989). This research predicts that incumbents with more or better access to financial resources have incentives to engage in predation and outlast rivals who are not in the financial position to prevent exit or bankruptcy. Predation may also yield reputation gains that enable firms to maintain their market dominance (Kreps and Wilson, 1982; Milgrom and Roberts, 1982). This is because predatory tactics can also be seen as

signals of aggression that create entry barriers for future competitors.

A parallel to the literature on incumbent responses to entry can also be drawn to explain incumbents' motives to engage in predation. Empirical findings show that incumbents respond more aggressively to entry when their incentives to do so are greater; for example, when their stakes in markets are high (Simon, 2005) or when they are facing a threatening entrant (Goolsbee and Syverson, 2008; Prince and Simon, 2014). In the airline industry, carriers may benefit from a predatory reputation, which can raise entry barriers in all their markets of operation (Simon, 2005). Moreover, the restoration of market share may increase industry dominance and lead to exploitation of market power in many more markets than the market of the predatory episode (Borenstein, 1991). Finally, carriers may reclaim airport or hub dominance through successful predation. This may lead to efficiencies through positive network externalities, but also to favorable treatment at hubs (Borenstein, 1989). Predation is thus likely to lead to increases in profit in the predatory market, but also to other material gains that may be harder to quantify.

2.2 Identification of predation

The majority of research in predation focuses on predatory pricing, under which incumbents offer (very) low prices after entry to drive competitors out of the market. This led to the development of a number of tools that aim to identify predation using price-cost based measures. Most notably, Areeda and Turner (1975) designed a framework to identify predatory pricing that is still considered the golden standard of antitrust applications. This tool is based on the comparison of price and (reasonable estimates of) short-term marginal and/or average variable costs, since pricing below cost can only be rationalized under the expectation of future gains. Williamson (1977), Baumol (1979) and Joskow and Klevorick (1979) also contributed to the development of an

appropriate identification framework by focusing on the pricing strategy of incumbents and whether this is consistent with short-term profit maximization.

Little attention is paid to non-price predatory tactics and their identification. Incumbents are not limited to using price as a strategic variable for predation, but could react to entry by increasing output, offering higher quality or taking actions that aim to push up rivals' cost. The majority of work focuses on raising rivals' cost, for example, through the abuse of government processes and legislation, or investment in advertising, innovation and R&D (Bork, 1979; Ordover and Willig, 1981; Salop and Scheffman, 1983; Krattenmaker and Salop, 1986). Despite non-price predatory tactics being regarded as plausible predatory reactions, they are not incorporated in a predation identification framework.

This is also the case in the airline industry, despite predatory allegations often including incumbents increasing capacity in response to entry. For instance, the vast majority of predatory airline cases involve carriers matching their rivals' fares while increasing their available seats and/or number of departures (Forsyth, 2018). Previous literature finds robust empirical evidence of competition through capacity expansion and price-cutting (Snider, 2008; Ciliberto and Tamer, 2009; Williams, 2012; Zhou and Ethiraj, 2018). Competition authorities and the judiciary also monitor capacity and argue that "claims of predation are more credible when they involve not only price cuts, but also significant capacity increases" (USDJ, 1997). Nevertheless, capacity increase by itself has not yet been utilized in order to identify predation. The pricing strategy of firms remains the core subject of investigation and other practices continue to play an insignificant role in distinguishing competitive from anti-competitive conduct (Comanor and Frech, 2015).

2.3 Capacity increase as a predatory response

We posit that capacity increase can be seen as a predatory response by arguing that it is not a short-term rational action for incumbents who face entry, and that it is a tactic that may effectively lead to the elimination of competition and the restoration of market power.

A necessary condition for predation is that the predatory tactic is *only* profitable under the expectation of eliminating competition. This is true for post-entry capacity increase by an incumbent monopolist. After entry takes place the incumbent is better off accommodating entry under the expectation of duopoly competition. The reason is that quantities are strategic substitutes for the two competitors (Bulow et al, 1985). An incumbent's profit maximizing response to capacity increase by the entrant is to decrease capacity; any other response would lower marginal profits. Increasing capacity can be seen as a commitment to pricing low in the future resulting from offering additional output in the market. It is a short-term sacrifice of the ex-monopolist's profit that can only be rational in the expectation of eliminating competition. This makes it an appropriate indicator of predatory behaviour. Similar to pricing below (marginal) cost, it defines a clear-cut threshold that singles out predation from intensified competition.

In addition, post-entry capacity increase by an incumbent monopolist is an effective way to eliminate competition and restore market power. First, excess capacity has a direct effect on market prices through increasing supply and can put downward pressure on prices without appearing predatory at first sight. Second, capacity expansion increases the incumbent's economic sunk cost and can act as a commitment device to fighting entry. In the U.S. airline industry, close to 70% of the aircrafts operated by airlines are owned rather than leased, and operating leases are usually long term agreements that tie airlines for a period of eight to ten years on average (Zhou and

Ethiraj, 2018). This implies that capital investment in capacity is not easily reversible. Investing in capacity after entry can therefore be an impediment to entry the same way that capacity expansion before entry can be a deterrent. As the preemption literature highlights, capacity expansion, compared to a price reduction, is more likely to be effective against competition because its costly and more irreversible nature make it a relatively credible threat (Spence, 1977; Dixit, 1979; Schmalensee, 1981). Incumbents may thus have incentives to signal their intention to fight competition through excess capacity rather than price cuts.

The role of capacity increase as a mechanism for predation is highlighted in the work of Snider (2008), who proposes a dynamic model of price and capacity competition in the airline industry. In the equilibrium of the game, predation arises as a result of large hub incumbents trying to eliminate small low-cost entrants that cut into their profitability by charging lower prices. Incumbents, who are more committed to the market as a result of earlier sunk investments, are able to prey on their rivals by making costly capacity commitments. Furthermore, Williams (2012) estimates a dynamic model of airline competition, in which forward-looking firms invest in capacity and compete in prices with capacity constraints. He also finds dominant hub carriers to be aggressively investing in capacity when facing low-cost carrier entry. In his dynamic model of airline competition, investing in capacity significantly increases the probability of exit of the entrant.

