ASSESSING LOW-FARE ENTRY IN AIRLINE MARKETS: IMPACTS OF REVENUE MANAGEMENT AND NETWORK FLOWS

by

Thomas O. Gorin

S.M., Transportation, Massachusetts Institute of Technology, 2000
Ingénieur des Arts et Manufactures, Ecole Centrale Paris, 1999

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Signature of Author: ______________________________
Department of Aeronautics and Astronautics
Center for Transportation and Logistics
September 2, 2004

Certified by: ______________________________
Dr. Peter P. Belobaba
Principal Research Scientist
Department Aeronautics and Astronautics
Thesis Supervisor

Certified by: ______________________________
Dr. John-Paul B. Clarke
Associate Professor of Aeronautics and Astronautics

Certified by: ______________________________
Dr. Amedeo R. Odoni
Professor of Aeronautics and Astronautics and Civil and Environmental Engineering

Certified by: ______________________________
Dr. Nancy L. Rose
Professor of Economics

Accepted by: ______________________________
Dr. Nigel H. M. Wilson
Professor of Civil and Environmental Engineering
Chair, Transportation Education Committee

Accepted by: ______________________________
Dr. Jaime Peraire
Professor of Aeronautics and Astronautics
Chair, Committee on Graduate Students

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ABSTRACT

The recent growth of low-fare, low-cost carriers has changed the competitive airline environment. In the US alone, low-fare carrier market shares have increased from just over 5% in 1990 to almost 25% in 2003. Traditional network carriers have consequently had to adjust to the changing competitive environment, which has led to cost reductions, fare structure simplifications and service adjustments. In addition, competitive responses of incumbent network carriers to low-fare entry have prompted concern regarding the potential for predatory practices in the airline industry.

Assessment of unfair competitive practices in airline markets has typically been based on the analysis of changes in aggregate measures, such as average fares, traffic and revenues. In this research, the effect of low-fare entry on incumbent network carriers is examined, with special focus on the impacts of entry on traditional measures of airline performance. An analysis of various markets with low-fare competition highlights the typical effects of low-fare entry on these traditional aggregate measures. In a thorough analysis of two specific cases, we show that these measures, although affected similarly by entry, were very poor predictors of the new entrant's success in these markets, and inadequate indicators of incumbent response. AirTran successfully entered the Atlanta-Orlando market, while Spirit failed to maintain its operations in the Detroit-Boston market. We highlight the differences between these two markets and explain why the performance of these two carriers was so different.

In a second part, a simulator of competitive airline networks – the Passenger Origin Destination Simulator – is used to model various scenarios of entry in a single market environment so as to determine the essential factors affecting traditional measures of airline performance following low-fare entry. Our simulation results show that these measures are greatly affected by the entrant's capacity relative to the

incumbent, by the incumbent carrier's competitive pricing response, and by the competitive revenue management situation. For example, average fares on the incumbent carrier can either increase or decrease following entry by a new competitor, depending on whether one or both airlines perform revenue management. In an extension of the simulations to a larger network environment, it is also shown that network flows of passengers affect the performance of all competitors, as measured by aggregate measures of performance. Furthermore, use of advanced network revenue management allows the incumbent carriers to rely on connecting passengers to mitigate the effect of entry on network revenues, but leads to amplified effects at the local market level.

Consequently, this research establishes that traditional aggregate measures of airline performance on their own do not constitute a reliable indication of the response of incumbent carriers, and provide even less information on their strategic intent, which is critical in identifying predation. This research also demonstrates the relationships between aggregate measures of performance and previously overlooked factors including relative entrant capacity, competitive pricing and revenue management, and flows of network passengers.

Thesis Committee:

Dr. Peter P. Belobaba, Principal Research Scientist
Department of Aeronautics and Astronautics, Committee Chairman

Dr. John-Paul B. Clarke, Associate Professor of Aeronautics and Astronautics

Dr. Amedeo R. Odoni, Professor of Aeronautics and Astronautics and Civil and Environmental Engineering

Dr. Nancy L. Rose, Professor of Economics

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I dedicate this thesis to my parents, whom I am proud to join as a doctor.

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CHAPTER 1

INTRODUCTION

In 1978, the US airline industry was deregulated to increase competition among air carriers, and to open the industry to new entrant competition. In the mid-1980s, the European airline industry began its own deregulation. Today, the focus is on low-fare, low-cost carriers, whose growth throughout the 1990s has been dramatic. In the US, low-fare carrier market shares have increased from just over 5% in 1990 to almost 25% in 2003. In Europe, Asia and Australia, low-fare carriers are blossoming.

In this context, 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, cost reductions, fleet rationalization and increased partnerships between traditional airlines. Competitive responses to low-fare entry can also be quite dramatic and have spurred concerns and comments regarding the existence of predatory behavior by researchers and airlines alike.

In this research, the effect of low-fare entry on incumbent network carriers is examined, with special focus on the impacts of entry on traditional measures of airline performance. The results illustrate how important it is to consider the effects of revenue management, network flows and competitive response to entry when explaining changes in average fares, revenues and other measures of airline performance. The results also call attention to the inappropriateness of aggregate measures of airline performance in assessing the nature of the response to entry by incumbent network carriers.

1.1. Overview of Changes in the Airline Industry since Deregulation

In October 1978, the Airline Deregulation Act allowed airlines to compete freely in the US domestic air transportation market. Individual carriers were given the right to choose where they would fly, how often and at what price. As a result, deregulation led to numerous changes in the airline industry's structure:

Among the more noticeable changes, hub and spoke networks, and new pricing and marketing policies were born. Many research studies show that one of the primary consequences of deregulation has been a substantial decrease in average fares (References). Other studies have raised concerns of increases in fares in markets where network carriers have a dominant position (US DOT, 2001; Kaplan, 1995).

Another consequence of deregulation has been a wave of new entry and failure of previously regulated carriers. Kaplan (1995) reports that, of the 19 jet operators formerly regulated by the Civil Aeronautics Board (CAB), only 7 survived until 1995. The most famous survivor, Southwest Airlines (created in 1971), remains a prosperous carrier today. Even more remarkably, it has been profitable almost every quarter since its creation and for 31 consecutive years (Air Transport World), in an industry where profitability is extremely volatile and cyclical: $5B net profit in 1997 compared to $8B net losses in 2001 (Hansman, 2003). At the same time, new entrants emerged and failed very quickly. For example, as will be discussed in Chapter 2, in 1981 alone, 13 new airlines were created, while 28 ceased operations.

Since the early 1990s, a new kind of airline has played an increasing role in the US airline industry. Low-fare, low-cost carriers have substantially increased their presence in the US domestic market, and now carry over 25% of total domestic US traffic (Hazel, 2003). Low-fare carrier presence has been expanding since 1998 when network carrier profitability initially started to decrease. After major network carriers drastically reduced their capacity (post 9/11/2001), low-fare, low-cost carriers further continued their expansion. On the east coast, JetBlue started operating in early 2000 from New York to Florida and southern California; Air Tran began its operations in 1994 out of Orlando and merged in 1997 with ValuJet's operation out of Atlanta. In the central United States, Midwest Express and ATA operate out of Chicago/Milwaukee, while Spirit operates out of Detroit. Frontier operates out of Denver, and JetBlue is expanding its presence on the West Coast, and in Denver. Southwest has a national presence in the United States, mostly in secondary airports. Other smaller low-fare carriers also operate in other regions of the United States.

The growth of low-fare carriers in the US has led to a number of responses from established US carriers, ranging from matching low-fare carriers' fares in competitive markets to offering bonus miles and free flights. These responses to entry consequently raised the question of unfair and predatory competition, as we discuss in subsequent chapters. In this context, regulatory bodies in the US (US DOT) and in Canada (Competition Tribunal) have suggested a need for regulation in order to ensure fair competition. In addition, a number of legal actions were undertaken in North America to determine whether incumbent network carriers were competing unfairly against low-fare competitors. For example, in the US, American Airlines was criticized by a number of its low-fare competitors, and subsequently sued by the US

Department of Justice (2001), while the Competition Tribunal in Canada attempted to determine whether Air Canada competed unfairly against CanJet (2000) and WestJet (2001).

As the situation evolves in North America, the recent deregulation of aviation markets in Europe has led to similar consequences: New entrant carriers proliferate and incumbent network carriers retaliate (i.e. respond to entry with comparable strategies as their North American counterparts). Burghouwt (2003) and ICAO (2003) provide a good discussion and description of the history and effects of European deregulation on aviation markets. Among the more successful low-fare carriers in Europe are EasyJet, Ryanair and Virgin Express. In this context, European regulators have also questioned the fairness of incumbent responses, as evidenced by the ruling of the German Federal Cartel Office, which imposed a €35 premium on Lufthansa's lowest one-way fares between Frankfurt and Berlin relative to that of its low-fare competitors (Bundeskartellamt, 2002).

The growth of low-fare carriers is not limited to North America and Europe. Asia and Australia are also currently experiencing the birth and growth of low-fare carriers. This increased competition by low-fare carriers all over the world has spurred a number of research efforts on the effect of low-fare entry in airline markets (c.f. Chapter 3).

In this research, we focus on identifying the major drivers of airline performance in the face of low-fare entry and illustrate the pitfalls associated with using aggregate measures to assess the nature of a response by incumbent carriers. Such aggregate measures include average fares, revenues and market share. As we will show, these measures are influenced by additional factors that make them inappropriate indicators of response to entry.

1.2. Research Objectives

Our goals are twofold. First, after providing essential definitions of low-fare entry and predatory practices in the airline industry, we highlight the inappropriateness of aggregate measure of airline performance in assessing the nature of a response to entry by incumbent network carriers. Second, given the inadequacy of these measures, we determine the important factors that affect such aggregate measures, and explain the impacts of these factors on these aggregate measures, through the use of simulation.

