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ASSESSING PREDATION IN AIRLINE MARKETS WITH LOW-FARE COMPETITION

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Abstract

Assessment of unfair competitive practices in airline markets has traditionally been based on the analysis of changes average fares, revenue and traffic following low-fare entry. This paper demonstrates the severe limitations of using such measures. In particular, our case studies show that despite very different perceptions by some analysts of apparent incumbent carrier response to entry, average fares, revenues and traffic measures showed very similar patterns of change in the cases studied. We then use a competitive airline market simulation to illustrate the importance of often ignored factors – revenue management and the flows of connecting network passengers on the flight legs affected by low-fare entry – in explaining the effects of entry on these aggregate measures of airline performance. These simulation results further reinforce the danger in using such measures as indicators of predatory behavior in airline markets.

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1. Introduction

The growth of low-fare, low-cost airlines throughout the 1990s has been dramatic. In the US, low-fare carrier market shares have increased from just over 5% in 1990 to about 25% in 2004. In Europe, Asia and Australia, low-fare carriers are blossoming. With the rapid growth of new entrants, traditional network carriers must fight to remain competitive and are therefore making changes to adapt to this new competitive environment. These changes include fare structure changes and cost reductions.

While low-fare carriers expand all over the world, regulators are increasingly concerned with the effects of low-fare entry on the competitiveness of the airline industry and the potential for predatory practices by incumbents. As a matter of policy, regulatory bodies – such as the US Department of Transportation – and researchers have attempted to devise tests or guidelines in order to determine whether predation occurs in airline markets. These tests attempt to compare pre- and post-entry incumbent revenues, costs and capacity to make a determination as to whether the incumbent engaged in predatory behavior. The analysis of traditional aggregate measures of airline performance (such as total local market revenues, average fare in the local market and traffic on each individual airline) has typically been the foundation of such comparisons. However, these tests have ignored the effects of network passenger traffic and revenue management on the incumbent carriers.

This article illustrates the limitations of using traditional measures of airline performance to assess the response of incumbent carriers to low-fare entry and demonstrates the impacts of new entrant capacity, revenue management and flows of network passengers on individual carrier performance. This article also strives to provide policy-makers with guidance and insights on the competitive importance of these previously ignored factors. The results show that traditional proposed tests of predation at best indicate the potential for predatory behavior, but do not provide a conclusive indication of predation.

2. Literature Review

Despite McGee's 1958 argument that predation was often an unprofitable business strategy unlikely to occur except under unusual market conditions, such as legal barriers to mergers and acquisitions, the literature on predation has been plentiful. The development of game theory in the 1960s and 1970s helped demonstrate that predation might lead to a rational equilibrium under specific conditions such as the "long purse" assumption (Edwards, 1955) or reputations models, as described by Kreps and Wilson (1982). In an effort to identify predatory pricing and predation in its more general sense, Areeda and Turner (1975, 1976 and 1978) designed a test of predatory pricing, based on the comparison of price and marginal cost. In 1977, Williamson suggested a short-term output-maximizing rule as an alternative to Areeda and Turner's marginal cost test. Baumol (1979), Joskow and Klevorick (1979), and others also discussed predatory pricing in its more general economic setting and proposed tests or rules for evaluating whether a pricing strategy is predatory. Most of the research on predation thus focuses on the comparison of revenues and costs.

Specific research on entry in airline markets has focused mostly on the effects of entry on traffic and fares. While many of these studies indicated a growing concern with respect to unfair competition and predatory pricing, few of these research efforts focused on identifying and understanding the dynamics of airline markets, and how they affect competition. For instance, Bailey et al. (1985), Morrison and Winston (1990), Windle and Dresner (1995), Perry (1995), and Oster and Strong (2001) all examine the impact of entry on average fares and traffic, distinguishing between entry by a low-fare carrier and a network carrier, and touch upon the issue of predation. Dodgson et al. (1991) provide a definition of predatory practices in the airline industry and concepts of relevance in identifying these practices. In addition, they highlight the irrelevance of cost-based tests of predation in airline markets.

Despite their recognition of airline-specific characteristics, none of these studies identify revenue management and network traffic flow effects as factors of critical importance in understanding and explaining the apparent response of incumbent carriers to low-fare entry. Airline revenue management started with overbooking research in the 1950s with Beckman's (1958) static optimization model. Later statistical models include the work of Taylor (1962), Simon (1968), Rothstein (1968, 1985) and Vickrey (1972). The primary tool of revenue management is fare class mix seat inventory control, the practice of determining the revenue maximizing number of seats to make available for each product (fare class) on each future flight leg departure. Littlewood (1972) and Smith (1984) provided the basis for the initial research on the topic of revenue management forecasting, which is used as an input to seat inventory control algorithms. Belobaba (1987a, 1987b) published the first leg-based seat inventory management algorithm for nested fare classes, known as the Expected Marginal Seat Revenue algorithm (EMSR). Building on this research, Belobaba (1989, 1992a, 1992b, 1994), Curry (1990), Brumelle and McGill

(1993) and others developed heuristic extensions as well as theoretically optimal formulations of the multiple nested class seat protection model.

Network revenue management constitutes a significant advance in the management of airline seat inventory when connecting passenger itineraries are involved. As a first step towards the development and implementation of network revenue management, Smith, Leimkuhler and Darrow (1992) described the notion of "virtual nesting". Williamson (1992) proposed a variety of OD control methods for connecting airline networks. More recent research focusing on the mathematics of network optimization applied to network revenue management includes the work of Gallego and Van Ryzin (1997), de Boer (2003), and Bertsimas and Popescu (2003).

For more detailed descriptions of previous research on airline revenue management, the reader is referred to McGill and Van Ryzin (1999), who provide a thorough review of the science of revenue management and its evolution. Belobaba (2002) also reviews the state of the practice as it relates to airline network revenue management.

Thus, past efforts to investigate competitive behavior in airline markets have been disconnected from the practice of revenue management and have involved almost exclusively the analysis of aggregate market measures of average fares and traffic. Overall, none of these studies have provided a satisfactory method to evaluate the possibility of predation, given the dynamics of airline networks and revenue management. More importantly, none of the previous research has attempted to estimate the impact of these factors on apparent incumbent performance after entry.

3. Case Studies

A two-tier approach was chosen to describe the effects of low-fare entry in airline markets. In a first step, the analysis of two comparable markets allows us to highlight the potential differences in the response of incumbent carriers to low-fare entry, as well as the perception of the severity of such responses on the part of policy-makers. In a second step, a simulation model is used to study the effects of revenue management and connecting network flows on individual carrier performance in markets with low-fare competition.