3 Data and methodology

3.1 Sample

We create a sample of fights between incumbent monopolists and new entrants that took place between 1993 and 2014 in the U.S. airline industry. These are episodes of entry in monopoly followed by exit (of the incumbent or entrant) in duopoly. We only focus on fights that end with the return to monopoly to exclude rapidly growing markets that may be able to accommodate more carriers. The examined time span produces 256 fights. Our full sample consists of 8,949 observations of panel data where the unit of observation is a given carrier in a given route and year-quarter. We define routes on an airport-to-airport basis, as is standard in the airline pricing literature (Gerardi and Shapiro, 2009; Dai et al, 2014). This means that a flight from New York Newark airport (EWR) and New York John F. Kennedy airport (JFK) to the same airport destination represent different routes in our analysis. Our panel includes all quarters of duopoly competition between the incumbent and entrant (the "fight period"), 8 quarters of the incumbent monopoly (the "pre-fight period") and 8 quarters of the post-exit monopoly (the "post-fight period"). This duration is chosen as a representative sample of the pre- and post-fight periods[1].

We construct our sample by using three sources of data that are provided by the Office of Airline Information of the Bureau of Transportation Statistics (BTS). We obtain airline ticket prices from the Airline Origin and Destination Survey (DB1B). DB1B is a 10% random sample of airline tickets from reporting carriers and includes the origin,

[1]We varied the examined duration of the of the pre- and post-fight periods in robustness analyses and obtained similar results (available upon request). Based on empirical research on the reaction to the threat of entry (Goolsbee and Syverson, 2008), an incumbent is expected to react in the quarters close to the entry episode. By expanding the event window to two years before entry we are more likely to capture a representative sample of the monopoly period. Similarly, in the post-fight period we expect any attempt towards recoupment to have materialized in the two years following the rival's exit.

destination and itinerary details of the passengers transported. We obtain carrier capacity and departure data, as well as supplementary characteristics for each route from the T-100 Domestic Segment database (T-100). T-100 contains domestic non-stop segment data reported by U.S. carriers on a monthly basis. It includes information on all passengers transported by the reporting carrier including origin, destination, aircraft type and service class, available capacity, scheduled departures, departures performed and load factor. In addition, we obtain carrier financial information, such as total assets, cash available and profitability from the F-41 Form Financial Data dataset of the BTS. We also obtain regional demographic information, such as population and personal income from the Regional Economic Accounts (REA) database of the Bureau of Economic Analysis. Finally, we obtain information on the Consumer Price Index (CPI) for airline fares from the Federal Reserve Economic Database (FRED) of the Economic Research department of the Federal Reserve Bank of St. Louis to seasonally adjust our examined airline fares for inflation.

3.2 Descriptive statistics

Table 1 presents details on the fights in our sample and summary statistics for incumbent and entrant carrier characteristics from the fight period. The fight characteristics are presented in Panel A of Table 1. In the majority of these fights (approximately 71%), the incumbent is the winner and thus manages to regain their monopoly. An entrant is successful in capturing the market in approximately 29% of the cases examined. More than 50% of these fights last less than 4 years, while 3 out of 4 fights have a duration of less than 6.5 years.

Panel B of Table 1 displays summary statistics on a number of carrier characteristics for the duration of the fight period. Comparing and contrasting these values for incumbents and entrants provides additional insight on the types of carriers involved

in those fights. In particular, entrants have relatively smaller networks compared to incumbents. We infer this by looking at the mean of the available seat miles[2], a frequently used measure of airlines' carrying capacity (2.37 bn. vs. 1.08 bn. for incumbents and entrants respectively, on average). Moreover, entrants are more likely to be start-up or smaller (regional) carriers compared to incumbents, which are more likely to be established (legacy) carriers. This is evident by comparing the total available assets, which are significantly higher for incumbents ($13.2 bn. vs. $4.88 bn. for incumbents and entrants respectively, on average), the average airport share of the two types of carriers (approximately 34% vs. 12% for incumbents and entrants respectively, on average), and the average age since foundation (approximately 60.8 years vs. 30.6 years for incumbents and entrants respectively, on average). Finally, entrants are more likely to be low-cost carriers (LCC) compared to incumbents. Approximately 35% of the entrants in our sample are LCCs, while only about 13% are LCC incumbents. We do not observe significant differences between the two types of carriers in terms of their cash available (relative to assets) and their load factor (which can be interpreted as a measure of efficiency). In general, entrants have many characteristics that make them likely prey. They are smaller in size, often start-up, less dominant at airports and with fewer financial resources.

[Insert Table 1 about here]

Table 2 presents summary statistics on the same firm characteristics for *predatory* and *non-predatory* incumbents. Predatory incumbents are defined as incumbents who increase capacity (measured by available carrier seats in a given route and year-quarter) during the fight period compared to the pre-fight period (on average). This happens

[2]Available seat miles (ASM) per route are calculated by multiplying the total number of seats available on a given route with the distance flown in miles. The total ASM of a given carrier is the sum of the ASM per route for all routes flown. ASM is a good measure of both network size (extent) and carrying capacity.

in 118 fights in our sample, which is approximately 46% of the cases examined. In the remaining 138 fights, incumbents decrease capacity or keep capacity constant following entry. We do not observe significant differences between the two types of incumbents, i.e. predatory and non-predatory incumbents appear to be similar with respect to those characteristics. Our defined predatory response (capacity increase) does not seem to be directly related to these firm characteristics. In addition, Table 2 summarizes market characteristics for routes in which incumbents increase capacity after entry and routes in which they do not. These are the average population and average regional income at end-point Metropolitan Statistical Areas (MSA), and the average market share of end-point airports with respect to other airports of the U.S. domestic market (in terms of passenger traffic). Markets in which incumbents increase capacity after entry do not significantly differ from markets in which incumbents maintained or reduced capacity. Similar to firm characteristics, these market characteristics are highly comparable for predatory and non-predatory incumbents.

[Insert Table 2 about here]

3.3 Variables and methodology

3.3.1 Condition 1: Predatory intent

A. Logit specification

We demonstrate predatory intent by testing whether incumbents who increase capacity following entry are more likely to be the winners of a fight. Capacity increase in this case is unprofitable under the expectation of duopoly competition and falls under the definition of a predatory tactic. We expect post-entry capacity increase by an incumbent to lead to a higher probability of winning a fight, as it decreases expected profits for the entrant. Given that the two groups of incumbents (predatory vs. non-

predatory) are highly comparable in terms of the type of firms involved and the market context, we believe this effect to be driven by engagement in successful predation.