As we will discuss in the literature review, it is often the case that regulatory agencies and researchers focus on aggregate measures of airline performance to determine the nature of a competitive response to entry. While some researchers recognize the difficulties and pitfalls associated with such conclusions, the lack of available disaggregate data, as well as the availability of aggregate data, often leads to the use measures such as average fares, market shares, and passenger traffic to evaluate the nature of a response to entry. This research will show, by using case studies and simulation, that these aggregate measures are in fact very poor indicators of the competitive situation. For example, we show in Chapter 4 that two apparently comparable markets with respect to these aggregate measures, led to opposite competitive outcomes for the low-fare carriers competing against two different network carriers.

Having illustrated the inappropriateness of these aggregate measures of airline performance, we explain which important factors affect these measures through the use of simulation. We identify relative competitor capacity, competitive revenue management capabilities and the flow of network passengers as major factors leading to various changes in aggregate measures of airline performance. In particular, we note that average fares, perhaps the most commonly used measure to assess the nature of a competitive response, tend to be most affected by these factors. As a result, if average fares are the most sensitive to the previously identified factors, they undoubtedly should not be used as the primary measure in evaluating the nature of a competitive response.

Another important finding of this research is the importance of revenue management under low-fare entry. It is often assumed that incumbent carriers engage only in pricing, capacity and marketing responses to entry. This research shows that even with no such response, the mere use of revenue management can lead to very different results from cases without revenue management. Furthermore, in a network environment, network revenue management also has a very distinct impact on individual airline performance as compared to leg-based revenue management.

1.3. Structure of the Thesis

The thesis is divided into three distinct parts. In the first part, we provide background information regarding the motivation of the research and the context in which it is set. In particular, we supply a brief history of the US airline industry and how it was affected by deregulation. We focus the discussion on the effect deregulation had on the growth of new entrant carriers in general, and follow this discussion with a description of the low-fare carrier business model (Chapter 2). Although this discussion tends to center on the US experience, the low-fare business model also applies to worldwide low-fare new entrant carriers. In this first part, we also discuss the concerns of government agencies with respect to unfair competition practices in the airline industry. Finally, we provide a discussion of existing literature on the topics of predatory practices and unfair competition, low-fare entry and revenue management in the airline industry (Chapter 3).

In the second part of the thesis (Chapter 4), we use case studies to identify important factors affecting new entrant and incumbent carrier performance. We first describe the results of general surveys with respect to individual airline performance before and after low-fare entry as evidenced by aggregate measures of performance. We then single out two specific markets (Atlanta-Orlando and Detroit-Boston) and provide an in-depth analysis of the effects of entry. We conclude by observing that aggregate measures of airline performance (as measured by average fares, market share or revenues) do not provide a complete picture of the competitive response of incumbent carriers. We also highlight a set of important factors which help to explain differences in aggregate measures of performance. These factors are relative competitor capacity, competitive revenue management settings and network flows of passengers.

In the third part of the thesis, we use the Passenger Origin Destination Simulator (PODS) to study the individual and joint effect of previously identified factors on individual carrier performance under the assumption of low-fare entry. We first simulate entry in a single market environment (to eliminate network flow effects) under various pricing conditions for the new entrant carrier. The incumbent carriers respond to entry by either matching the new entrant carrier's lowest fare only – which we refer to as a limited match response – or by completely matching the new entrant carrier's fare structure – which we refer to as a full match response. In this single market environment, we first focus in Chapter 5 on the effect of relative competitor capacity. In Chapter 6, we add revenue management, and study the effect of revenue management and relative competitor capacity on individual carrier performance. We then extend the results to a large network environment (Chapter 7) in order to capture the combined effect of network flows of passengers with relative competitor capacity and revenue management on individual carrier performance. Results support the observation that aggregate measures of airline performance are highly dependent on these individual factors and should therefore not be used to explain the response of incumbent carriers to entry. Results also show the impact of each of these individual factors on individual carrier performance as well as the joint effect of these factors.

CHAPTER 2

CONTEXT AND MOTIVATION OF THE RESEARCH

New entrant carriers have been the focus of much attention in the recent past as more and more airlines are created, often with the goal of providing low-fare competition to established carriers. The shift in the strategy of new entrant carriers in the 1990's – from niche carriers in underserved markets to low-fare carriers directly challenging the dominance of network carriers – has changed the competitive environment and the way new entrant carriers are perceived by their competitors: Low-fare new entrant carriers are now considered a threat to network carrier profitability.

In this chapter, we discuss the evolution of low-fare new entrant carriers and the ensuing concerns with predatory practices, as motivation to the research and upcoming case studies and simulations. We first provide a definition of low-fare new entrant carriers and discuss the history and evolution of new entrants in the U.S. airline industry. We give a brief chronological account of changes in the airline industry followed by a discussion of the situation as it is today. We highlight the importance the low-fare business model in the airline industry today and provide a comparison of the traditional model of airlines, as exemplified by U.S. Majors[1] and international flag carriers, to this more novel business model introduced by low-fare new entrant carriers all over the world. We then explore the impact that these carriers have had on the airline industry and, finally, we discuss the concerns of low-fare carriers and government agencies alike, with respect to unfair competition and predatory response to entry.

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[1] Majors are defined by the Department of Transportation as those airlines with annual operating revenues of over $1,000,000,000.

2.1. Low-Fare New Entrants: A Definition

Most research studies usually fail to define the term new entrant airline. The wording of these studies implies that any airline that does not qualify as a "US Major" is a new entrant carrier. Some studies even go as far as to implicitly equate new entrants to low-fare or low-cost carriers and vice-versa. In the next few paragraphs, we attempt to set a stricter definition of the term, without restricting the scope of our study. We first define the concept of a new entrant carrier, and then that of a low-fare new entrant carrier.

2.1.1. New Entrants

The notion of "new entry" literally requires us to distinguish two types of entry: (1) entry into the airline industry as whole, and (2) entry into a specific market.

Therefore, according to the first type of entry, any airline starting operations should qualify as a new entrant airline. We will refer to this type of entrant as an industry new entrant. Naturally, "new entrant" is often equated with "small". A new entrant airline, by our first definition, is a small carrier having recently started operations in the airline industry. Unsurprisingly, size matters in the airline industry, and a large established carrier will therefore benefit from economies of scale and will not be overly susceptible to entry in any single market. A new entrant on the other hand will be more likely to suffer from intense competition in any one of the few markets it serves. Becoming an established carrier is therefore related to the size of the airline, which can be measured in terms of fleet, network size or passenger traffic.

A new entrant can also be an airline that offers service in a market that it did not previously serve. We will refer to this type of entrant as a market new entrant. Note that an established carrier – such as a US Major – could qualify as a market new entrant. Another observation is that any industry new entrant will necessarily be a market new entrant in any market it serves. Once again, determining when this carrier ceases to qualify as an entrant is critical. In this type of entry, while market share and size of the airline will undoubtedly play an important role in the success of entry, it should not be the only determinant of the market new entrant status. It therefore seems relevant to limit the length of time during which a carrier is considered a market new entrant.

The confusion between new entrant carriers and low-fare, low-cost airlines is an easy one to make in that industry new entrants today are in majority low-fare, low-cost airlines. Market new entrants, on the other hand, can be established network carriers, or low-fare, low-cost carriers. In the remainder of the thesis, we focus on new entrant carriers in general: whether they are industry or market new entrants will be somewhat irrelevant to the research presented here, although the general assumption will be that the carriers modeled are market new entrants, operating according to the low-fare carrier business model, as described in Sections 2.1.2 and 2.3.

2.1.2. Low-Fare New Entrants

Low-fare new entrants are simply industry or market new entrants that provide service at substantially lower fares than incumbent network carriers did (or still do) post-entry. For example, numerous studies focus on the "Southwest Effect" (Hallowell and Heskett, 1993; Bennett and Craun, 1993; US DOT, 2001) and conclude that, as a general rule, when Southwest Airlines enters a new route, average fares decrease by approximately fifty percent, while traffic at least doubles. In Section 2.2, we expand the discussion on entry in the US airline industry since deregulation as well as low-fare entry since 1990.

In his 2004 thesis, Dietlin (2004) argues that fares in the airline industry are market driven rather than cost driven. Fares in the airline industry are based on origin-destination markets, rather on the cost of providing the service, which depends on the various routings offered by the airline. As a result, Dietlin argues that the notion of low-fare carrier is inappropriate since all carriers can arbitrarily price at low fare levels to match their competition, independently of their cost structure. While it is true that fares are in part market driven in the airline industry, it is also the case that only low-cost carriers can afford to price below existing steady-state fare levels and maintain a sustainable operation. In this respect, and since costs will not be taken into account in this thesis, we refer to low-fare airlines with the implication that the fares are lower because their costs allow for such low-fares.

The notion of low-fare entry is relative to pre-entry fare structure. Therefore, when referring to low-fare entrants, we will use the following guidelines. A carrier will be deemed a low-fare carrier if its fare structure undercuts that of the incumbent carriers previously operating in the market. We can arbitrarily set the minimum level of undercutting deemed admissible to meet the "low-fare" requirements to thirty percent below pre-entry unrestricted fare levels. Another possible measure of fare level could also be the average fare[2] on the new entrant carrier as compared to the incumbent carrier's pre-entry average fare. However, as this thesis is set to demonstrate, average fares (and other similar measures) are a limited indicator of a carrier's pricing structure, as they reflect a number of additional competitive effects that

[2] Airlines routinely offer multiple fares within any particular origin-destination market in an attempt to price discriminate. One measure of the fare paid by passengers in a particular market is therefore the average fare in the market on a particular airline.

also influence the carriers' average fares (including, but not limited to, revenue management, relative competitor's capacity, frequency, etc.).

2.2. The Airline Industry after Deregulation: The Birth of Low-Fare Carriers

2.2.1. New Entrants since U.S. Deregulation in 1978

Before 1978, the Civil Aeronautics Board (CAB) determined the routes each airline flew and the prices they should charge in each market. The Airline Deregulation Act, approved by Congress on October 24, 1978, and signed into law four days later by President Jimmy Carter, put an end to the era of regulation.

Deregulation brought many changes to the airline industry: The most notable changes were the growth of the "hub and spoke" networks, increased competition, reduction in fares, growth in air travel and of course new entrant carriers (Kaplan, 1995).