Several studies (Perry, 1995; Oster and Strong, 2001; Gorin, 2004) of airline markets with low-fare new entrant competition have concluded that low-fare entry usually leads to:

- An increase in total local market and incumbent local traffic
- A decrease in average fares, both at the market level and on the incumbent carriers
- An increase in total aircraft departures in the market
- An increase in total market revenues

In our case study, a detailed analysis of, and comparison between, two markets with low-fare competition provides an illustration of the complexities of competition in airline markets.

In the first case, Delta Air Lines faced competition from ValuJet in its Atlanta-Orlando market. In the first quarter of 1994, ValuJet entered the Atlanta-Orlando market with 25 weekly roundtrips (as many as four daily roundtrips on certain days) using DC9-32 aircraft (with a capacity of about 115 seats). ValuJet entered the market with substantially lower fares (~50%) than those offered by the other nonstop carriers in the market (Delta Air Lines and Trans World Airlines). Almost ten years later, ValuJet is still operating in the market (under the name AirTran), as is Delta.

In the second case, Spirit Airlines entered the Detroit-Boston market on April 15, 1996 with a DC9-21 aircraft (90 seats) and offered a single daily roundtrip flight. This low cost, low fare carrier entered the market with considerably lower fares (~75%) than those formerly offered by Northwest, the only airline previously offering nonstop service. On September 8, 1996, Spirit exited the market, less than five months after its entry.

The severity of the competitive response by the dominant incumbents in these two markets appears on the surface to be very different. On the one hand, Delta Air Lines has been viewed as a relatively lenient competitor with respect to its response to low-fare entry, as evidenced by the continued growth of Air Tran in Atlanta, Delta's primary hub. On the other hand, Northwest Airlines is considered a far more aggressive competitor, as shown by the numerous studies describing its anti-competitive behavior. The Detroit-Boston market is no exception and is further described by Oster and Strong (2001) as potentially exhibiting anticompetitive practices.

Despite the different perceptions of the response of incumbent carriers in these particular markets, Table 1 shows that traffic, average fares and revenues paint an incomplete picture of the impacts of entry and provide no information regarding the specifics of the incumbents' response. In particular, a year-over-year comparison of Delta and Northwest's traffic, fares and revenues – which corrects for seasonal trends – shows that these measures of airline performance changed in very similar ways after entry in both cases. As shown in Table 1, the measures of traffic, average market fare and revenues experienced remarkably similar patterns in these two examples of low-fare entry, despite widespread perceptions that Northwest's response in the Detroit-Boston market was much more severe, and potentially anti-competitive.

Airline	Year-Over-Year Percent Change		
	Traffic	Average Fare	Revenues
Delta ATL-MCO	+59.7%	-51.3%	-22.2%
Northwest DTW-BOS	+63.3%	-48.8%	-17.4%

Table 1: Relative change in quarterly traffic, average fare, departures and revenues on the incumbent network carriers (based on US Department of Transportation DB1A database, see Gorin, 2004 for more detail)

Despite the similarity in the response of incumbent carriers, as depicted by these aggregate measures, Delta and Northwest were perceived as very different competitors, as mentioned In addition, these aggregate measures do not provide any information regarding the pricing response (or lack thereof) of the incumbent carriers to low-fare entry, let alone the intent of these carriers to force their low-fare competitors out of the market.

In the following sections we simulate entry in both a single market environment as well as in a full network environment in order to illustrate the dangers in using these measures as indications of the nature of the response by incumbent carriers. Our results also show how flows of network passengers and revenue management affect these measures of airline performance and can distort the perceptions of entry in airline markets.

4. Simulation

Unlike analytical models, which are limited to static observations that overlook the effects of passenger booking patterns and the effects of airline revenue management practices, simulations allows for a dynamic representation of competitive airline markets. In addition, static models cannot accurately model demand, booking behaviors, forecasting, and competitive airline interactions, and inevitably lead to inconclusive or even misleading findings due to the necessary simplifications required for the models to remain tractable.

Rather than oversimplifying, we use the Passenger Origin Destination Simulator (PODS), a simulator of a competitive airline network. Abundant literature is available on PODS, including a detailed description of the underlying algorithms (Hopperstad, 1997 and 2000), general discussions of the structure of PODS by Belobaba and Wilson (1997) and Lee (1998), an explanation of the forecasting models used in PODS by Zickus (1998) and Skwarek (1996) and a validation of the passenger choice model by Carrier (2003). In all these references, various revenue management methods commonly used by airlines and simulated in PODS are also described.

In the following simulations, we assume that the market does not structurally change after entry. For example, we assume that conditional passenger preference towards any particular airline remains unchanged by entry: Given that the passenger does not choose to travel on Airline 3 (new entrant), his/her preference between airlines 1 and 2 (incumbent network carriers) is the same as his/her preference when there are only airlines 1 and 2 operating in the market. Similarly, we assume that total potential demand remains a function of price, as governed by the existing price-demand curve in the market, irrespective of the number of competitors in the market.

The demand for air travel is split into business demand and leisure demand, where 35% of total demand is business oriented while the remaining 65% of demand is leisure demand. Business passengers are characterized by a higher willingness-to-pay as well as a greater sensitivity to restrictions imposed on fare products offered by the airlines. While these assumptions are not overly restrictive, it may be argued that low-fare entry has a structural effect on the market. For tractability reasons, and since there is little evidence of this in the literature discussed previously, we do not model any structural change.

4.1. Simulation of Entry in a Single Market Environment

In this first scenario, airlines operate in a single market environment, where two initial competitors (one nonstop – Airline 1, the other one connecting – Airline 2) are faced with low-fare entry. The new entrant carrier (Airline 3) enters the market with a schedule identical to that of the nonstop incumbent carrier (to eliminate potential schedule effects) and with different aircraft capacity levels.

4.1.1. Simulated Scenarios

We simulated two competitive scenarios to allow comparisons "before" and "after" new entry into an airline market. In the base case, two incumbent airlines compete, one of which offers only nonstop service in the market (Airline 1) while its competitor offers only connecting service (Airline 2). In the second scenario, we add a third carrier – the new entrant – which then also offers nonstop service in this market, and competes with both incumbents but more directly with the nonstop incumbent carrier.