We estimate the probability of an incumbent being the winner of a fight by means of a logistic regression with the dependent variable *incumbent wins*. This is an indicator variable that is equal to 1 in routes where the incumbent is the winner of the fight ($N = 181$) and equal to 0 in routes where the entrant is the winner of the fight ($N = 75$). The two events are by definition mutually exclusive, i.e. it is only possible for either the incumbent or the entrant to win a fight. For the purpose of this analysis we collapse our full sample to the 256 observations of a fight episode. For each fight we record the winner, the fight duration and averages of market and firm characteristics from the fight period. Our logistic regression therefore only exploits the cross-sectional variation in the data.

We regress *incumbent wins* on three key independent variables: the *capacity change ratio*, the *price change ratio* and the *predatory response indicator*. These variables are described in detail below (for summary statistics, refer to Table 3):

- **Capacity change ratio:** This ratio is calculated by dividing the average capacity of the incumbent carrier during the fight period by its average capacity during the pre-fight period. Incumbents therefore increase (decrease) average capacity after entry if the ratio is larger (smaller) than 1. Capacity is measured by the total number of seats that are made available in a route and year-quarter by a given carrier. We expect the effect of this variable on the incumbent winning probability to be positive and significant. This would imply that the higher the capacity after entry, the more likely it is for an incumbent to win a fight.

- **Price change ratio:** This ratio is calculated by dividing the average price charged by the incumbent during the fight period by its average price during the pre-fight period. Incumbents therefore increase (decrease) average prices after entry if the ratio is larger (smaller) than 1. We expect the effect of this variable on the incumbent winning probability to be negative and significant. This would imply that the lower the average prices after entry, the more likely it is for an incumbent to win a fight. Controlling for price changes after entry is important in order to correctly identify predation through capacity increase. For example, lowering prices after entry could create additional demand for flights and thus justify a capacity increase by incumbents.

- **Predatory response indicator:** This is an indicator variable that is equal to 1 when incumbents increase capacity after entry and equal to 0 when they maintain the same capacity or reduce capacity after entry. It is therefore equal to 1 when the capacity change ratio is larger than 1. We expect the effect of this variable on the incumbent winning probability to be positive and significant. This would imply that capacity increases after entry (a predatory response according to our definition) increase the likelihood of an incumbent being the winner of a fight.

In addition, we control for characteristics of the incumbent and entrant firm, relative characteristics of the two competing carriers and market characteristics. This is important in order to ensure that the 256 fights used in our analysis are comparable in terms of the firms participating and the market conditions[3]. The firm characteristics examined are the *relative size* of carriers (measured by the ratio of available seat miles of the incumbent with respect to the entrant), the *incumbent size* (measured by the available seat miles of the incumbent), the *relative efficiency* of carriers (measured by

[3]The selection of firm and market characteristics is based on previous research on incumbent reactions to entry (Simon, 2005) and airline pricing (Gerardi and Shapiro, 2009).

the ratio of the load factor of the incumbent with respect to the entrant), the *relative liquidity* of carriers (measured by the ratio of cash-to-assets of the incumbent with respect to the entrant), the *relative airport dominance* of carriers (measured by the ratio of average passenger share at end-point airports of the incumbent with respect to the entrant), the *relative experience* of carriers (measured by the ratio of years since foundation of the incumbent with respect to the entrant), and two indicator variables for low-cost carriers for the incumbent and entrant (*incumbent LCC* and *entrant LCC*).

The market characteristics examined are the *average population* and the *average personal income* at end-point airport Metropolitan Statistical Areas (MSA), the *average airport share* in passengers of the end-point airports with respect to other airports in the U.S., a control for *market extent* measuring potential competition in the route (measured by a count of firms with presence at both end-points of a route that are not yet incumbent in the market), and a control for *market demand* (measured by the average of the logarithm of the passengers transported in a route). All firm and market characteristic variables are averages of the fight period for each route. For an overview of these control variables, together with summary statistics, refer to Table 3.

[Insert Table 3 about here]

B. Two-stage model

Incumbents are more likely to react predatory when it is meaningful to do so. A predatory response is an endogenous strategic choice of the carrier that may be related to unobserved characteristics that are difficult or impossible to measure. It is therefore important to identify predation determinants in order to shed light on the motives of a predatory response, explain why certain incumbents react predatory and others not, and incorporate this in the estimation of the probability of winning a fight.

We use a two-stage model (2SLS) in which the second stage remains the same as in the analysis of the previous sub-section. In the first stage, we analyze the factors that make engagement in predation more likely by regressing the predatory response indicator on potential predation determinants that facilitate as instruments in the two-stage estimation. Most of these determinants are based on the literature discussed in Section 2.1 on the motives of predation and aggressive reaction to entry. First, we expect incumbents with more assets and cash available to be more likely to engage in predation. We use *pre-fight average assets* and *pre-fight average cash-to-assets* to measure the financial size and liquidity of a carrier during the pre-fight period. Second, we expect engagement in predation to be related to the type of entrant and the incumbent's incentives to respond. We use entrant carrier fixed effects to capture the variation in the type of entrant, and the *pre-fight route population* (measured by the logarithm of the average end-point population) and the *pre-fight incumbent network extent* (measured by incumbent available seat miles) to capture incentives to respond. We expect incumbents to have more incentives to react predatory in larger markets due to higher stakes and when they are active in many routes due to higher reputation gains. All variables are averages of the pre-fight period and thus more likely to be exogenous.

Our descriptive statistics reveal that firm and market characteristics are highly comparable for predatory and non-predatory incumbents. This does not help uncover the underlying mechanism that makes capacity increase the chosen response to entry in about half of the examined fights. We thus look further than the firm and market characteristics used in previous literature. We argue that reacting predatory is likely related to the pre-entry incumbent capacity. If capacity before entry is low relative to market extent then there is more room to predate by increasing capacity post-entry. This implies that predating through capacity is an available strategy for the incumbent. To investigate this, we construct the variable *capacity difference* that measures the difference between observed and expected route capacity during the pre-fight period. We calculate expected route capacity by regressing the logarithm of total available capacity in a given route and year-quarter on the following exogenous market characteristics of the pre-fight period: the logarithm of the average end-point population and its square, the general enplanement index and its square (Gerardi and Shapiro, 2009), carrier fixed effects, year-quarter fixed effects and route-fight fixed effects. *Capacity difference* is then calculated by subtracting the estimated expected route capacity from the observed route capacity in each route and averaging over the pre-fight period. We expect the likelihood of engaging in predation to be decreasing as *capacity difference* increases. A higher *capacity difference* implies that observed route capacity is higher than expected route capacity and that the incumbent may not have enough room to further increase capacity after entry.