In 1978, the CAB reported 37 "certificated route air carriers" in its Air Carrier Financial Statistics publication (Air carrier financial statistics; Accounting, Cost and Statistics Division, Bureau of Accounts and Statistics, Civil Aeronautics Board). By 1979, the CAB reported 54 such carriers: of these 54 carriers, 17 were new entrant carriers, while the 37 pre-deregulation carriers remained.

In 1982, the CAB introduced a classification of Certificated Air Carriers into four distinct groups:

1. Majors, whose annual revenues exceed one billion dollars
2. Nationals, whose annual revenues range between $75 million and $1 billion
3. Large regionals, whose annual revenues range between $10 million and $75 million and
4. Medium regionals, whose annual revenues are below $10 million

Note that the $75 million threshold set in 1982 by the CAB was increased to $100 million in 1984. In addition, the Bureau of Transportation Statistics (Employees Certificated Carriers Database, Office of Airline Information) also provides an a posteriori breakdown of carriers (including cargo airlines) according to the CAB classification from 1978 on – even though this classification was only implemented in 1982.

Table 2.1 shows the evolution of the total number of carriers in the US as well as the breakdown by group from 1978 on. The total number of carriers quickly increased in the early 1980's as a number of new entrant carriers started operations. As shown in Figure 2.1, in 1979 alone, there were 17 new entrant carriers, compared to a total of 37 carriers listed in 1978, that is, over thirty percent of the carriers flying in 1979 were new entrant carriers. The total number of carriers kept increasing until 1981 when it started to level off. The number of airlines increased from 37 in 1978 to 78 in 1981, which represents a 111% increase within three years of deregulation.

Focusing on individual groups, we observe that in 1978 the CAB referenced 14 majors, 11 nationals, 6 large regionals and 6 medium regionals. By 1981, the number of majors remained constant, while the number of nationals had increased to 20, the number of large regionals to 9, and the number of medium regionals to 35, bringing the total number of carriers up from 37 to 78. Table 2.1 highlights the volatility of the numbers within each group, and shows that the greatest variations occur mostly within the category of regional carriers (medium or large).

	CARRIER TYPE				
YEAR	**Major**	**National**	**Large Regional**	**Medium Regional**	**TOTAL**
1978	14	11	6	6	**37**
1979	14	15	7	18	**54**
1980	14	18	10	24	**66**
1981	14	20	9	35	**78**
1982	11	16	15	22	**64**
1983	11	15	20	23	**69**
1984	13	14	30	17	**74**
1985	13	14	26	18	**71**
1986	13	17	27	17	**74**
1987	12	12	24	16	**64**
1988	12	12	25	18	**67**
1989	10	17	21	17	**65**
1990	12	15	19	13	**59**
1991	10	15	21	10	**56**
1992	10	16	19	20	**65**
1993	11	16	21	25	**73**
1994	11	23	23	23	**80**
1995	11	24	28	23	**86**
1996	12	24	23	24	**83**
1997	13	24	21	17	**75**
1998	13	24	21	19	**77**
1999	13	24	18	20	**75**
2000	14	24	13	16	**67**

Table 2.1: Civil Aeronautics Board & Bureau of Transportation Statistics – Certified Route Air Carrier

Figure 2.1 shows the evolution of the number of actual new entrants, exits and total airlines from 1979 on. This number reflects the variation in the total number of carriers from one year to the next. Figure 2.1 illustrates that there were many new entrant airlines immediately after deregulation until the mid 1980's when fewer carriers entered the US airline industry. In the early 1990's, the number of entries increased again to finally stabilize between five and fifteen per year. The number of carriers exiting the market follows a somewhat similar pattern with a spike in total number of exits in 1981, probably due to the increase in oil prices in the late 1970's followed by the 1981-82 recession of the US economy. Overall, entries and exits consistently represent about 15-20% of total airlines.

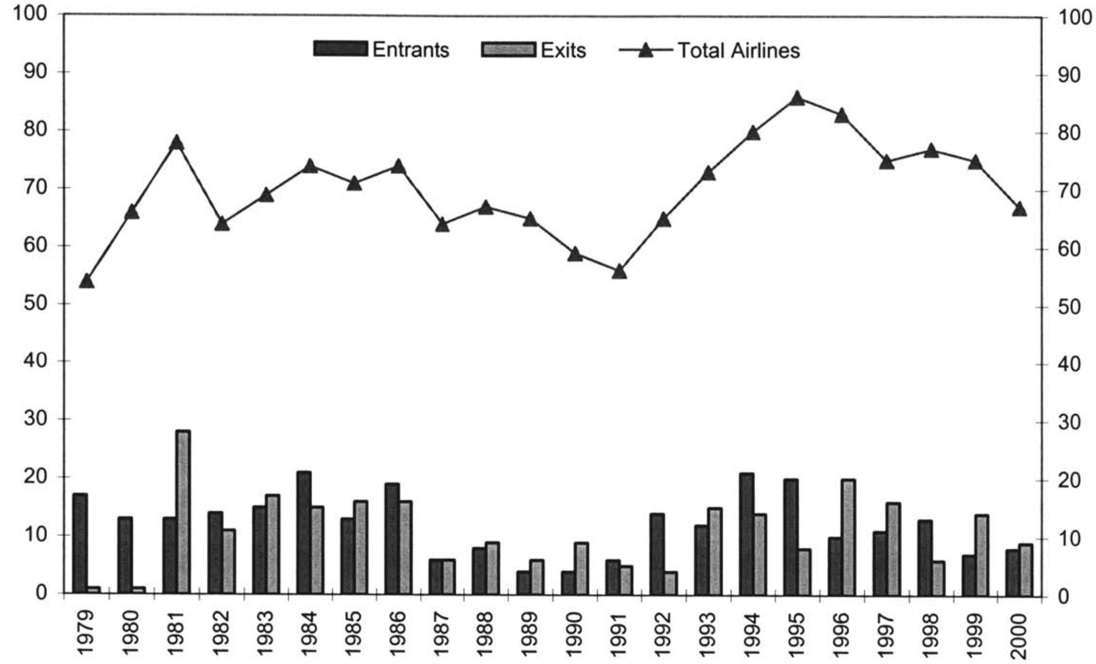

Figure 2.1: Annual entering, exiting and total carriers in the U.S. airline industry post-deregulation (Source: Civil Aeronautics Board & Bureau of Transportation Statistics – Certified Route Air Carrier)

Figure 2.2 shows the cumulative number of entries and exits in the US airline industry and illustrates the continued renewal of the airline industry, with over 250 carriers starting operations between 1979 and 2000, and almost as many discontinuing operations in the same time period. Altogether, there were more cumulative new entrants than exits. Figure 2.2 highlights the number of entries increased consistently until 1986, after which it leveled off until 1992 when this number started increasing again.

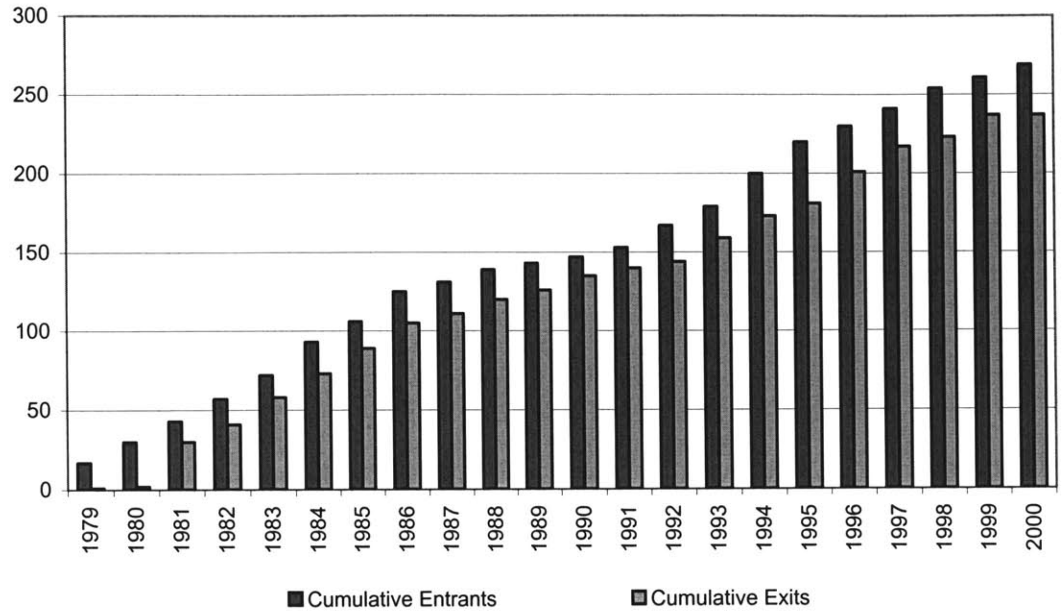

Figure 2.2: Cumulative number of entrants and exits since 1979 (Source: Bureau of Transportation Statistics, Office of Airline Information)

It is interesting to note that although one would expect new entrant carriers to start with small operations (falling under the category of "medium regional"), this is not necessarily the case. America West, for instance, began operating as a "large regional" in 1983. By 1986, America West became a national, and, finally, in 1990 reached the status of US major. JetBlue's 2000 revenues also immediately classified the airlines as a "national" carrier, and it remains a national, despite its 500% growth in revenues between 2000 and 2002. Conversely, AirTran followed a more classical pattern and started operations in 1994 as a medium regional, then became a large regional in 1997 and a national in 1998. Table 2.2 shows a sample of new entrants within each of the four categories created by the CAB and emphasizes the fact that most new entrants start operations as large or medium regionals, with a few notable exceptions such as JetBlue which started as a national carrier in 2000.

Among the major impacts of deregulation on the US airline industry, we noted the advent of hub-and-spoke networks, the decrease in average fares and the relative freedom of entry. This discussion emphasizes the impact of deregulation on entry, and highlights that while many new entrants did not survive very long, some of today's more successful airlines date back to post-deregulation. We gave the example of America West, which started as a large regional with three aircraft and became a major in 1990. Conversely, a number of established carriers also disappeared in the period between 1978 and 1990, for lack of profitability.