The purpose of Airline 2 – the connecting incumbent carrier – is to act as a "relief valve" for the excess market demand and to allow passengers to have an alternative to the nonstop carrier. Airline 2 thus represents all the connecting alternatives available to passengers in a more realistic market. As a result, we assume that Airline 2 offers a large capacity relative to demand in this market (identical to that of the nonstop incumbent carrier), even though its connecting flight options (paths) are far less desirable than those of Airline 1. The loads, revenues and overall performance of Airline 2 are therefore not of particular interest in this discussion. From here on, we thus refer to the nonstop incumbent simply as the incumbent carrier.

Baseline Case: No Entrant Competition

Without new entrant competition, the market is served by two competing incumbent carriers, each offering three daily departures. Airline 1 offers three daily nonstop flights while its competitor offers three connecting flights, each with 30 seats on each flight, for a total of 90 seats per day in the market for each carrier. Table 2 summarizes the frequency, capacity and baseline pricing of the incumbent carriers.

CARRIER	CAPACITY	FREQUENCY	PRICING
Airline 1	90 seats (3x30)	Three daily flights	Four fare classes with four different fare levels Y, B, M and Q (see Table 3)
Airline 2	90 seats (3x30)	Three daily flights	

Table 2: Capacity, frequency and pricing overview without entrant competition

All other characteristics are exactly the same for both airlines. There is no passenger preference for either airline, other than the preference induced by path quality (nonstop vs. connecting paths).

The baseline prices for each fare class are set as shown in Table 3, along with the restrictions associated with each individual fare class in this baseline scenario. Y class is the unrestricted fare class in the market; while B, M and Q classes are increasingly restricted. The more restrictive the fare class in terms of advance purchase requirements and restrictions (roundtrip, Saturday night stay, and non-refundability requirements), the cheaper the associated fare. We refer to this fare structure as the standard fare structure.

Fare Class	Fare	Restrictions			
		Roundtrip Requirement	Saturday Night Stay	Non Refundable	Advance Purchase
Y	$261	No	No	No	No
B	$135	Yes	No	No	7 days
M	$92	Yes	Yes	No	14 days
Q	$63	Yes	Yes	Yes	21 days

Table 3: Fare classes, sample associated fares and restrictions for the standard fare structure in the baseline scenario

As described in most of the literature on PODS, these fare settings lead to a lower relative total disutility (sum of actual fare paid and disutility "costs" of restrictions) associated with higher fare classes (Y and B) for business passengers, and conversely, a lower relative disutility of lower fare classes (M and Q) for leisure passengers. That is, the total disutility costs of the sum of the actual fare paid and fare restrictions on the lowest fares are still perceived by leisure passengers to be lower than the total cost of the unrestricted "full fare".

Finally, since the purpose of this paper is in part to examine the impact of revenue management on "traditional" measures of incumbent performance, we allow the incumbent carriers to either accept requests for seats on a first-come, first-served basis (FCFS), or to use Fare Class Revenue Management (FCRM). In the case of FCFS seat request acceptance, passengers book seats in a first-come, first-served manner, and the only controls that airlines can use to differentiate between fare products are advance purchase requirements that effectively close down a fare class beyond a given deadline, or restrictions that have an impact on the passengers' buying decision.

In the case of FCRM, the simulated airlines use a combination of Booking Curve detruncation, Pick-up forecasting, and Expected Marginal Seat Revenue algorithm (Belobaba, 1987), as extensively described in the PODS and Revenue Management literature (e.g. Gorin, 2000) and used by many airlines. Under Fare Class Revenue Management, advance purchase requirements and restrictions still apply, and are reinforced by revenue management controls to protect seats for later-booking high-fare passengers, in turn limiting seats made available to early-booking low-fare passengers.

New Entrant Scenario

In this second scenario, we add a third carrier, referred to as the new entrant. Upon entry, the new entrant carrier offers three daily nonstop flights scheduled at the exact same times as the nonstop incumbent carrier's flights (Airline 1). We chose to mirror the nonstop incumbent's schedule in order to eliminate the effect of schedule preference on passenger choice. In this scenario, passengers now have the option of flying on the nonstop incumbent carrier, its nonstop new entrant competitor, or the connecting incumbent carrier.

The new entrant offers a two-tier fare structure as follows (c.f. Table 4):

1. Fully unrestricted Y class fare set at $135 (the same fare as the B class fare on the incumbent carrier in the base case), approximately 48% lower than the previous Y fare
2. Restricted M class fare (roundtrip and Saturday night stay requirements with 14 days advance purchase) priced $10 below the base case Q fare on the incumbent, at $53

Fare Class	Fare	Restrictions			
		Roundtrip Requirement	Saturday Night Stay	Non Refundable	Advance Purchase
Y	$135	No	No	No	No
M	$53	Yes	Yes	No	14 days

Table 4: Two-tier fare structure details (new entrant carrier)

This two-tier fare structure is based on our observation that many low-fare new entrants typically offer a simplified fare structure, as compared to that of incumbent carriers. The notion of simplification does not necessarily involve the removal of all restrictions and advance purchase requirements, but rather a decrease in the number of fare classes offered, and consequently in the complexity of the fare structure. In addition, low-fare new entrants typically offer substantially lower fares relative to the incumbents' standard fare structure.

In order to test the effect of the entrant's capacity on market performance, we also simulated various capacity levels offered by the new entrant on its three daily flights. New entrant capacity ranges between 15 seats per flight and 50 seats per flight, with intermediate capacity settings of 25 and 30 seats.

Finally, we let the new entrant carrier either accept seat requests on a first-come, first-served basis, or use Fare Class Revenue Management. In the simulations presented here, we assumed that all competitors have the same revenue management system (or lack thereof), or that the incumbent carriers use Fare Class Revenue Management while the new entrant does not.

Incumbent Response to Entry

Upon entry, we assume that the incumbents either fully match the entrant's fare structure or only respond with a limited fare match. The limited match response represents the less aggressive response whereby the incumbent carriers only match the lowest available fare in the market in their most restrictive fare class. As a result, the incumbent carriers are offering a fare of $53 in their Q class, which is more restrictive than the M class fare offered on the new entrant carrier at the same price. Table 5 summarizes the type of service, frequency, capacity, fares and revenue management approach of each carrier in the competitive case, under the limited match assumption.

Competitive Case	Service	Frequency & Capacity	Fares by Fare Class				Revenue Management
			Y	B	M	Q	
Airline 1	Nonstop	3x30	$261	$135	$92	$53	FCFS or FCRM
Airline 2	Connecting	3x30	$261	$135	$92	$53	FCFS or FCRM
Airline 3 (New Entrant)	Nonstop	3x15-25-30or50	$135	n/a	$53	n/a	FCFS or FCRM

Table 5: Competitive case summary (limited match response from incumbents)

4.1.2. Results

In the following paragraphs, we first illustrate how average fares can be misleading in interpreting the response of incumbent carriers to low-fare entry, as simulated in the single market environment described above. We then highlight the impact of revenue management controls on average fares, revenues and traffic. In the next section, we extend the results to a large network environment to further explore the effects of network flows of passengers on these measures.