3.3.2 Condition 2: Predatory recoupment

We also test for a second necessary condition for predation, namely the extent to which recoupment of the predatory investment is likely to occur. This analysis attempts to quantify the material gains of predation and to test the extent to which these are

realized after the exit of competitors. We estimate the relative price premium and relative capacity of predatory and non-predatory incumbents in the fight and post-fight periods with respect to the pre-fight period. Recoupment of the predatory investment by predatory incumbents would imply a significant increase in prices for given capacity in the post-fight period. However, we should expect no change between the pre- and post-fight period for non-predatory incumbents.

The relative price and capacity are estimated by exploiting the within-market variation due to the entry and exit in each route. The panel structure of our data allows us to control for time invariant carrier and route heterogeneity. We also include year-quarter fixed effects to ensure that our results are not driven by changes in unobserved factors that are time specific. Finally, we control for potential market growth by means of the following variables: the general enplanement index and its square, and the logarithm of the average end-point population and its square. These control variables were first introduced by Borenstein and Rose (1994) and have been frequently employed in the airline pricing literature in order to capture exogenous variation in market size (Gerardi and Shapiro, 2009; Dai et al, 2014). We thus ensure that our identified coefficients are not biased as a result of market growth or decline. For example, growth in market size may result in firms enjoying higher premia over time and could bias our price coefficients upwards.

4 Empirical analysis

4.1 Logit estimation

Table 4 reports the results of the analysis on predatory intent, that is the effect of a predatory response on the likelihood of winning a fight. Panel A reports the logit estimates with the dependent *incumbent wins* on three sets of variables: firm characteristics, market characteristics and strategic variables in the disposal of the incumbent.

All variables are included in Column (1) of Panel A except from the predatory response indicator. Incumbent size, relative efficiency and relative airport dominance have a positive effect on the probability of the incumbent winning the fight. Moreover, the cost structure of a carrier appears to be important in the determination of the winner. LCCs are more likely to win a fight irrespective of whether they are incumbents or entrants. We find that the incumbent being an LCC has a positive and significant effect on the probability of the incumbent winning the fight, while the entrant being an LCC has a negative and significant effect on the probability of the incumbent winning the fight. Furthermore, we find little evidence for market characteristics having a significant effect on the likelihood of the incumbent winning a fight.

The coefficients of interest with regards to predatory intent are the coefficients of the price and capacity ratio under Column (1). We estimate a negative and significant coefficient for the price ratio (-2.978) and a positive and significant coefficient for the capacity ratio (1.498). These are in accordance with our expectations. First, the lower the average price of the incumbent after entry, the more likely it is for an incumbent to win, ceteris paribus. Second, the higher the capacity of the incumbent after entry, the more likely it is for an incumbent to win, ceteris paribus. Controlling for firm and market characteristics, but also for price changes after entry, we find that incumbents with a higher capacity after entry are more likely to win a fight against their new rival.

In Column (2) of Panel A, we estimate the same model as in Column (1) and include the predatory response indicator. The estimated coefficients for the firm and market characteristics are highly comparable and our conclusions remain unchanged. The coefficient of the price ratio is also negative and significant (-3.033) as in the previous specification. However, the estimated coefficient of the capacity ratio is now not significantly different from zero at conventional significance levels. The capacity effect is fully absorbed by the predatory indicator, which has a positive and significant coefficient (1.730). Incumbents that increase capacity after entry are more likely to win a fight. Distinguishing predatory from competitive capacity changes is sufficient in explaining why certain incumbents are more likely to win a fight than others. Our results therefore provide evidence for effective predatory capacity responses to entry. In Panel B of Table 4, we report average marginal effects for the logistic regression of specification (2). We find that engaging in a predatory capacity response increases the probability of incumbents winning a fight by approximately 16 percentage points, on average. For comparison, this effect is similar in magnitude to the effect of being an LCC: an incumbent being an LCC increases the probability of winning a fight by 19 percentage points, while an entrant being an LCC lowers the probability of the incumbent winning a fight by approximately 15 percentage points, on average.

[Insert Table 4 about here]

4.2 Two-stage estimation

We use a linear two-stage model in order to avoid forbidden regression specification issues due to the binary endogenous regressor (Hausman, 1983). Two-stage least squares (2SLS) are preferred because only a least squares estimation of the first stage is guaranteed to yield residuals that are uncorrelated with the fitted values and covariates.

An alternative for modeling a non-linear first stage exists (e.g. Adams et al, 2009) but is not recommended when the dependent variable in both stages is binary (Angrist and Pischke, 2008; Wooldridge, 2010). 2SLS estimates are consistent albeit less efficient than estimates that take into account the non-linear nature of the dependent variables. This is less important in our case as we are interested in average marginal effects.

Table 5 reports the 2SLS estimates of our analysis on predatory intent. In Panel A, the second stage estimates are presented in a similar manner to the logistic regression estimates of Table 4. We also report the estimates of a linear regression of specification (2) of Table 4 for comparison. Both the linear regression and 2SLS results are largely in line with the ones in our logit specification. Despite the loss of efficiency due to the linear model, we find comparable average marginal effects for most firm and market characteristics. The coefficients of the incumbent LCC indicator and relative airport dominance are two exceptions, as they become insignificant in this specification. Some market characteristics (population, airport size and market extent) are estimated to be significant in contrast to the logit specification, although they maintain their sign and relative magnitude at means. The coefficients of all strategic variables are also similar to the ones in the logit specification and yield comparable average marginal effects. For example, a predatory response to entry increases the probability of the incumbent winning a fight by approximately 22 percentage points, on average.

The estimated coefficients of the first stage instruments are presented in Panel B. The explanatory power of the included instruments is good and our model identifies a couple of predation determinants. We find no evidence for "deep-pocket" motives since the coefficients of the pre-fight asset and cash variables are both insignificant. In addition, we find no evidence for the incumbent's network extent having an effect on the engagement in predation. Contrary to our expectation, we find that incumbents are more likely to increase capacity after entry in smaller routes. An explanation for

this empirical finding may be that reacting predatory in smaller markets is likely to be less risky for incumbents who want to stay under the radar of competition authorities. Another explanation may be that smaller markets are less likely to maintain more than one firm, so that a predatory response is more likely to be effective. In accordance with our expectation, we find that capacity difference in the pre-fight period has a negative effect on the likelihood of engaging in predation. The higher observed route capacity is relative to expected route capacity, the lower the chance of the incumbent responding predatory to entry. This suggests that the decision to react predatory may depend on whether incumbents still have room to increase capacity in the given market after entry, that is whether predating through capacity increase is a feasible strategic response.