	1979	1980	1981	1982	1983	1984	1985
Nationals	Air California	Midway	American Trans Air	Texas Int'l		Braniff, Inc.	
	Air Florida	New York Air	Transtar				
	Pacific Southwest	People Express					
	Southwest						
Large Regionals	Empire	Alaska Int'l		Muse	Air Illinois	Air Atlanta	Britt
		Rosenbalm		Pacific East	America West	Aspen	Jet America
		Southern Air		Pacific Express	Hawaii Express	Buffalo	Markair
					Intl Air Service	Florida Express	Pilgrim
					Sunworld	Frontier Horizon	Ports of Call
						Horizon Air	South Pacific
						Key	
						Midwest Express	
						Pacific Interstate	
						Ryan	
						Tower	
Medium Regionals	Altair	Air North	Aeromech	American Int'l	Air Express	Aerial	Airlift
	Big Sky	American Eagle	Aerostar	Arista	All Star	Airmark	Atlantic Gulf
	Cochise	Cascade	Air Nevada	Arrow	Blue Bell	Flight Intl-Aerostar	Galaxy
	Colgan	Golden Gate	Air North/Nenana	Best	Challenge	Independent	Independent Air
	Golden West	Great American	Challenge	Emerald	Gulf Air Transport	Jet Charter	Jet East
	Imperial	Mid South	Elan	Global	Jet Fleet	Skystar	Rosenbalm
	Mackey	T-Bird	Guy America	Jet America	Mid-South	Total	Skybus
	Mississippi Valley		Midstate	Northeastern	Northern Air	Trans Air Link	
	NewAir		Sea Airmotive	Overseas	South Pacific	Trans International	
	Sky West		Sun Land	Peninsula	Sun Country		
	Southeast		Western Yukon				
	Swift Air						

Table 2.2: New entrant carriers 1979-1985 (Source: Bureau of Transportation Statistics, Employees Certificated Carriers Database, Office of Airline Information)

	1986	1987	1988	1989	1990	1991	1992	1993
Majors	Federal Express							
Nationals	Transtar		United Parcel	Horizon Trump			Emery	Atlantic Southeast
Large Regionals	Air America Emerald Evergreen Five Star Horizon Air Interstate Key Mid Pacific Northern Air Cargo Presidential Royal West Skyworld	Orion	Gulf IASCO Rich Westair	Kalita Northern	Executive	American Int'l Braniff Int'l Carnival Simmons Trans States	Reno Air	UFS Morris
Medium Regionals	Aeron Challenge Air Cargo Challenge Air Int'l Mcclain Millon	Amerijet Conner Express One Florida West MGM Grand	Air Transport Trans Continental Trans Intl		Casino Express North America Private Jet	Wilbur's	Airline of Americas Airmark Airline AV Atlantic Fine Airlines Int'l Cargo Express Kiwi Miami Air Patriot Ryan Sierra Spirit Airlines Worldwide	Atlas Air Capital Air Continental Micro Eagle Airlines Empire Omni Air Express Sierra Pacific Trans American Ultraair

Table 2.3: New entrant carriers 1986-1993 (Source: Bureau of Transportation Statistics, Employees Certificated Carriers Database, Office of Airline Information)

	1994	1995	1996	1997	1998	1999	2000
Nationals	Altantic Southeast	Continental Express		Atlantic Southeast	American Eagle	National	Jet Blue
	Business Express	Mesa		Reno	Challenge Air Cargo		Legend
	DHL Airways	Trans States					World Airways
	Trans State						
	USAIR Shuttle						
Large Regionals	Air South	Challenge	Gemini	Fine Airlines	Champion Air	Trans Continental	Expressnet
	Frontier	Fine	Pan Am	Mesaba	North American		
	North American	Sun Jet		Northern	Northern Air Cargo		
	Polar Air	Viscount		Northern American	Transmeridian		
	USAfrica	Western Pacific					
Medium Regionals	AirTran	Air 21	Falcon	Capital Cargo	Falcon	Accessair	Ameristar
	Capital Air Express	Custom Air	Jettrain	Lynden	Pro Air	Allegiant	Planet
	Kitty Hawk	Eastwind	Laker	Panagra	Reliant	Asia Pacific	Southern Air
	Midway	Nations	Pace	Sierra Pacific	Renown	Lorair	Sun World
	Ryan Int'l	Paradise	Prestige	Sky Trek	Sunworld	Southeast	
	Sierra	Renown	Sierra		Tradewinds		
	Sportsflight	Sierra Pacific	Sun Pacific		Winair		
	Trans American Chrtr	Tatonduk	Sun World				
	Trans Continental	Trans Meridian					
	ValuJet	Tri Star					
	Viscount Air	USA Jet					
		Vanguard					

Table 2.4: New entrant carriers 1994-2000 (Source: Bureau of Transportation Statistics, Employees Certificated Carriers Database, Office of Airline Information)

2.2.2. New Entrants Today

Since 1990, numerous new entrant carriers have started operations in the US airline industry, while a significant number of other new entrants were either absorbed by larger airlines or forced to cease operations for lack of profits. The better known of these new entrant carriers are, for example, Frontier, Spirit, Midway (bankrupt), JetBlue, Vanguard (bankrupt), AirTran, Pan Am, Reno Air and National (bankrupt). Table 2.3 and Table 2.4 list new entrants in the US Airline industry between 1986 and 2000, as reported by the Office of Airline Information. The wave of entry in the US airline industry has changed in nature from the decade following deregulation. Since the early 1990s, new entrant airlines have recognized the difficulty of competing with established network carriers and learned from the success of Southwest Airlines. As a result, new entrant carriers have since then focused on a different business model: the low-fare business model.

Table 2.5 shows a ranking of the top US domestic carriers as a function of their market share (expressed in Revenue-Passenger Miles, RPMs) during the fourth quarter of 2001. Among these airlines, low-fare carriers rank from largest to smallest as follows: Southwest, America West, ATA, JetBlue, AirTran, National, Spirit and Frontier (as also reported by Aviation Daily, 2002a). We note here that Southwest, while the largest low-fare carrier, produces less than fifty percent of the total RPMs[3] of United, but has about fifteen percent more enplanements than United (due to its much shorter haul operations). We also observe quite substantial differences between RPM rankings and enplanement rankings, be it overall, amongst traditional carriers or amongst low-fare carriers. For example, we noted the difference between Southwest and United. Similarly, Delta has about 30% more enplanements than United, but fewer RPMs. AirTran has about the same RPMs as JetBlue, but almost twice as many enplanements. As mentioned earlier, the difference between enplanements and RPMs is a consequence of the average distance flown by the airline (length of haul), since RPMs incorporate distance, whereas enplanements do not.

Based on Table 2.5's numbers, and focusing on the top 20 domestic US carriers, we observe that among the top 20 carriers, seven are low-fare carriers, which account for 15% of the top 20 carriers' RPMs and 20% of enplanements in the fourth quarter of 2001. At the end of 2003, low-fare carriers' share of domestic passengers reached 25% (Hazel, 2003) and was still growing.

[3] RPMs are Revenue Passenger Miles which measure the product of passengers and mileage flown. As such, RPMs are a measure of the airline's traffic.

AIRLINE	RPMs (000's)	ENPLANED PASSENGERS
United	23,680,752	15,389,335
American	22,089,489	16,733,074
Delta Air	20,443,957	20,191,717
Northwest	14,678,525	10,976,660
Continental	12,289,078	9,151,588
Southwest	10,771,113	17,186,354
US Airways	8,885,143	11,142,615
America West	4,022,802	4,134,650
Trans World	3,304,974	3,868,692
Alaska	2,726,362	3,014,471
American Trans Air	1,795,555	1,475,732
JetBlue	1,050,217	904,303
AirTran	1,016,512	1,853,398
Hawaiian Air	998,117	1,228,453
American Eagle	784,710	2,691,810
Comair	727,000	1,815,007
National	708,117	542,622
Atlantic Southeast	642,981	1,644,382
Spirit Air Lines	569,412	540,074
Frontier	533,816	621,932
Continental Micronesia	473,747	260,368
Midwest Express	436,570	472,343
Mesaba Aviation	348,599	1,243,105
Aloha	321,328	962,638
Air Wisconsin	314,633	1,023,229
Horizon Air	300,211	1,033,524
Sun Country	265,542	209,979
Vanguard	262,290	315,911
Trans States	110,119	395,191

Table 2.5: US airlines RPMs and passenger enplanements in Q4, 2001 (Source: Form 41 database)

2.3. The Low-Fare Carrier Business Model

The growing importance of low-fare carriers in the US domestic market, and in the rest of the world, warrants a more detailed discussion of the specifics of the low-fare carrier business model. Low-fare carriers started offering service even before deregulation in the U.S, as intra-state routes were not subject to federal regulations. Southwest Airlines started its operations in 1971 within Texas by flying two Boeing 737 aircraft between Dallas and Houston. As discussed earlier, low-fare new entrant carriers kept developing in the US, but, while Southwest had become a US Major by 1990, low-fare carriers accounted for less than 7% of US domestic air passengers in 1991, compared to 81% for US Majors (SH&E, 1993). However, the past decade has seen a tremendous growth in low-fare carrier traffic, which had increased to 18% of US domestic passengers by 2001 (Swelbar, 2002), and close to 25% by 2003 (Hazel, 2003).

In the following section, we present a comparison between low-fare and traditional carriers and provide some insights as to the strategic differences and the performance implications of these differences. We then briefly discuss the overall impact of low-fare carriers on the airline industry.

2.3.1. Comparison of Low-Fare and Traditional Network Carriers

New entrant carriers and traditional network carriers typically have different business models. The four major elements of the low-fare business model can be summarized as follows: (1) low-fares combined with low-frills service, (2) simplified distribution and passenger processing, (3) high aircraft utilization within a simplified fleet, and (4) high labor productivity. As we establish in the next few paragraphs, while there are some differences between the traditional and low-fare model, these mainly stem from the performance of operations of each type of carrier and not necessarily from structural differences between the two types of carriers. In particular, we briefly discuss pricing and its impact on network structure, distribution and marketing, fleet choice and assignment and employee relations, and how each is affected by and influences the low-fare business model.