A common misconception of competition in airline markets, and more particularly of low-fare entry into airline markets, is that lower average fares on the incumbent carrier (relative to the new entrant carrier) are indicative of an aggressive pricing response. Our results show that, even in the case of a limited response by the incumbent carrier, its average fare (as well as revenues and traffic) is severely affected by low-fare competition in the market (when all carriers use revenue management). Figure 1 shows that the incumbent carrier's average fare decreases significantly following entry by a low-fare competitor and remains consistently lower than that of the new entrant carrier. The explanation of this result lies in the more attractive entrant fare structure simulated in this case, which leads to the diversion of all but low-fare traffic (as limited by the entrant's capacity) from the incumbent carrier to the new entrant competitor. As a result, the incumbent carrier's average fare decreases relative to pre-entry, and remains consistently lower than that of the new entrant carrier (which carries high-fare business traffic previously traveling on the incumbent). As new entrant capacity increases (relative to incumbent capacity), the entrant's revenue management system recognizes the need to fill more seats, and makes more low-fare seats available on the new entrant, hence the decrease in average fare with increasing new entrant capacity.

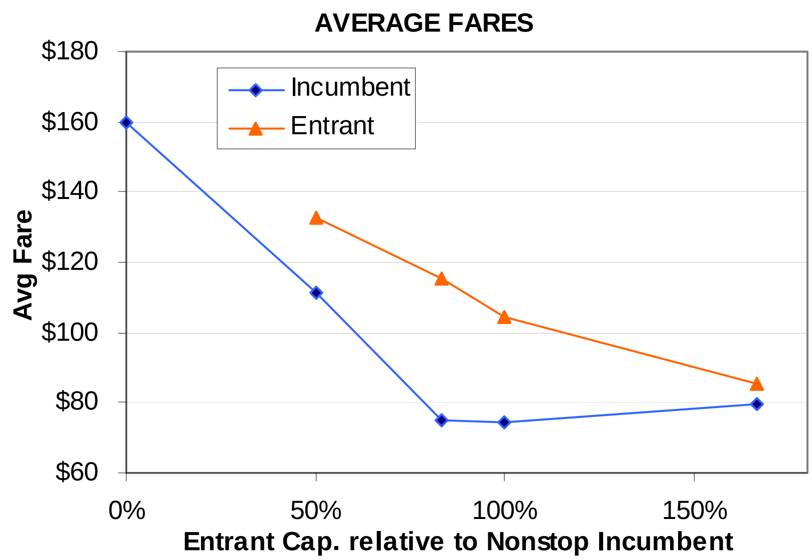

Figure 1: Average fare on nonstop incumbent and entrant carrier as a function of relative entrant capacity in the limited match case

The impact on incumbent and entrant revenues and traffic is shown in Figure 2, and follows from the effect of entry on incumbent and entrant average fares.

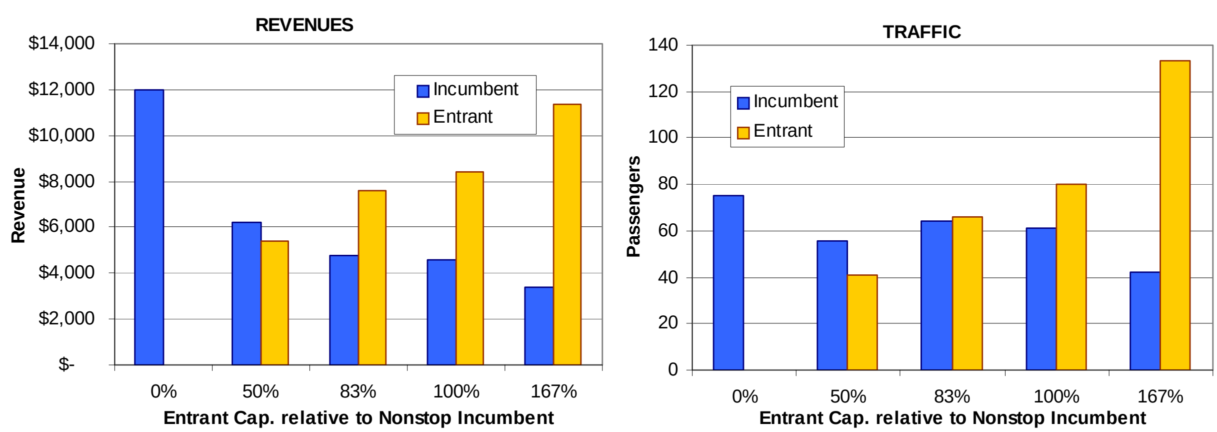

Figure 2: Revenues and traffic on nonstop incumbent and new entrant as a function of relative entrant capacity in the limited match case

These simulation results illustrate the effects of entry on average fares, revenues and traffic under the assumption of a limited fare response, and further demonstrate that changes in average fares, revenues and traffic cannot provide reliable information pertaining to the nature of an incumbent's response to low-fare entry.

The results also demonstrate how the effects of entry on incumbent and new entrant average fares, revenues and traffic are directly affected by the use of revenue management techniques by the competitors. Figure 3 shows the incumbent carrier's average fare as a function of its revenue management system and that of its competitor. In particular, when none of the carriers use revenue management, the incumbent carrier's average market fare increases with increasing new entrant capacity. This effect is explained by the fact that as the new entrant carrier increases its capacity, the availability of seats in the market increases, and low fare passengers therefore split between the two carriers in the market. Since business passengers are assumed to book later, the greater capacity increases the availability of seats later in the booking process, making these seats available to business passengers, and consequently increasing the average fare on the incumbent carrier as entrant capacity increases.