[Insert Table 5 about here]

4.3 Predatory recoupment

The estimates of the price and capacity analysis of fights with predatory and non-predatory incumbents are reported in Table 6 and 7, respectively. The dependent variable of the price specification is the logarithm of the median price of the carrier-route-quarter price distribution. The dependent variable of the capacity specification is the logarithm of the total available seats of a carrier in a given route and quarter. The reported coefficients can be interpreted as percentages with respect to our reference category, which is the pre-fight period. All specifications include route-fight, year-quarter and carrier fixed effects, and the market controls described in Section 3.3.2.

Our results indicate that predatory incumbents are more likely to exploit market power after the exit of their rival compared to non-predatory incumbents. Controlling for market size and unobservables that are route, carrier and time specific, we find that predatory incumbents increase prices significantly in the post-fight period (approx-

imately 4% higher than pre-fight). However, the post-fight prices of non-predatory incumbents remain below the pre-fight level (approximately 3% lower). Furthermore, we estimate that the post-fight capacity of predatory incumbents remains above the pre-fight level (approximately 34% higher), while the post-fight capacity of non-predatory incumbents is not significantly different from their capacity in the pre-fight period. Maintaining excess capacity in the post-fight period may indicate that predatory incumbents realize that their capacity was too low before entry. Furthermore, it may be a way for the (now experienced) winner to prevent further entry to the market (Spence, 1977; Dixit, 1980).

Overall, we find that predatory incumbents increase prices above the pre-fight level, while their offered capacity is also significantly higher in the post-fight period. Given that our empirical analysis exploits within market variation, the cost structure of firms is unlikely to be affected by the entry and/or exit. Since the post-fight revenue of predatory fights is estimated to be significantly higher, we can thus infer that profitability also likely increases. This is not the case in non-predatory fights. This can be seen as an attempt to recoup the predatory investment or as evidence for material gains from successful predation.

[Insert Table 6 and 7 about here]

4.4 Robustness analyses

We perform a number of additional analyses to ensure the robustness of our conclusions. First, we use the number of departures instead of the total seat capacity of the carrier to construct the capacity change ratio and the predatory response indicator. We thus examine whether carriers respond to entry by offering additional flights or simply increase the carrying capacity of existing flights. The new capacity change ratio is

calculated by dividing the average number of departures of the incumbent during the fight period by its average number of departures during the pre-fight period. Similarly, the new predatory response indicator is equal to 1 if carriers increase their average departures after entry and 0 if they maintain the same average departures or reduce departures after entry. We estimate using 2SLS and instrument the new predatory response indicator as described in Section 3.3.1.B. The results are reported in Table 8 together with the output of our main 2SLS specification in which we use the total seat capacity of the carrier (see Table 5). The estimated coefficients for the firm and market characteristics are similar, as well as the coefficients for the strategic variables. Our conclusions thus remain the same.

Second, we restrict the number of years between entry and exit to refine the type of fight examined. As reported above, 50% of the examined fights last less than 4 years and 25% of the examined fights last longer than 6.5 years. We exclude step-wise longer fights from our analysis in order to ensure we are studying real "fights" between incumbents and entrants. The potential bias that is introduced by examining all fights is likely to be downward if a number of those longer fights end with, for instance, a merger between firms and not an exit. Table 8 reports the results of repeating the 2SLS analysis and restricting the fight duration to 4 and 3 years, respectively. Despite the loss of observations, our conclusions remain the same when looking at shorter fights. In fact, the estimated marginal effects of the price ratio and the predatory indicator are larger in magnitude the shorter the fight examined. Controlling for firm and market characteristics, and for price changes after entry, we find that a predatory capacity response increases the probability of the incumbent winning a fight by approximately 26 and 35 percentage points in fights that are shorter or equal to 4 and 3 years, respectively (on average).

[Insert Table 8 about here]

5 Conclusion

In an extensive ex-post analysis of 256 instances of entry in monopoly in the U.S. airline industry, we find evidence of behaviour that is consistent with predation, i.e. engagement in short-term irrational actions that effectively lead to competitor exit, restoration of monopoly power and increased future profits. The novelty of our paper in the empirical examination of predation is to put forward an identification framework that relies solely on capacity and not on the traditional comparison of price and cost, but also to investigate and empirically test predation determinants. Our empirical setting of 256 fights in duopoly is unique, especially in the examination of responses to entry. Previous theoretical literature studies similar contexts under relatively specific assumptions, while the empirical literature focuses on a limited number of cases (e.g. Kwoka and Batkeyev, 2019).

Our research has significant implications for policymakers. Our empirical evidence suggests that predation not only takes place but has also been successful in the U.S. airline industry. This is alarming for an industry in which concentration significantly increased in recent years. Exploring the motives of predation reveals that engagement in predatory tactics is likely related to the extent to which a market is saturated with respect to capacity in the pre-fight period. This suggests that predation may be related to engagement in anti-competitive conduct before the entry occurs. A trade off between pre- and post-entry responses, would imply that predation may be path dependent and thus less likely to occur when the incumbent attempted to deter entry by preemption. The calculation of expected capacity based on exogenous market characteristics may therefore present an opportunity for identifying markets where predation is more likely to occur in practice.

Further research is necessary to support the predation identification framework put forward in this paper and examine its applicability and external validity. A potential avenue for future empirical work would be to examine fights that do not necessarily end with an exit. These may be fights in which firms initially react aggressively or even predatory but eventually choose to accommodate. These may also be fights that return to monopoly through a merger between the two competitors. Looking at firm responses in these different types of fight may reveal more about the reasons why certain incumbents react predatory and others not and may also provide additional robustness to the conclusions presented in this paper. Finally, while it is out of the scope of this paper to estimate firm costs, doing so would allow to demonstrate recoupment by means of profitability and not by relying on revenue and making assumptions about the cost structure of firms.

References

Adams, R., Almeida, H., and Ferreira, D. (2009). Understanding the relationship between founder-CEOs and firm performance. *Journal of Empirical Finance*, 16(1), 136-150.

Angrist, J., and Pischke, J. S. (2008). *Mostly Harmless Econometrics*. Princeton University Press.