Low-Fares, Low Frills and their Impact on Network Structure

Typical target markets for low-fare entry are "under-served and over-priced" short-haul markets. Swelbar (2003) notes that 88% of the markets served by low-fare carriers have a daily traffic greater than 100 passengers per day each way (PDEW), which represents 98% of their total traffic. The strategy of low-fare carriers is thus to offer service in parallel markets with high demand – where they are unlikely to prompt strong reactions from incumbent carriers – at lower fares and with limited service (e.g. no food or advance seat assignments). For instance, Southwest Airlines does not offer advance seat assignments, does not provide meals, and does not process inter-line connections of passengers or luggage with other airlines. Similarly, EasyJet does not sell connecting tickets and therefore does not guarantee connections that might have been built by the passengers.

Low-Fares

With respect to actual fares, low-fare carriers claim that they offer a simpler fare structure, which is more transparent to passengers and therefore more willingly accepted. While the simplicity of the fare structure is not always obvious, it appears that low-fare new entrants have fewer restrictions on their products (i.e. less price discrimination), with one substantial difference in the absence of the Saturday night stay on such carriers as EasyJet or Ryanair, and reduced change fees. The absence of such restrictions as minimum stay requirements or Saturday night stay stems from low-fare carriers' willingness to sell one-way tickets.

Obviously, low-fare carriers offer low fares that are substantially cheaper than most of those of traditional carriers. For example, the much-discussed "Southwest Effect" (Bennett and Craun, 1993; Hallowell and Heskett, 1993) usually contends that, upon entry in a market, average fares drop by at least 50% while traffic at least doubles. As we discuss later in the thesis, the decrease in average market fare can be a result of the decrease in actual fares offered in the market, but can also be a consequence of the increased capacity and demand stimulation in the market.

Low-Fare Carrier Network Structure

Although some low-fare carriers do not sell connecting tickets, numerous low-fare carriers do (e.g. ATA, AirTran, Spirit, JetBlue, Southwest, Frontier), therefore indicating that connections are often allowed. As a result, and unlike what is often assumed, low-fare carriers do not offer point-to-point[4] service only: Their service is often a hybrid of point-to-point and network strategies. Low-fare carriers generally offer relatively more point-to-point routes than traditional network carriers, but they also operate out of focus cities, many of which closely resemble hubs. Furthermore, when studying the route map of any low-fare carrier, it is quite clear that these carriers concentrate a substantial portion of their flights on their focus cities. The confusion on the nature of the service offered by low-fare carriers is one that originates with Southwest Airlines' initial service offerings. In its beginning, Southwest did not offer connecting service to its passengers, but only because of the legal hurdles it faced in its initial focus city (Dallas Love Field) that prevented it from operating flights outside of Texas and the three neighboring states and even to sell connections through Dallas.

The most important reason why low-fare airlines cannot operate strictly on a point-to-point basis resides partly in the fact that the allocation of aircraft resources is far more efficient in a hub-and-spoke network than in a point-to-point network. The number of flights necessary to fully serve all possible markets within a set of n cities, through a hub, is to have one flight in each direction from each spoke to the hub (properly timed to allow for connections), that is, 2n flights per day. Conversely, the point-to-point network requires n(n-1) flights for each market to be served.

[4] Point-to-point service refers to operating the airline in such a manner as to serve markets without requiring a connection through a hub and therefore providing more convenient service to travelers. The obvious downside of point-to-point service, as opposed to hub-and-spoke service, is the lack of traffic flow consolidation at the hub.

Without further discussing the characteristics of hub-and-spoke networks and point-to-point networks, let us list some of the more important advantages and pros and cons of each type of network, as detailed by Belobaba (Belobaba and Simpson, 1995):

- As mentioned previously, hub-and-spoke networks require fewer flights to serve the same number of markets as a point-to-point network.
- Hub-and-spoke networks allow airlines to consolidate multiple origin-destination markets on the same flights for higher load factors. This in turn allows airlines to serve smaller cities, which would otherwise not be served.
- The consolidation of traffic in hub-and-spoke networks also allows for more frequent service between cities.
- Point-to-point networks offer nonstop service, which is a more desirable service to travelers, but at a greater cost, and lesser frequency.
- With respect to robustness of the network, point-to-point networks are less likely to be impacted by disruptions as each market can be served individually and independently of other markets.

Overall, the hub-and-spoke network approach has undeniable economies of scale advantages and is usually adopted by medium and large airlines. As discussed previously, low-fare carriers do not operate a hub-and-spoke network per se, but their strategy is centered on focus cities where they can take advantage of these economies of scale. Given the route map of these carriers, most of these connections must be offered at the focus cities, which now even more closely resemble hubs.

Distribution, Marketing and Passenger Processing

Low-fare carriers take advantage of simplified distribution and marketing practices to reduce their costs per passenger. For instance, Southwest, Ryanair or EasyJet flights can only be booked through the airline's own reservation system (internet or telephone reservations) and are not available in traditional Computer Reservation Systems (CRS), thus bypassing the per-booking charges. Electronic ticketing further decreases booking costs.

In terms of quality of service, low-fare carriers advertise low-frills and therefore provide less on-board amenities than traditional carriers, do not offer pre-flight lounges, and rarely offer first class service.

However, other aspects of traditional and low-fare carriers' products are very similar. Both low-fare and traditional airlines offer frequent flyer programs, even though their marketing may be somewhat different. Traditional airlines offer mileage-based point accrual while low-fare airlines such as AirTran offer free flights after a number of paid flights, or points based on the distance traveled on such carriers as JetBlue. Altogether, the spirit of the programs is the same: Reward frequent travelers. With respect to redemption opportunities however, traditional network carriers generally offer more options than do low-fare carriers, through their more extensive network coverage (particularly internationally) and airline and other partners (hotels, car rental companies, etc.).

Fleet

Fleet may be the single biggest difference between low-fare new entrant carriers and traditional carriers. New entrants generally operate a single aircraft type or family of aircraft, thus taking advantage of the cost savings of "fleet commonality". With a single family of aircraft, all employees are qualified to work on every airplane in the fleet, hence reducing the cost of training and increasing the flexibility of workforce scheduling.

Traditional carriers, on the other hand, often rely on numerous aircraft types. To perform a more relevant comparison, one would have to exclude the international portion of traditional network carriers' operations. Even so, traditional carriers often operate many more aircraft types than new entrant carriers. Having realized the cost implications, traditional carriers are beginning to consolidate their fleets around aircraft families. Nonetheless, this remains a notable difference between low-fare carriers and traditional network airlines.

In addition, aircraft utilization[5] also differs between low-fare airlines and traditional network carriers. Typically, low-fare airlines achieve greater utilization. For example, Table 2.6 shows that JetBlue's aircraft utilization for 2000 was 12.0 hours per day, 11.6 hours per day in 2001 (and over 12.7 hours per day in 2002, according to JetBlue's 2002 annual report). In comparison, United's average daily utilization was only 10.5 and 10 hours per day in 2000 and 2001 respectively, despite a much longer stage length[6] (stage length should be positively correlated with utilization, as the longer the average flight, the less time the aircraft is expected to spend on the ground, and therefore the higher the utilization).

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[5] Aircraft Utilization: Average daily aircraft usage in terms of block-hours, i.e. from pushback to arrival at destination gate.

[6] Stage Length: Average distance flown between origin and destination (i.e. between one take-off and the following landing)

CARRIER		UTILIZATION 2000	UTILIZATION 2001	STAGE LENGTH 2000	STAGE LENGTH 2001
Traditional	American	10.0	9.7	1,164	1,179
	Alaska	10.8	10.4	789	797
	American Eagle	7.5	7.1	250	268
	Continental	10.5	10.3	1,154	1,178
	Delta	10.3	9.6	871	885
	Northwest	9.7	9.1	914	928
	TWA	10.4	9.9	869	844
	United	10.5	10.0	1,145	1,181
	US Airways	10.1	9.5	639	667
Low-Fare	America West	11.0	9.7	878	894
	ATA	9.5	9.7	1,061	1,208
	AirTran	10.7	9.9	534	539
	JetBlue	12.0	11.6	831	986
	Southwest	11.0	10.8	492	515

Table 2.6: Average daily aircraft utilization (Source: USDOT, T100 database – Form 41)

A more appropriate comparison of utilizations can be achieved by comparing utilization of a single aircraft type across carriers, as different aircraft types are used for different purposes and routes, thus distorting the comparison. For example, the technical design of the Boeing 767 as well as its size make it more suitable for longer haul operations, and, as such, will likely increase the average utilization of the fleet. In contrast, the Boeing 737 is typically used on much shorter flights, thus having a very different utilization than that of the 767. Table 2.7 shows the utilization rates of Boeing 737s used by Southwest and that of Airbus A320s used by JetBlue, compared to the utilization of these same aircraft on traditional network carriers. JetBlue has a higher utilization rate on its A320s than any of the traditional network carrier which also use this aircraft type, by as much as 2.5 hours per day compared to US Airways, or 21.4% higher relative utilization, irrespective of the average stage length which may be quite different for both carriers. These differences are even greater when compared to JetBlue's reported average utilizations of 12.6 hours and 12.9 hours in 2001 and 2000 respectively (JetBlue annual reports). Similarly, we can compare Southwest's utilization of 737-300/700s to Delta's utilization of the same aircraft on stage lengths of 544 and 531 miles respectively. As shown in Table 2.7, Delta's utilization was 8.53 and 8.36 hours per day in 2000 and 2001 respectively, compared to Southwest's 11.23 and 10.87 hours per day. Altogether, this represents a 24% and 23% higher utilization for each of these two years, in favor of Southwest Airlines.