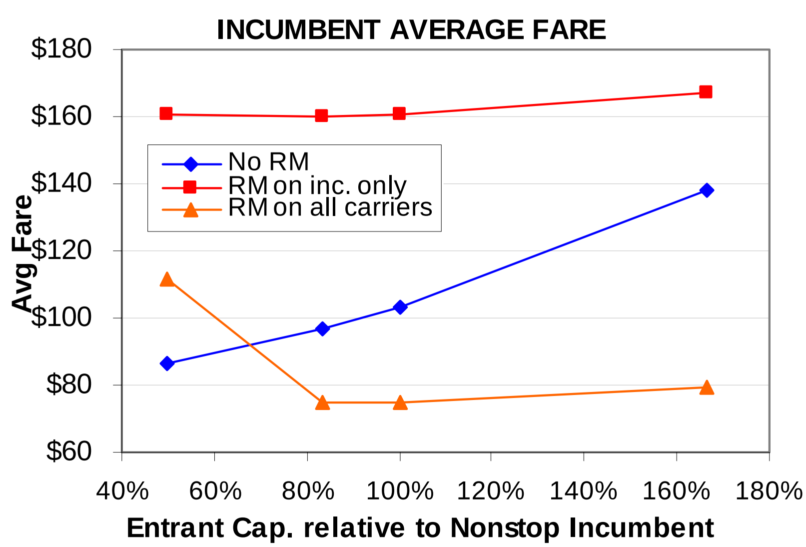

Figure 3: Incumbent carrier average fare as a function of relative entrant capacity and competitive revenue management under the limited match case

When only the incumbent carriers use revenue management, the ability of the incumbent to forecast the arrival of high-fare demand later in booking process allows it to maintain a high average fare in the market. Revenues, however, decrease following entry but remain the highest of all three cases simulated (as shown in Figure 4).

Finally, when all carriers use revenue management, the incumbent's average market fare decreases following entry (up to an entrant capacity of about 80% of the incumbent's capacity) and remains stable as new entrant capacity increases. This effect is a consequence of the combination of a more attractive fare structure on the new entrant carrier and its use of revenue management. The entrant forecasts late-booking high-fare passengers, but, given its small capacity, is only able to accommodate a small portion of that traffic. The incumbent carrier carries the remainder of that traffic (since it also forecasts this passenger demand), as long as the new entrant's capacity remains small. When the entrant's capacity exceeds total business demand in the market, it diverts all of the business traffic and the incumbent carrier is forced to carry almost exclusively low-fare traffic. In this case, the use of revenue management on the incumbent cannot make up for its less attractive fare structure relative to the low-fare new entrant carrier.

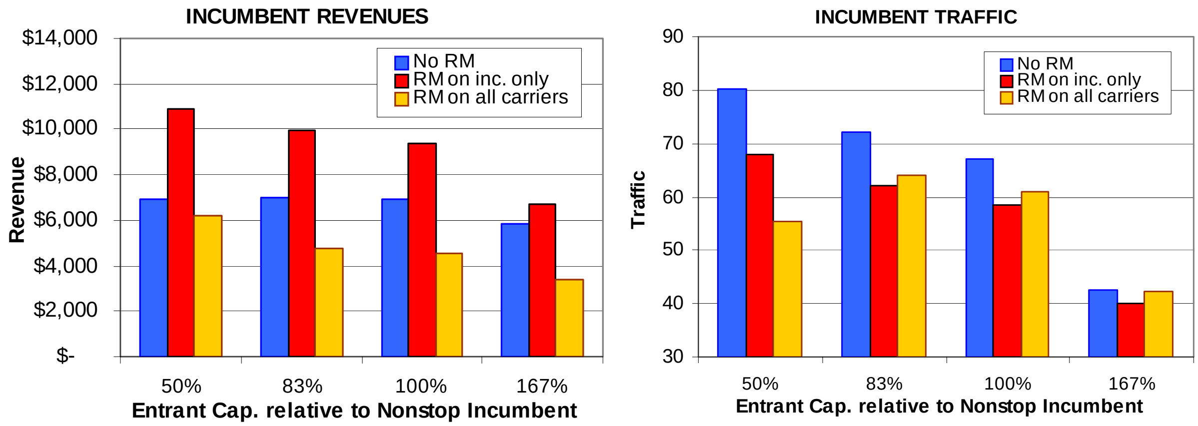

Figure 4: Incumbent carrier revenues and traffic as a function of relative entrant capacity and competitive revenue management situation

Figure 4 shows the effects of entry on incumbent revenues and traffic as a function of the competitive revenue management situation as well as the new entrant's capacity relative to the incumbent carrier. It shows in particular that the incumbent carrier's revenues are consistently highest when it uses revenue management while the new entrant does not. Traffic, on the other hand, is highest on the incumbent carrier when it accepts passenger bookings on a first-come, first-served basis. Figure 4 also shows that the incumbent carrier's revenues are higher when none of the competitors use revenue management than when both carriers use revenue management. It is important to stress here that these results do not imply that the incumbent carrier would achieve higher revenues if it did not use revenue management when the new entrant does. In fact, our results show (see Gorin, 2004) that revenues would be significantly lower on the incumbent carrier under this scenario and thus reinforce the importance of revenue management, particularly in a low-fare environment.

Our results for the single market scenario simulated thus highlight the significant impact of revenue management and relative entrant capacity on traditional measures of airline performance (average fares, revenues and traffic), and thus emphasize the dangers in using these measures as indications of predatory behavior in airline markets.

4.2. Simulation of Entry in a Network Environment

We now extend our simulations to a larger network environment in order to illustrate the effects of network flows of passengers combined with revenue management on average fares, traffic and revenues.

4.2.1. Simulated Scenarios

In the network scenario, the two previously described incumbent carriers operate a full hub network schedule, each offering connecting opportunities through its hub. The new entrant carrier (Airline 3) offers only nonstop service in a subset of Airline 1's local markets, specifically the ten markets with the highest local demand from Airline 1's hub.

The network in which the three competing carriers operate includes 40 cities, in addition to two individual airline hubs. Figure 5 shows a geographical layout of the network overlaid on a map of the US with the two incumbent carriers' route structure. It also shows the two incumbent network airlines' hubs, H1 and H2.