Areeda, P., and Turner, D. F. (1975). Predatory pricing and related practices under Section 2 of the Sherman Act. *Harvard Law Review*, 88, 697.

Bamberger, G. E., and Carlton, D. W. (2006). Predation and the entry and exit of low-fare carriers. *Competition policy and antitrust*.

Baumol, W. J. (1979). Quasi-permanence of price reductions: A policy for prevention of predatory pricing. *The Yale Law Journal*, 89(1), 1-26.

Benoit, J. P. (1984). Financially constrained entry in a game with incomplete information. *The RAND Journal of Economics*, 490-499.

Borenstein, S. (1989). Hubs and high fares: dominance and market power in the US airline industry. *The RAND Journal of Economics*, 344-365.

Borenstein, S. (1991). The dominant-firm advantage in multiproduct industries: evidence from the US airlines. *The Quarterly Journal of Economics*, 106(4), 1237-1266.

Bork, R. (1979). *The antitrust paradox: A policy at war with itself*.

Bulow, J. I., Geanakoplos, J. D., and Klemperer, P. D. (1985). Multimarket oligopoly: Strategic substitutes and complements. *Journal of Political economy*, 93(3), 488-511.

Carlton, D., Israel, M., MacSwain, I., and Orlov, E. (2019). Are Legacy Airline Mergers Pro-or Anti-Competitive? Evidence from Recent US Airline Mergers. *International Journal of Industrial Organization*, 62, 58-95.

Ciliberto, F., and Tamer E. T. (2009). Market structure and multiple equilibria in the airline markets. *Econometrica*, 77(6), 1791-1828.

Comanor, W. S., and Frech, H. E. (2015). Economic Rationality and the AreedaTurner Rule. *Review of Industrial Organization*, 46(3), 253-268.

Dai, M., Liu, Q., and Serfes, K. (2014). Is the effect of competition on price dispersion nonmonotonic? evidence from the us airline industry. *Review of Economics and Statistics*, 96(1), 161-170.

Dixit, A. (1979). A model of duopoly suggesting a theory of entry barriers. *Bell*

Journal of Economics, 10(1), 20-32.

Dixit, A. (1980). The role of investment in entry-deterrence. *The Economic Journal*, 90(357), 95-106.

Forsyth, P. (2018). *Competition versus Predation in aviation markets: a survey of experience in North America, Europe and Australia*. Routledge.

Fudenberg, D., and Tirole, J. (1986). A" signal-jamming" theory of predation. *The RAND Journal of Economics*, 366-376.

Genesove, D., and Mullin, W. P. (2006). Predation and its rate of return: The sugar industry, 18871914. *The RAND Journal of Economics*, 37(1), 47-69.

Gerardi, K. S., and Shapiro, A. H. (2009). Does competition reduce price dispersion? New evidence from the airline industry. *Journal of Political Economy*, 117(1), 1-37.

Geroski, P. A. (1995). What do we know about entry?. *International Journal of Industrial Organization*, 13(4), 421-440.

Goolsbee, A., and Syverson, C. (2008). How do incumbents respond to the threat of entry? Evidence from the major airlines. *The Quarterly journal of economics*, 123(4), 1611-1633.

Hausman, J. A. (1983). Specification and estimation of simultaneous equation models. *Handbook of econometrics*, 1, 391-448.

Joskow, P. L., and Klevorick, A. K. (1979). A framework for analyzing predatory pricing policy. *The Yale Law Journal*, 89(2), 213-270.

Krattenmaker, T. G., and Salop, S. C. (1986). Anticompetitive exclusion: raising rivals' costs to achieve power over price. *The Yale Law Journal*, 96(2), 209-293.

Kreps, D. M., and Wilson, R. (1982). Reputation and imperfect information. *Journal of Economic Theory*, 27(2), 253-279.

Kwoka, J. and Batkeyev, B. (2019). Strategic Responses to Competitive Threats: Airlines in Action. *Review of Industrial Organization*, 54(1), 83-109.

Matsushita Electric Industrial Co. v. Zenith Radio, 475 U.S. 574 (1986).

McGee, J. S. (1958). Predatory price cutting: the Standard Oil (NJ) case. *The Journal of Law and Economics*, 1, 137-169.

Milgrom, P., and Roberts, J. (1982). Predation, reputation, and entry deterrence. *Journal of Economic Theory*, 27(2), 280-312.

Ordover, J. A., and Willig, R. D. (1981). An economic definition of predation: Pricing and product innovation. *The Yale Law Journal*, 91(1), 8-53.

Poitevin, M. (1989). Financial signaling and the" deep-pocket" argument. *The RAND Journal of Economics*, 26-40.

Prince, J. T., and Simon, D. H. (2014). Do incumbents improve service quality in response to entry? Evidence from airlines' on-time performance. *Management Science*, 61(2), 372-390.

Salop, S. C., and Scheffman, D. T. (1983). Raising rivals' costs. *The American Economic Review*, 73(2), 267-271.

Schmalensee, R. (1981). Economies of scale and barriers to entry. *Journal of Political Economy*, 89(6), 1228-1238.

Selten, R. (1978). The chain store paradox. *Theory and decision*, 9(2), 127-159.

Simon, D. (2005). Incumbent pricing responses to entry. *Strategic Management Journal*, 26(13), 1229-1248.

Snider, C. (2008). Predatory Incentives and Predation Policy: The American Airlines Case. *Working Paper*.

Spence, A. M. (1977). Entry, capacity, investment and oligopolistic pricing. *The Bell Journal of Economics*, 534-544.

United States Department of Justice, USDJ (1997). Predation in the Airline Industry. Retrieved from https://www.justice.gov/atr/speech/predation-airline-industry.

United States of America v. AMR Corporation, American Airlines, Inc., and American Eagle Holding Corporation. 140 F. Supp. 2d 1141 (2001).

Williamson, O. E. (1977). Predatory pricing: A strategic and welfare analysis. *The Yale Law Journal*, 87(2), 284-340.

Williams, J. W. (2012). Capacity investments, exclusionary behavior, and welfare: A dynamic model of competition in the airline industry. *Working Paper*.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press.

Zhou, Y.M., and Ethiraj, S. (2018). Competition within and across Market Positions: Strategic Responses to Entry Threats. *Working Paper*.