	UTILIZATION				STAGE LENGTH			
A/C TYPE	737-300/700		A320		737-300/700		A320	
YEAR	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**
Continental	9.81	9.36			1,048	950		
Delta	8.53	8.36			559	553		
Northwest			10.70	10.02			1,011	1,035
United	10.07	9.29	11.45	10.39	640	647	1,405	1,313
US Airways	9.48	8.93	9.86	9.12	514	476	691	598
America West	10.05	8.41	12.23	10.95	637	591	1,205	1,154
ATA		10.03						
JetBlue			11.99	11.60			831	986
Southwest	11.23	10.87			526	499		

Table 2.7: Boeing 737 and Airbus A320 average daily utilization (Source: Form 41)

This higher utilization of aircraft by low-fare carriers is made possible by higher employee productivity (discussed in the next paragraph) which allows for quicker turnaround times, as exemplified by Southwest's average turn-around time of 20.3 minutes for continuing flights compared to American's 50.3 minutes in 1993 (SH&E, 2003). In addition, hub banking[7] also negatively affects traditional carriers' aircraft utilization.

Altogether, fleet commonality and utilization are a major difference between traditional carriers and low-fare airlines.

Employee Relations and Productivity

Without launching into an extended discussion of labor relations in the airline industry, let us mention here that the airlines have traditionally had poor labor relations. Recent contract negotiations between United Airlines and its pilots, for example, led to a "work-to-rule sick-out" in the middle of the summer of 2001. There are numerous such examples amongst traditional network carriers.

By comparison, low-fare carriers such as Southwest Airlines have better employee relations, which admittedly allow them to achieve higher performance, as explained by Gittell, Hansman and Dunning's (2000) report of their conversation with Southwest Airlines' top management team. In particular, Libby Sartain, Vice President, People at Southwest Airlines explains that Southwest is "*a work/family friendly place. ...It's very flexible in scheduling, for example. It's more of an attitude here than formal policies. We do not have flex time and other family programs officially, but there is a lot of flexibility for shift*

[7] Hub banking is the practice of timing incoming and outgoing flights at the hub in order to allow passengers to connect.

trading and such". Similarly, as described by Gittell and O'Reilly (2001), JetBlue also boasts better employee relationships, but in a slightly different way than Southwest: from the start, JetBlue centered its employee groups around five core values – safety, caring, integrity, fun and passion – while focusing on maintaining a union-free environment. However, the difference lies mostly in employee productivity rather than in unionization rates or wages. For example, 89% of Southwest Airlines' employees are unionized. In terms of wages, ramp agents at American Airlines and Southwest Airlines have similar base hourly wages (Gittell and Oliva, 2002).

The major difference in productivity stems from much more flexible work rules that allow cross-utilization of employees, whenever possible and legal. At Southwest, for example, pilots often help prepare the aircraft between flights while flight attendants clean the aircraft. At the same time, ground staff works hard to perform quick turnarounds of the aircraft. Altogether, these differences are reflected in aircraft operating costs per block hour, which are much lower for low-fare carriers. For example, Southwest's total operating costs per block hour on its 737-300/700s were $1738 for the first quarter of 2001, compared to $2995 at Delta for the same aircraft type. Looking at crew costs only, Southwest's costs are 55% lower than Delta's, at $365 compared to $805 per block hour on the 737-300.

Another usual indicator of employee productivity is available seat miles per employee (ASMs[8] per employee and per quarter). Once again, during the fourth quarter of 2001, Southwest's 542,050 or JetBlue's 649,750 ASMs per employee and quarter far exceeded United's 373,400 or American's 369,790, despite the larger aircraft and longer length of haul on the latter carriers. Compared to US Airways' more similar stage length and aircraft size, Southwest still produces 31% more ASMs per employee than US Airways' 413,380 (Aviation Daily, 2002b, 7/19/2002).

Overall, labor accounts for about 40% of total airline costs (US DOT, Form 41), and lower labor costs therefore are a critical advantage in favor of the low-fare carriers. For example, labor costs per available seat mile (ASM) were 3.61 cents at United and 3.66 cents at American, compared to 2.70 cents at Southwest in the fourth quarter of 2000, despite the larger aircraft and longer stage length of the two Majors. However, as explained by Still (2002), part of the cost advantage comes from productivity, but also from age and seniority levels, which will likely narrow the difference in cost structures in the near future. Recent press articles report an increase in Southwest Airlines' overall costs, including an increase in labor costs from 38% of total costs to 45% of total costs (USA Today, 3/2/2004).

[8] ASMs are Available Seat Miles and provide a measure of the airline's output.

Conclusion

Low-fare carriers and traditional network carriers are similar in terms of their network structure and pricing strategy (beyond route choice and actual fare values). The major difference between traditional network carriers and low-fare carriers therefore resides in the low-fare carriers' operations and cost structures, the latter of which being much lower than those of traditional carriers, as a result of their higher fleet utilization, fleet commonality, greater employee productivity and lower distribution costs. For example, Southwest's unit costs (cost per available seat mile or CASM) were 7.67 cents in the second quarter of 2001, or less than 53% of US Airways' unit costs on its domestic operations (14.57 cents).

In terms of operations, low-fare carriers operate pseudo hub-and-spoke networks with slight modifications in terms of availability of connections and inter-line agreements, and comparatively offer more non-stop point-to-point service than traditional network carriers.

According to Rollin King and Herb Kelleher, founders of Southwest Airlines, "*if you get your passengers to their destinations when they want to get there, on time, at the lowest possible fares, and make darn sure they have a good time doing it, people will fly your airline*". This business approach has proven very successful for Southwest, JetBlue and many other low-fare carriers all around the world.

2.3.2. Impact of Low-Fare Carriers

Upon entry of a low-fare carrier, it is often expected and documented that the average fare will drop by about 50% while traffic at least doubles (e.g. Bennett and Craun, 1993; Perry, 1995). Once the frequency of service on the new entrant becomes sufficient, the low-fare carrier becomes a viable alternative for both business and leisure traveler alike, particularly on short-haul routes where meals and better seating are not as important as on longer routes.

The impact of low-fare carriers has therefore been rather dramatic on traditional network carriers' operating profits. As shown in Figure 2.3, all the major traditional carriers experienced net losses starting late in 2000. While the losses can be attributed in part to the events of September 2001, there is growing evidence that the expansion of low-fare travel options combined with the decreasing willingness-to-pay of business travelers, has played a major role in this trend.

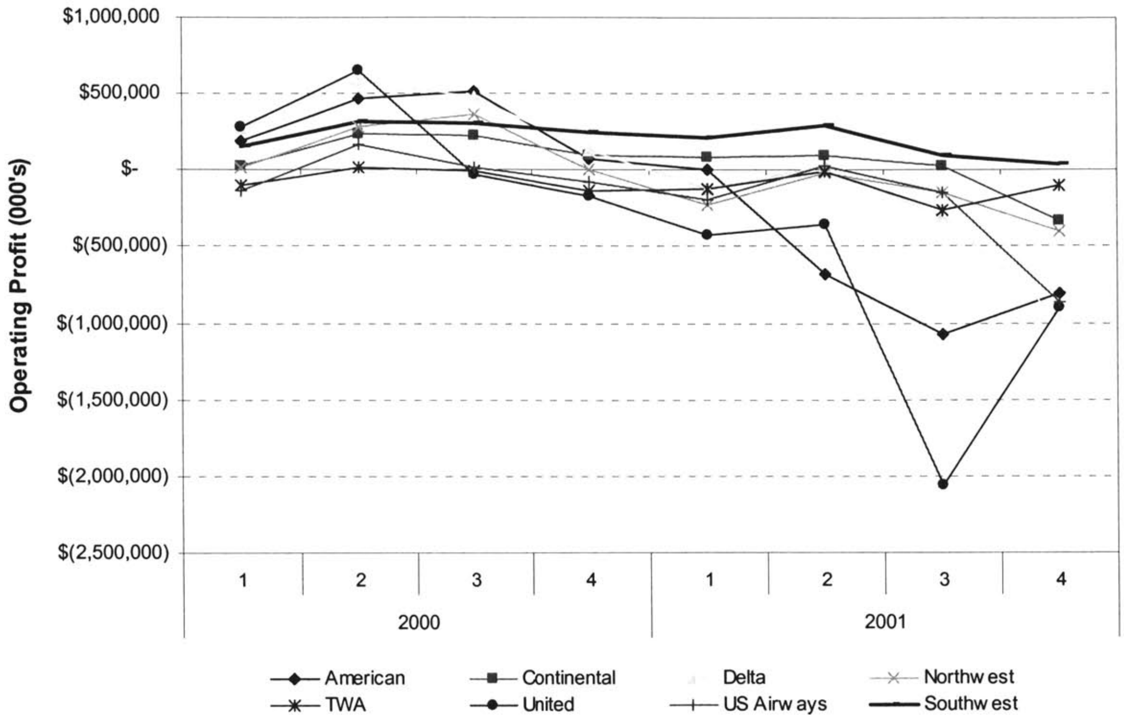


Figure 2.3: Airline operating profits in 2000 and 2001 (Source: Form 41 database)

Hazel (2003) shows that the combined low-fare carrier domestic US market share has been increasing since the early 1990s from 6% to almost 25% in 2003. Swelbar (2003) shows that the exposure of US Majors to low-fare competition has generally increased in all regions of the US by one to five percentage points since September 2001. At the carrier level, however, major network airlines have experienced variable exposure to low-fare competition. For example in August 2003, relative to September 2001, Delta's exposure to low-fare competition had increased by over 20%, while US Airways and Northwest Airlines' exposures had increased somewhat less (Swelbar, 2003). Comparatively, United, American and Continental's exposures had decreased between September 2001 and August 2003. Since then, JetBlue has expanded its service on the east coast, and as a result, American's exposure to low-fare competition has increased.

Other interesting effects of low-fare carriers include the decrease in domestic yields[9] in the US airline industry. While yields have been decreasing, low-fare carrier ASMs have increased, and the cost differential between low-fare and traditional network carriers has kept increasing (i.e. the cost advantage

[9] Yields are revenues per passenger and per mile and represent an indication of unit revenues. Another measure of unit revenues is RASM, or revenue per available seat and per mile, which provides a more appropriate comparison with CASM (cost per available seat and per mile)

of low-fare carriers has kept growing). Nonetheless, Swelbar estimates that the growth potential for low-fare carriers is not unlimited and is nearing its end. He estimates that another 1.6% market share can be gained by low-fare carriers, given the current US domestic market conditions.