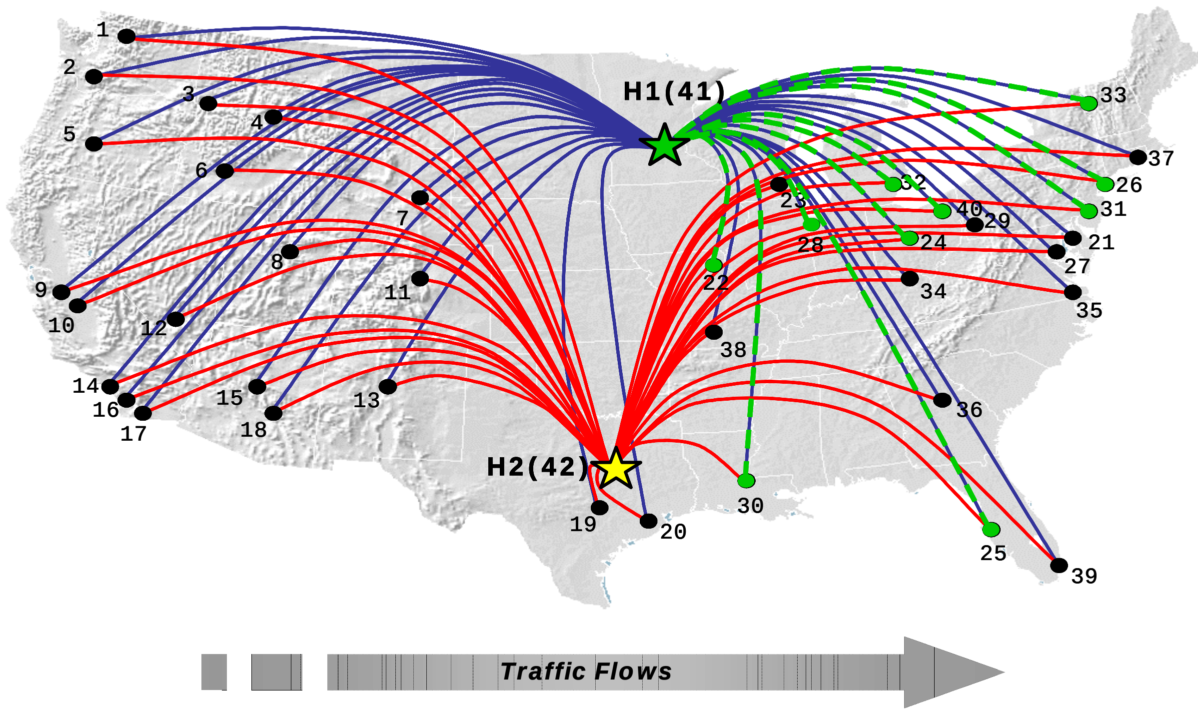

Figure 5: Simulated airline networks

Traffic on this network flows only from West to East such that each network airline offers service only from western spoke cities (1 through 20) to its hub, and from the hub to eastern spoke cities. Nonstop service is available from cities 1 through 20 to hubs H1 and H2, on Airline 1 and Airline 2 respectively, and from hubs H1 and H2 to cities 21 through 40, on Airline 1 and Airline 2 respectively. In addition, Airlines 1 and 2 also offer hub-to-hub service between H1 and H2. As a result, passengers traveling from a western spoke to an eastern spoke must connect either through H1 or H2. Passengers traveling from a western spoke to H1 or H2 can either travel nonstop on the appropriate carrier, or connect through the other carrier's hub. Finally, passengers traveling from either hub to an eastern city also have the option of flying nonstop from that hub or connecting through the competing carrier's hub.

The new entrant carrier, Airline 3, offers nonstop service in the top ten markets with the largest local demands from H1 to eastern cities (also shown on Figure 5), and therefore competes directly with Airline 1's nonstop service in these local markets.

Each of the two incumbent network carriers offers three daily departures in each of the 482 markets served in this network, either as nonstop or connecting itineraries. Flight departures are timed so that each network airline's hub operates three daily connecting banks allowing for connections from western cities towards eastern cities. The new entrant's flights coincide with the incumbent carrier's flight departures in each of the local markets with low-fare competition, but the new entrant does not carry any connecting traffic from Airline 1 or Airline 2. In other words, interlining is not allowed in this simulation (including between Airline 1 and Airline 2).

The incumbent carriers use a total of 126 flights to serve all 482 markets with three frequencies each and with 100 seats per flight. The new entrant carrier operates 30 flight legs in its ten markets. All new entrant flights have the same capacity, which we varied in the simulations between 30, 50 and 70 seats per flight to assess the effect of new entrant capacity on incumbent and new entrant performance.

The pricing strategies of incumbent and new entrant carriers are the same as in the single market case -- the new entrant carrier enters the market with a two-tier fare structure (based on the incumbents' pre-entry standard fare structure) that the incumbent network carriers either partially or fully match, but only in the ten markets with low-fare entrant competition. In the other 472 markets without low-fare competition, the incumbent carriers maintain their standard fare structure, as previously described (c.f. Table 2). In order to evaluate the impact of revenue management methods, the incumbent carriers now either jointly use leg-based fare class revenue management (FCRM) or network revenue management (referred to as Net. RM). The new entrant carrier always uses FCRM as its revenue management method. In the case of network revenue management, we use a combination of Booking Curve detruncation, Pick-up forecasting, and Displacement Adjusted Virtual Nesting algorithm (Williamson, 1992), as implemented by many airlines.

4.2.2. Results

Our simulations of a large network environment allow us to model the effects of flows of network passengers and thus observe the added effect of these network synergies on incumbent carrier revenues and traffic. Figure 6 shows the difference between local market revenue losses and total network revenue losses on the incumbent carrier following low-fare entry in a portion of its network – we refer to this difference as incumbent “revenue recovery”. The results clearly indicate that the incumbent carrier was able to recover a significant amount of revenue from its connecting network passengers, and that the amount of the revenue recovery depends on the new entrant’s capacity as well as the competitive revenue management situation.

Figure 7 shows how flows of network passengers affect the incumbent’s revenues as well as how revenue management changes the composition of local and connecting traffic to improve the mix of passengers from a revenue perspective. In particular, in both cases pictured in Figure 7, following low-fare entry, the incumbent carrier loses local traffic to the new entrant carrier, and its revenue management system then allows more connecting traffic to replace the loss in local traffic. Network revenue management further recognizes the difference between low-fare local traffic and higher fare connecting traffic and thus forces even more local traffic off the incumbent carrier in favor of more connecting traffic, which leads to the greater revenue differential pictured in Figure 6.