Table 1: Fight and carrier characteristics

Panel A: Fight characteristics

Number of fights	256	Fight duration (in years)	
		First quartile:	2.5
Incumbent wins	181 (70.7%)	Median:	4
Entrant wins	75 (29.3%)	Third quartile:	6.5

Panel B: Carrier characteristics

	Incumbent				Entrant			
	Mean	**St. Dev.**	**Min**	**Max**	**Mean**	**St. Dev.**	**Min**	**Max**
Available seat miles (bn.)	2.37	1.41	0.20	5.85	1.08	1.11	0.01	5.48
Load factor	0.68	0.13	0.16	0.90	0.60	0.17	0.10	0.90
Total assets ($ bn.)	13.2	8.95	0.15	47.9	4.88	6.92	0.01	26.9
Cash-to-assets ratio	0.04	0.06	0.00	0.22	0.08	0.10	-0.21	0.34
Carrier airport share	0.34	0.15	0.04	0.74	0.12	0.09	0.00	0.38
Age (years)	60.8	15.8	7.75	82.4	30.6	22.6	1.00	80.4
Low-cost	0.13	0.34	0.00	1.00	0.35	0.47	0.00	1.00

Table 2: Predatory vs. non-predatory incumbents

	Predatory (N = 118)				Non-predatory (N = 138)			
Carrier characteristics	**Mean**	**St. Dev.**	**Min**	**Max**	**Mean**	**St. Dev.**	**Min**	**Max**
Available seat miles (bn.)	2.40	1.48	1.97	5.85	2.35	1.35	1.97	5.83
Load factor	0.70	0.11	0.34	0.90	0.66	0.14	0.16	0.88
Total assets ($ bn.)	12.5	8.14	0.15	26.8	13.8	9.57	0.15	48.0
Cash-to-assets ratio	0.04	0.06	0.00	0.20	0.05	0.06	0.00	0.22
Carrier airport share	0.35	0.15	0.04	0.74	0.33	0.15	0.04	0.74
Age (years)	59.3	16.8	7.75	75.0	62.1	14.8	7.75	82.4
Low-cost (%)	0.15	0.36	0.00	1.00	0.11	0.31	0.00	1.00
Market characteristics								
End-point population (m.)	4.27	3.24	0.30	12.6	4.38	3.10	0.52	12.6
End-point income ($ k.)	34.8	7.26	21.5	51.8	34.8	7.46	21.5	58.2
Airport passenger share	0.02	0.01	0.00	0.05	0.02	0.01	0.00	0.05

Table 3: Summary statistics for the main specification variables

Firm characteristics	**Mean**	**St. deviation**	**Min**	**Max**
Relative size	15.67	61.37	0.117	643.2
Incumbent size (bn.)	2.37	1.41	0.2	5.85
Relative efficiency	1.313	0.812	0.367	7.214
Relative liquidity	30.71	126.6	-199.1	829.5
Incumbent LCC	0.129	0.336	0	1
Entrant LCC	0.347	0.474	0	1
Relative airport dominance	8.834	17.33	0.307	135.9
Relative experience	5.448	9.135	0.108	60
Market characteristics				
Average population (m.)	4.33	3.16	0.30	12.6
Average personal income (k.)	34.8	7.35	21.5	58.2
Average airport share	0.015	0.007	0.002	0.049
Market extent	12.63	4.154	2.6	23.7
Market demand	8.297	0.638	6.322	9.896
Strategic variables				
Price change ratio	0.921	0.188	0.297	1.45
Capacity change ratio	1.181	0.876	0.164	10.52
Predatory response indicator	0.461	0.499	0	1

Relative variables are calculated by dividing the incumbent variable by the respective entrant variable. The price (capacity) change ratio is calculated by dividing the average price (capacity) of the incumbent in the fight period by its average price (capacity) in the pre-fight period.

Table 4: Predatory intention and the probability of winning a fight

Panel A: Logistic regression estimates		
Dependent: Incumbent wins	**(1)**	**(2)**
Firm characteristics		
Relative size	-0.075 (0.057)	-0.089 (0.066)
Incumbent size	0.717 (0.301)**	0.729 (0.302)**
Relative efficiency	3.792 (1.630)**	3.643 (1.620)**
Relative liquidity	0.002 (0.002)	0.003 (0.002)
Incumbent LCC	2.276 (0.887)***	2.100 (0.919)**
Entrant LCC	-1.709 (0.766)**	-1.654 (0.750)**
Relative airport dominance	0.505 (0.173)***	0.515 (0.181)***
Relative experience	0.258 (0.209)	0.285 (0.203)
Market characteristics		
Average population	-0.147 (0.206)	-0.122 (0.224)
Average personal income	-0.440 (0.261)*	-0.381 (0.275)
Average airport share	0.423 (0.358)	0.516 (0.375)
Market extent	0.128 (0.087)	0.090 (0.093)
Market demand	-0.894 (0.486)*	-0.929 (0.531)*
Strategic variables		
Price change ratio	-2.978 (1.326)**	-3.033 (1.383)**
Capacity change ratio	1.498 (0.448)***	0.399 (0.481)
Predatory response indicator		1.730 (0.639)***
Constant	2.207 (4.538)	3.608 (4.983)
Observations	245	245
Pseudo R-squared	0.509	0.532

Panel B: Average marginal effects	
	(2)
Firm characteristics	
Relative size	-0.008 (0.006)
Incumbent size	0.066 (0.024)***
Relative efficiency	0.332 (0.117)***
Relative liquidity	0.000 (0.000)
Incumbent LCC	0.191 (0.075)***
Entrant LCC	-0.151 (0.060)**
Relative airport dominance	0.047 (0.017)***
Relative experience	0.026 (0.017)
Market characteristics	
Average population	-0.011 (0.021)
Average personal income	-0.035 (0.024)
Average airport share	0.047 (0.036)
Market extent	0.008 (0.008)
Market demand	-0.085 (0.046)*
Strategic variables	
Price change ratio	-0.276 (0.124)**
Capacity change ratio	0.036 (0.043)
Predatory response indicator	0.157 (0.059)***

Robust standard errors are reported in parentheses. Standardized coefficients are reported for incumbent size, average poulation, average income and average airport size. Significance levels are indicated by: *** p<0.01, ** p<0.05, * p<0.1

Table 5: Two-stage model on predatory intention (2SLS)