2.4. Predatory Behavior: Concerns Expressed by Governmental Agencies and New Entrant Carriers

Altogether, operating an airline, let alone a small airline, has proven to be a very uncertain and challenging business. Numerous new entrant carriers have gone bankrupt or have been acquired by larger airlines in the past (People Express, Shuttle America, Midway, etc.). Yet, new airlines are still created, as was JetBlue, which started operating in early 2000, or Virgin USA, which is expected to being operating soon.

The creation and failure of new entrant airlines and the dominance of network carriers have led the U.S. and Canadian governments, and the European Union, to worry about the problems of predatory practices and pricing, which are a subset of deeper concerns that we discuss in the next sections. We start by defining predation in general and its relevance to the airline industry.

2.4.1. Predatory Practices: Definition

While predatory pricing might be considered a simple concept, and described as such by a number of authors, Spector (2001) argues in his 2001 article that there has been no unifying definition of predatory pricing used in the literature. He therefore proposes to "clarify some of the most fundamental questions regarding the issue of predatory pricing", namely "the definition itself…" In particular, Spector mentions three definitions of predatory pricing that mistakenly have been assumed to be the same definition:

1. An action is predatory if it is not the most profitable action unless its effects on other firms' entry or exit decisions are taken into account
2. An action is predatory if (1) is satisfied AND if the ability to later reverse the action which caused the other firms to exit or not to enter, i.e. the ability to raise prices or decrease output, is necessary to make the action profitable
3. An action is predatory if it induces the exclusion or prevents the entry of an equally efficient or more efficient rival.

Spector concludes, with the help of a simple model and the application of legal theory, that these three definitions are not equivalent and that the second definition constitutes the "best" definition of predatory pricing.

The Organisation for Economic Co-operation and Development (OECD) also provides a definition of predatory pricing as a "*straightforward theory*" (OECD, 1989). This definition coincides relatively well with that of Spector but further details the mechanics of predatory pricing: "*The predator, already a dominant firm, sets its prices so low for a sufficient period of time that its competitors leave the market and others are deterred from entering*". Under the assumption that both firms are equally efficient, this strategy implies not only that all firms will suffer substantial losses but more importantly that the predator has some means of surviving longer than its victim. Such means include availability of cash reserves or cross-subsidization from other markets or products. Furthermore, for this strategy to be viable, the predator must have some expectation of recovering its losses through future gains and exploitable market power.

In addition, this publication rightly observes that predation occurs not only through predatory pricing, but also by means of "non-price predation". The airline industry provides a good example of an industry where non-price predation can occur: Airlines have developed frequent flyer programs as an incentive for customers to stay loyal to one (or a few) airline(s), based on their travel habits, the network reach, capacity and frequency of service of their airline of interest. We further detail the research efforts undertaken to define and refine the notions of price and non-price predation in the literature review (Chapter 3).

2.4.2. Regulatory Agencies' Concern over Predatory Behavior in Airline Markets

One of the concerns of the US DOT (and of other regulatory agencies all over the world) is that traditional network carriers use their dominance to force new entrant carriers out of markets. For example, Spirit has complained about Northwest increasing its frequencies and lowering its fares in response to entry in such markets as Detroit to Boston or Detroit to Philadelphia. In Europe, the Federal Cartel Office of Germany (Bundeskartellamt, 2002) issued an injunction against Lufthansa's "pricing measures" in the Berlin-Frankfurt route, in January 2002. The Cartel Office contended that Lufthansa's lowest fares were too low in regards with Germania Airlines' own fares and demanded that they be raised to 35 euros above the price charged by Germania instead of the previous five euros. According to the Cartel Office, this injunction was "warranted by Lufthansa's product advantages such as inflight service, its frequent flyer program and its greater flight frequency on the route". The Cartel Office thus relies on the potential for non-price predation as justification for the decision. Despite an appeal from Lufthansa, this ruling was upheld in April 2002.

2.4.3. Disadvantages of the lack of competition to travelers

Given the assumption that traditional network carriers are able to force new entrants out of airline markets, a report by the US DOT (2001) determined that the average fare paid by travelers was, on average, 54% higher for passengers traveling in a market where no low-fare competition was available. By this report, the DOT acknowledges the importance of low-fare new entrant carriers in the airline industry.

In another study, Windle and Dresner (1995) discuss the impact of entry of a new entrant airline on average fares in a specific market, and focus on the differences between entry by a smaller, low-fare carrier and by a major network carrier. The study also looks at long run fares: Are the low fares maintained? The study concludes that low fare carriers have a greater impact on average fares than lack of concentration: Having low-fare competition in a market reduces the average fares more than having extensive competition. In addition, the study shows that new entrant carriers tend to maintain their low prices beyond the first year after entry.

Thus, the major concern of new entrant carriers and government agencies alike is that the major traditional network carriers unfairly compete against low-fare new entrants, which in turn negatively impacts the consumers of air travel.

2.5. Conclusion

The US airline industry has changed dramatically since 1990. A new low-fare business model has emerged and proven to be quite successful and durable, when applied to a subset of the air transportation markets. While the model's success depends upon these airlines' ability to lower costs and increase employee productivity (relative to that of traditional network carriers), it does not appear to be a viable replacement for traditional network carriers altogether. The mere fact that low-fare new entrant carriers choose not to enter small markets where traditional network carriers can take advantage of the consolidation of network flows at hub locations shows that low-fare carriers could not profitably meet the global needs for air transportation. With respect to the difference between the two business models exemplified by each type of carrier, we contend that the distinction is not so much in the network structure and operation of the airline as in the lower cost structure created by the increased productivity of employees and better utilization of capital equipment (e.g. aircraft).

Nonetheless, the threat posed by low-fare carriers has led to various responses to entry by network carriers, that in turn raised the awareness of government agencies and low-fare carriers alike. Even as these low-fare carriers continue to grow in the domestic US air transportation market (and all over the world), the extent to which a competitive response is perceived to be "unfair" or even predatory remains of critical importance.

CHAPTER 3

LITERATURE REVIEW

In this chapter, we review the existing research in three separate areas of interest that relate to this research: (1) Predatory practices in the general economic sense, (2) Predatory practices as applied to the airline industry, and (3) Revenue Management.

The notion of predatory pricing and predatory practices occupies an important place in the motivation of this research. The fear of unfair competition and the desire for a healthy competitive environment have been at the heart of the debate regarding low-fare entry, between traditional network airlines and low-fare new entrant carriers, government agencies and network carriers, and government agencies and low-fare carriers. Our discussion of predatory practices focuses on the fundamental economic concepts and rules devised by researchers to test for predatory pricing.

The brief introduction to Revenue Management practices in the airline industry presented later in this chapter provides the basic theory needed to understand the simulation scenarios as discussed in Chapters 5 through 7. This discussion also serves as a preliminary indication of the importance of Revenue Management effects on average fares, passenger traffic and revenues, and other aggregate measures of airline performance.

3.1. Economic Basis for Predation

Early research efforts regarding predatory conduct focused on economic relationships between revenues and costs. According to economic theory, there numerous competitive situations, of which four are of particular interest for this discussion: Monopolies, where a single firm serves the market for a product and has no competition; Duopolies, when two firms compete in a market; Oligopolies, when a small number of firms compete, and, perfect competition. Pindyck and Rubinfeld (2001) explain the basics of microeconomics, and the assumptions upon which the above-mentioned competitive situations rely. We briefly discuss the extremes of perfect competition and monopoly, in relation to predatory pricing. Predatory pricing is often understood as pricing below cost, which is the assumption we use in the following examples.

In a situation of perfect competition, predatory pricing is not expected to be a viable strategy as price does not depend on any individual firm's output but rather on total output (through a price-demand curve), which cannot be significantly changed by any single firm's output. Therefore, a firm which would try to price below cost (at any output level) could not expect to have any impact on its competitors. It would only hurt itself by reducing its own profits. Besides, demand is such that the firm pricing below cost could not produce high enough outputs to satisfy all the market demand, which would further contribute to its demise.

Conversely, the monopolistic case is a much more feasible and realistic setting for predatory behavior. The behavior of any firm has direct impact on price and output levels. There are therefore opportunities to price below cost without necessarily foregoing substantial amounts of profits while deterring entry. Such behavior would potentially allow the incumbent to plan on a long-term strategy to later recover profits lost in the short-term. For example, pricing below marginal cost is clearly sub-optimal as it implies that marginal revenues are strictly less than marginal costs (since price is typically at least as high as marginal revenues), which in turn entails sub-optimal profits for the monopolist (as optimality is reached at equal marginal costs and revenues). Areeda and Turner (1975) further argue that pricing below cost, and more specifically below marginal cost, is predatory (as we discuss in Section 3.2).

Given this basic economic theory, Areeda and Turner discuss the fact that under certain circumstances, price competition can have anticompetitive effects. As they state, "*a firm which drives out or excludes rivals by selling at unremunerative prices is not competing on the merits, but engaging in behavior that may properly be called predatory*". In one of the first research efforts on predatory pricing, they propose an economic approach to testing for predation, setting the stage for numerous research efforts on the issue of predatory practices, as discussed below.

3.2. History of Research on Testing for Predatory Pricing

In 1958, McGee (1958) set the stage for discussions on predatory pricing. His article focused on the Standard Oil case of 1911, according to which the company had used monopolistic practices, and more precisely local price-cutting, to achieve and perpetuate its monopoly position in the oil refining business. By 1914, in the Clayton Act, predatory price discrimination was hence included in a group of business practices which called for explicit statutory prohibition. Interestingly, McGee argues that price predation is often an unprofitable business strategy which could therefore not have been used by Standard Oil. In particular, predatory price-cutting does not explain how the predator acquired the monopoly power that he needs to practice it, nor does it make sense to apply such a strategy, as it would often be more profitable and reliable to purchase the rival. McGee also points out that variations in prices among similar markets may be accounted for in terms of variations in demand elasticities, but do not imply that one of the competitors is preying on the other. As we discuss in this thesis, this last point is critical to airline markets where decreasing average fares are too often used as an indication of predatory pricing, when in fact, as McGee explains, they are only a reflection of the price-demand curve in the market. McGee concludes that predatory pricing is a very unlikely monopolistic strategy which requires unusual market conditions, such as legal barriers to mergers and acquisitions.