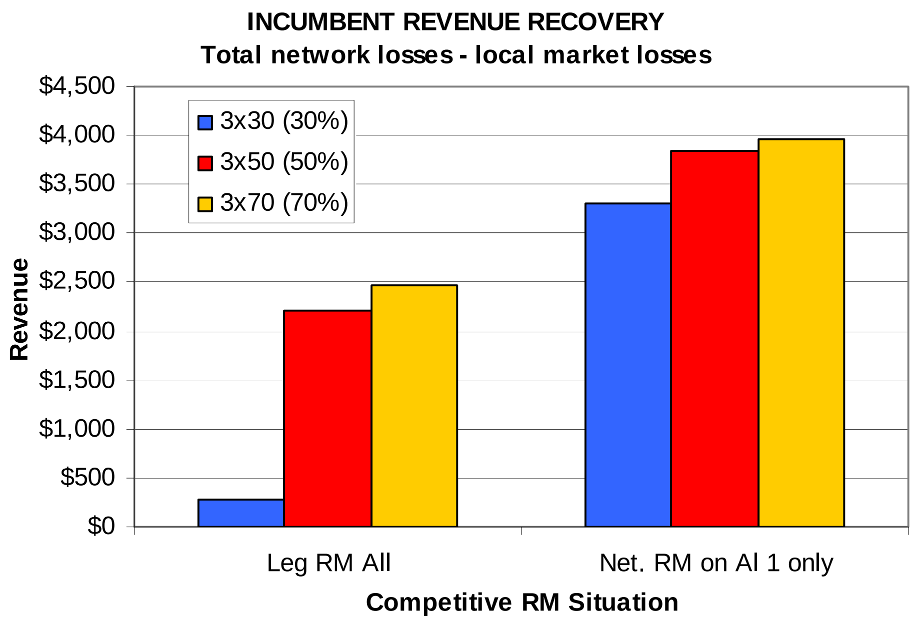

Figure 6: Incumbent revenue recovery, i.e. difference between total network revenue losses and local market revenue losses on the incumbent network carrier

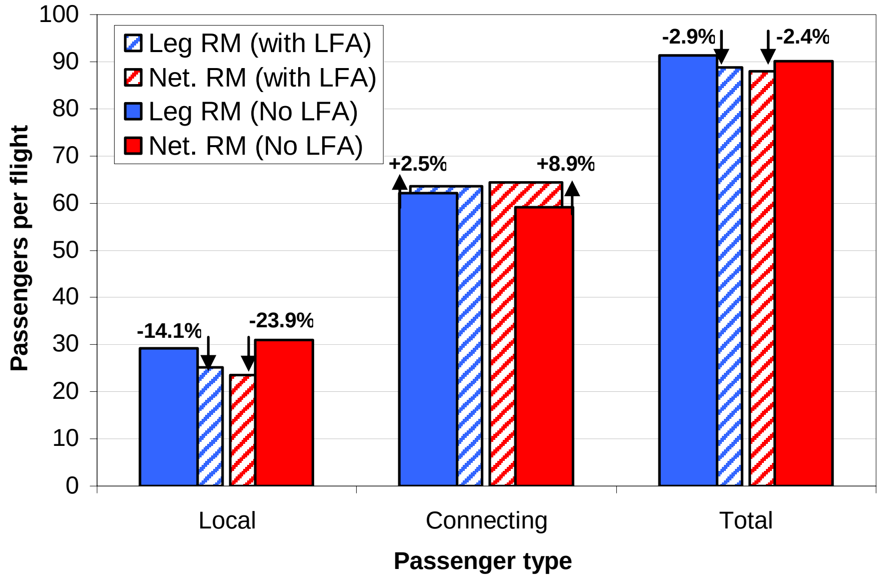

Figure 7: Effect of entry and revenue management on local and connecting incumbent network carrier traffic

In summary, the incumbent carrier can use Network RM methods to replace local market traffic with connecting traffic to mitigate the impact of entry on network revenues. As a consequence, the incumbent's average local market fare is less affected by entry, as it focuses on high-fare local traffic. Local market revenues, however, tend to suffer more from entry than in the single market case, as incumbent foregoes low fare traffic in favor of more lucrative network passengers.

These simulation results thus highlight the effects of flows of network passengers combined with competitive revenue management, pricing response and relative entrant capacity on incumbent and new entrant measures of average fares, revenues and traffic. The results also emphasize the limited information provided by these measures with respect to each carrier's actual performance and response to entry.

5. Applications to Studies of Competition in Airline Markets

Typical studies of competition in airline markets (e.g. US DOT, 2001) identify predatory conduct based on observations of average market fares, traffic and revenues, as previously discussed. In this section, three typical observations leading to suspicion of predatory conduct are discussed. Our results show that these findings, if misinterpreted, may lead to erroneous conclusions regarding predatory behavior in airline markets.

Response to entry raises suspicion when:

1. The incumbent carrier's average market fare is lower than that of the new entrant carrier. This is often seen as an indication of aggressive pricing response from the incumbent carrier.

2. The incumbent carrier's average market fare decreases after entry. The decrease in incumbent average fare is assumed to reflect an aggressive incumbent pricing response.

3. The incumbent carrier's local market traffic increases, but its local market revenues decrease. Decreasing revenues and increasing traffic are again presumed to reflect an overly aggressive pricing response leading to greater traffic but lower revenues.

We have already explained why the first conclusion does not hold when considering competition in airline markets, as it fails to account for revenue management and flows of network passengers. We now discuss each the remaining two statements and explain how they can lead to erroneous conclusions regarding the nature of the incumbent carrier's response to low-fare entry. Based on our simulation results, which do not imply any predatory motive on the part of the incumbent carrier and further allow only a limited set of responses from the incumbent carriers (constant incumbent capacity, limited or full match of entrant fares), we demonstrate how the above guidelines can lead to the conclusion that the incumbent carrier responded to low-fare entry with predatory practices, when in fact it did not.

5.1. Decrease in Incumbent Average Fare as an Indication of Predatory Pricing

Our case studies and simulation results have shown that low-fare entry is usually accompanied by a decrease in the incumbent's average market fare. This effect is often construed as an indication of aggressive response and potential predatory pricing in response to entry.

As shown in Figure 8, a more aggressive response to low-fare entry does not necessarily lead to a lower average fare. In the case of entry with a two-tier fare structure with all carriers using fare class revenue management, as simulated in Figure 8, the incumbent carrier's average fare is lower under the more aggressive response strategy (full match) only at low entrant capacity. The more aggressive incumbent response to entry actually allows the incumbent carrier to maintain a higher average market fare when the new entrant carrier chooses to enter the market with a relatively high capacity.

The explanation for this result lies in the number of passengers that are potentially diverted from the incumbent carrier. In the limited match case, at high entrant capacity, diversion of traffic from the incumbent carrier to the entrant is so high that the effect on the incumbent's average fare is greater than if it had matched the fare structure on the new entrant carrier. The revenue management system on the entrant carrier forecasts the late-booking demand, as does the incumbent carrier's system. However, the more attractive fare structure on the entrant (under the assumption of a limited response to entry) leads to a diversion of all business traffic towards the new entrant carrier. In contrast, when the incumbent fully matches the entrant's fare structure, it can also carry some of the late-booking business traffic.