Panel A: Linear regression and second stage estimates		
Dependent: Incumbent wins	**Linear regression**	**Second stage 2SLS**
Firm characteristics		
Relative size	-0.001 (0.002)	-0.001 (0.002)
Incumbent size	0.055 (0.030)*	0.055 (0.029)*
Relative efficiency	0.143 (0.040)***	0.143 (0.039)***
Relative liquidity	0.001 (0.000)***	0.001 (0.000)***
Incumbent LCC	0.043 (0.092)	0.043 (0.089)
Entrant LCC	-0.166 (0.069)**	-0.165 (0.066)**
Relative airport dominance	0.000 (0.001)	0.000 (0.001)
Relative experience	0.011 (0.004)**	0.011 (0.004)**
Market characteristics		
Average population	-0.059 (0.029)**	-0.059 (0.028)**
Average personal income	-0.052 (0.036)	-0.052 (0.034)
Average airport share	0.055 (0.027)**	0.055 (0.026)**
Market extent	0.026 (0.007)***	0.026 (0.007)***
Market demand	-0.045 (0.051)	-0.045 (0.051)
Strategic variables		
Price change ratio	-0.302 (0.152)**	-0.302 (0.147)**
Capacity change ratio	0.021 (0.019)	0.021 (0.033)
Predatory response indicator	0.221 (0.060)***	0.222 (0.105)**
Constant	0.697 (0.478)	0.701 (0.481)
Observations	245	245
R-squared	0.347	0.347

Panel B: First stage estimates	
Dependent: Predatory response indicator	
Instruments	
Pre-fight average assets	-0.039 (0.089)
Pre-fight average cash-to-assets	-0.835 (0.880)
Pre-fight route population	-0.782 (0.229)***
Pre-fight incumbent network extent	-0.359 (0.236)
Capacity difference	-0.222 (0.074)***
Entrant fixed effects	YES
Observations	245
F-statistic (p-value)	3.691 (0.000)
R-squared	0.546

Robust standard errors are reported in parentheses. Standardized coefficients are reported for incumbent size, average poulation, average income and average airport size. Significance levels are indicated by: *** p<0.01, ** p<0.05, * p<0.1

Table 6: Price and capacity analysis of predatory fights

Price premium/discount		Price	Capacity
Incumbent	Fight period	-0.099 (0.017)***	0.444 (0.117)***
	Post-fight period (winner)	0.036 (0.015)**	0.341 (0.101)***
Entrant	Fight period	-0.180 (0.027)***	0.241 (0.171)
	Post-fight period (winner)	0.088 (0.072)	0.659 (0.197)***
Controls	Route-fight FE	YES	YES
	Year-quarter and carrier FE	YES	YES
	Market controls	YES	YES
Observations	Number of fights	118	118
	N	3,419	4,092

The reference category is the pre-fight period of the predatory fight. Robust standard errors reported in parentheses. Significance levels are indicated by: *** p<0.01, ** p<0.05, * p<0.1

Table 7: Price and capacity analysis of non-predatory fights

Price premium/discount		Price	Capacity
Incumbent	Fight period	-0.071 (0.017)***	-0.633 (0.117)***
	Post-fight period (winner)	-0.031 (0.016)**	-0.055 (0.100)
Entrant	Fight period	-0.095 (0.027)***	-0.307 (0.174)*
	Post-fight period (winner)	-0.070 (0.031)**	0.392 (0.155)**
Controls	Route-fight FE	YES	YES
	Year-quarter and carrier FE	YES	YES
	Market controls	YES	YES
Observations	Number of fights	138	138
	N	3,572	4,857

The reference category is the pre-fight period of the non-predatory fight. Robust standard errors reported in parentheses. Significance levels are indicated by: *** p<0.01, ** p<0.05, * p<0.1

Table 8: Robustness analyses

Two-stage least square (2SLS) estimates				
Dependent: Incumbent wins	**Seats (Base)**	**Departures**	**≤ 4 years**	**≤ 3 years**
Firm characteristics				
Relative size	-0.001 (0.002)	-0.001 (0.002)	0.000 (0.001)	-0.001 (0.001)
Incumbent size	0.055 (0.029)*	0.060 (0.030)**	0.061 (0.038)	0.074 (0.039)*
Relative efficiency	0.143 (0.039)***	0.135 (0.041)***	0.091 (0.031)***	0.082 (0.030)***
Relative liquidity	0.001 (0.000)***	0.000 (0.000)**	-0.000 (0.000)	-0.000 (0.001)
Incumbent LCC	0.043 (0.089)	0.043 (0.089)	0.153 (0.096)	0.173 (0.112)
Entrant LCC	-0.165 (0.066)**	-0.175 (0.068)***	-0.031 (0.083)	0.049 (0.090)
Relative airport dominance	0.000 (0.001)	0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)
Relative experience	0.011 (0.004)**	0.010 (0.004)**	-0.002 (0.004)	-0.004 (0.005)
Market characteristics				
Average population	-0.059 (0.028)**	-0.063 (0.027)**	-0.024 (0.032)	0.018 (0.035)
Average personal income	-0.052 (0.034)	-0.055 (0.035)	-0.048 (0.044)	-0.090 (0.046)*
Average airport share	0.055 (0.026)**	0.056 (0.026)**	0.089 (0.035)**	0.090 (0.035)**
Market extent	0.026 (0.007)***	0.027 (0.007)***	0.014 (0.009)	0.015 (0.009)
Market demand	-0.045 (0.051)	-0.035 (0.051)	0.004 (0.054)	-0.085 (0.051)*
Strategic variables				
Price change ratio	-0.302 (0.147)**	-0.309 (0.147)**	-0.508 (0.216)**	-0.525 (0.242)**
Capacity change ratio	0.021 (0.033)	0.017 (0.026)	0.001 (0.022)	-0.025 (0.028)
Predatory response indicator	0.222 (0.105)**	0.212 (0.103)**	0.259 (0.101)**	0.352 (0.102)***
Constant	0.701 (0.481)	0.638 (0.482)	0.824 (0.515)	1.559 (0.448)***
Observations	245	245	129	101
Pseudo R-squared	0.347	0.345	0.369	0.343

The results of the main 2SLS specification are reported in the first column as a reference. In the second column specification, the capacity change ratio and the predatory response indicator are calculated using carrier departures instead of total seat capacity. In the third and fourth column, the main 2SLS specification is used and the selection of fights examined is reduced to fights with a duration of less or equal than 4 and 3 years, respectively. Robust standard errors are reported in parentheses. Standardized coefficients are reported for incumbent size, average poulation, average income and average airport size. Significance levels are indicated by: *** p<0.01, ** p<0.05, * p<0.1