Finally, when new entrant capacity is small, matching the fare structure of the entrant actually leads to the diversion of the incumbent carrier's own business traffic towards a lower fare, hence the decrease in revenues.

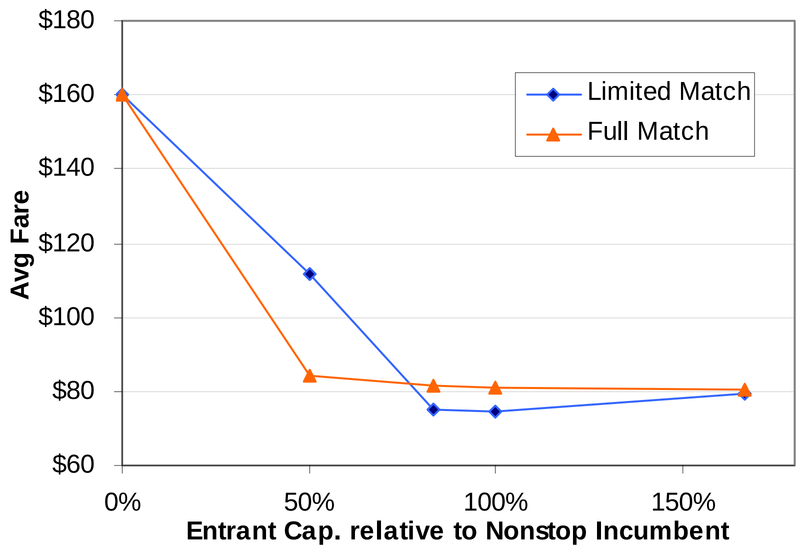

Figure 8: Incumbent carrier average fare as a function of the incumbent pricing response (single market case)

5.2. Traffic Increases and Revenue Decreases as Indicators of Aggressiveness of Response to Low-Fare Entry

The combination of the effects of low-fare entry on incumbent carrier traffic and revenues is often used as a means of identifying predatory responses to entry. For example, an increase in traffic accompanied by a decrease in local market traffic could be considered an unprofitable and potentially predatory response to entry. However, as shown in Figure 9, under assumptions of entry with a two-tier fare structure in the single market case, the full match response, while it is the response strategy which leads to an increase in incumbent carrier traffic (and a decrease in revenues), is also the response strategy which maximizes incumbent carrier revenues (among the simulated alternatives). The less aggressive limited match response does not allow the incumbent carrier to retain as much traffic in the local market, which affects its local market revenues. As a result, the combination of a decrease in incumbent carrier revenues and increase in traffic should not be used as an indication of predatory behavior.

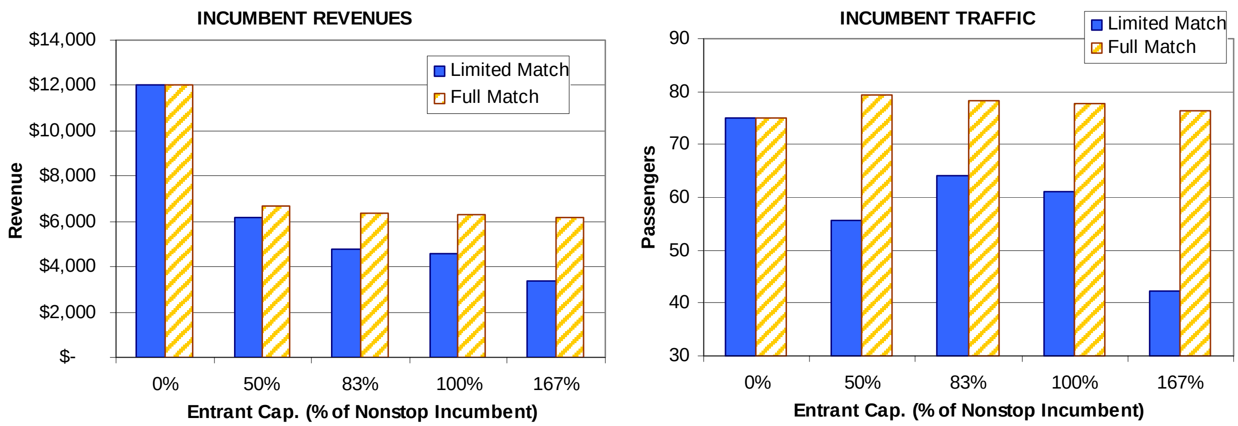

Figure 9: Incumbent carrier traffic and revenues as a function of its pricing response (single market case)

Our simulation results in a large network environment also show that network flows of passengers can lead to a greater decrease in local market revenues, but a lesser decrease in total network revenues (as highlighted in Figure 6). The trade-off between local and connecting passengers – through the use of revenue management – can lead to a greater decrease in local market revenues compared to total network revenues, thus further illustrating how revenues don’t provide information on the nature of the competitive response of incumbent carriers faced with low-fare competition.

In summary, the traditional indicators of potential predatory conduct, incumbent average fare relative to new entrant average fare, decrease in incumbent average fare and decrease in incumbent revenues, can be very misleading and potentially lead to erroneous conclusions regarding predatory conduct in the airline industry.

6. Conclusions

Our results clearly show that claims of predatory behavior in airline markets cannot be evaluated using traditional approaches to predation based on revenues and costs. Furthermore, revenue management and flows of network passengers add to the complexity of competition in airline markets and further blur the conclusions that might be drawn from the analysis of traditional measures of airline performance such as average fares, revenues or traffic.

Our results have shown that these measures provide little information regarding the performance of individual carriers, or the nature of their response to low-fare entry. In addition, changes in these measures after entry are affected by a combination of factors including entrant capacity relative to incumbent carrier capacity, pricing strategy of incumbent and entrant, competitive revenue management and flows of network passengers.

In particular, the effects of revenue management and flows of network passengers have traditionally been overlooked in previous research of low-fare entry and incumbent response, and should be accounted for when studying airline markets in general and the effects of entry in particular, as they significantly affect average fares, revenues and traffic, as previously discussed.

It is therefore crucial that evaluation of competitive responses to low-fare entry in airline markets take into account new entrant capacity, specific fare actions and entrant pricing strategy as well as the use of revenue management (or lack thereof) by some or all competitors.

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This research would not have been possible without the tremendous help and programming talent of Craig Hopperstad, who wrote the Passenger Origin Destination Simulator used in this research, and implemented the revenue management methods in the simulation environment. We also thank the Sloan Foundation for its generous support and funding of the MIT Global Airline Industry Program.

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