Regardless of McGee's conclusions, the development of game theory in the 1960s and 1970s led to conclusions that predation might lead to a rational equilibrium under specific conditions. In particular, Posner (1979) argues that predation is a plausible policy for a profit maximizing firm, which may have been followed by Standard Oil. Other examples include the "long purse" assumption (Edwards, 1955; Benoit, 1984), under which the predator is assumed to have infinite resources and the prey limited cash reserves, which can lead to a Nash equilibrium where predation is the better solution for the predator. Similarly, reputations models, as described by Kreps and Wilson (1982) or Milgrom and Roberts (1982), where the multi-product predator develops a reputation for toughness by using predatory practices in one market to deter entry in others, also make predation a rational behavior.

Areeda and Turner (1975) were consequently among the first to propose a test for the existence of predatory pricing. They claim that pricing at or above average total cost cannot be considered predatory. Similarly, they argue that pricing at or above marginal cost does not constitute predatory pricing, even though equally efficient rivals may be drawn out of the market for lack of available capital. On the other hand, pricing below marginal cost is predatory unless above average cost. Marginal cost, however, is very difficult to evaluate, and, as a result, Areeda and Turner propose a test procedure based on the comparison of prices and average variable costs, which they use as a proxy for marginal costs. Their proposal states that prices that are profit maximizing, above average total costs or below average total costs but above marginal costs (or average variable costs as a surrogate for marginal costs) should be considered non-predatory. Any other price is predatory.

This article prompted immediate discussion from a number of authors, including Scherer (1976) who instead advocates a method that would maximize total long-term welfare, but does not "*know how these* *variables can be assessed without a thorough examination of the factual circumstances accompanying the monopolist's alleged predatory behavior*". Similarly, Williamson (1977) suggests using an output-maximizing rule in the short term, along with a time limit on the rule to ensure that when the entrant has recovered the costs of entry, competition becomes free again. In response to these objections and comments, Areeda and Turner (1977, 1978) provide a discussion and ranking of cost-based and output-based rules, as shown in Table 3.1. Yet, Baumol (1979) also objects to the Areeda-Turner rule and claims that they overlook the temporal side of predation and do not account for the prospect of increased long-term profits from predatory pricing for the established firm. In order to overcome this limitation, Baumol suggests imposing on the established firm a "*quasi-permanence*" of the price reduction. Joskow and Klevorick (1979) propose a unifying framework to approach the problem of price predation, using a two-tier approach. The first step assesses the market situation and determines if the situation warrants further scrutiny. The second step consists of a behavioral study of the firms using cost-based rules.

Rule	Discouraging Inefficient Entry	Inducing Higher Pre-Entry Output
Average Variable Cost	1	5
Average Cost	2	4
Short Run Marginal Cost	3	3
Output Limitation	4	2
Price Maintenance	5	1

Table 3.1: Areeda and Turner's ranking of various rules (1: Best – 5: Worst)

In his 2001 article, Spector (2001) argues that there has been no unifying definition of predatory pricing used in the literature, and further offers a comparison of existing definitions, as previously discussed in Chapter 2. He then proceeds to compare the various rules designed to test for predatory prices (cost, output or two-tier based, as previously discussed) and concludes that "*no single rule, however carefully designed, can be applied to all predation claims, and that the rule of reason should often be used*". Scherer (1976), Joskow and Klevorick (1979), and Spector (2001) all conclude that a thorough analysis of the factual circumstances surrounding the claim of predatory behavior is critical.

Furthermore, the previously discussed tests cannot always be used. The airline industry, for instance, does not offer the possibility of directly comparing revenues and costs. This is a direct consequence of the dichotomy of supply and demand described by Belobaba (1995): At the market level, it is possible to determine the revenues and therefore some average measure of price per passenger. However, costs cannot be estimated in a simple way, as the costs of flying a plane from one city to another cannot be fully assigned to local market passengers. Any particular flight usually is shared by local and connecting passengers, which implies that some the connecting passengers should bear some of the costs of flying the aircraft. Other approaches (Wu and Dorman, 2002) contend that costs can be assigned at the flight level, but that revenues should be prorated on any specific flight to account for connecting traffic, which essentially leads to the same problem of dichotomy of supply and demand. Since there is no way to accurately assign costs (or revenues, depending on the approach) and therefore compare revenues and costs, there is a need for another approach to the problem of predation in the airline industry, independent of cost-based rules.

3.3. Entry and Predation in the Airline Industry

There have been a large number of research efforts on the question of predatory pricing, but notably little opposition to the concept of predation other than McGee (1958) and Baumol (1982). The latter does not refute the existence of price predation per se, but rather describes conditions under which a natural monopoly might behave comparably to perfect competition and thereby be exempt of predatory behaviors. Baumol identifies equal access to economies of scale, free entry and exit, and sustainable prices as the conditions for perfect contestability of a market. A number of authors were tempted to apply contestability to the airline industry (e.g. Bailey, Graham and Kaplan, 1985; Bailey and Baumol, 1984), but, as Levine (1987) points out, while it "*leaves in place the predictions of the structure and performance of airline markets that were developed before deregulation using vaguer, and probably inapplicable, forms of the theory of perfect competition*" and has the "*virtue of focusing relatively precisely on the conditions necessary to achieve competitive performance from markets with few sellers*", contestability "*turns out to be wrong as a predictor of the behavior of deregulated airline markets*".

One of the first research efforts in post-deregulation airline markets was undertaken by Bailey, Graham and Kaplan (1985). They thoroughly describe the positioning of new entrant airlines shortly after deregulation and further explain the detail of the cost structure differential between established airlines (pre-deregulation airlines) and new entrant airlines, as we did in Chapter 2. Bailey, Graham and Kaplan then go on to discuss the issue of contestability of airline markets, and conclude that the airline industry is not an industry where markets are perfectly contestable, as introduced by Baumol in 1982. Hurdle, Johnson, Joskow, Werden and Williams (1989) reiterate this observation, and attempt to discover which deviations from perfect contestability significantly affect performance. Whinston and Collins (1992) observe the impact of entry on the stock valuation of incumbent airlines and conclude that the drop in valuation of incumbent airlines upon entry by People Express is an indicator of sunk costs of entry, which goes against the theory of contestability of airline markets.

In "uncontestable" airline markets, the discussion of the impacts of competition on average fares led Bailey, Graham and Kaplan (1985) to present evidence that airlines in concentrated markets (where they are dominant) are able to charge higher fares than airlines in more competitive markets. In addition, they study the effect of potential entry on airline performance. Hurdle, Johnson, Joskow, Werden and Williams (1989) also conclude, through econometric modeling and hypothesis testing, that performance is most affected by the number and concentration of incumbents, as well as by the number of potential entrants that are not deterred by economies of scale or scope. In a pragmatic study of the effects of entry and competition on fares, Morrison and Winston (1990) establish that deregulation led to a decrease in average fares, compared to equivalent Standard Industry Fare Levels (SIFL) set by the CAB. The study concludes that there should be a greater focus on enhancing the effects of competition. Whinston and Collins (1992) study the impact of entry on fares, sales and schedules and find that there is a far greater impact on the market of entry (airport pair) than on parallel markets (other airport pairs within the city pair) with the same catchment area.

While most previously discussed studies focused on the immediate impact of entry on incumbent revenue performance and average fares, Windle and Dresner (1995), also researched the long-term impact of entry. More specifically, their findings are twofold: First, they observe that the impact of entry is quite different if the entrant is a low-fare carrier or another traditional network carrier. In the former case, fares drop sharply, while no such effect is observed in the latter case. In addition, entry by a low-fare carrier is shown to have a more significant impact on fares than competition: Fares are generally lower if a low-fare carrier operates within the market than if there is extensive competition between traditional network carriers in that market (as measured by the Hirschman Hirfindahl index). Second, Windle and Dresner conclude that the lower prices generated by low-fare competition are sustained beyond entry and are not merely promotional. Perry (1995) also related her observations on the effect of low-fare, low-cost entry on the airline industry and on passenger behavior, and observed the impact of deregulation and market entry on revenues, traffic and fares. In particular, she argues that most of the increase in traffic in such markets is attributable to incumbent airlines' response to entry. At the same time, the US DOT (1995) published a report on the revolution introduced by low-cost airlines. The study details the savings to passengers resulting from entry of low-cost carriers and asserts that one in seven passengers flies because of the low-cost service now provided to them.

Finally, some of the most recent work includes that of Oster and Strong (2001), and the US Department of Transportation (2001). In the former, Oster and Strong observe that the benefits of deregulation have come from two distinct types of competition. In long-haul markets, competition between network carriers has boosted competition and led to lower prices while, in short-haul markets, it is competition between network carriers and low-fare carriers that has produced this increased competition. Oster and Strong (2001) further explore the details of predation in the airline industry and the challenges in applying a cost-based test such as Joskow and Klevorick's (1979). The DOT's study focuses on hub fares[10] and notes that these fares are, on average, much higher in markets without low-fare competition. Furthermore, the discrepancies are even greater in short-haul markets. Finally, the DOT points out that the usual explanations for high hub fares – passenger mix, operational cost, quality of service and the "Southwest Effect" – only apply when low-fare competition is not present. They conclude that it is the lack of competition and not the rationales listed that explain these high hub fares.

Given previous research efforts on competition in the airline industry, other research studies focused on predatory behavior in the airline industry and how to test for its existence. In their 1991 study of predatory behavior in aviation, Dodgson, Katsoulacos and Pryke (1991) provide a detailed discussion on predation in the airline industry. They define predatory behavior and introduce concepts of relevance in identifying predation. After reviewing the evidence in Europe and the US, they conclude that none of the "bright-line" rules suggested in research studies focusing on predation (e.g. Areeda and Turner, Williamson, or Joskow and Klevorick) can be reasonably and successfully applied to the airline industry. They advocate the use of the "rule of reason" based on a study of the entry conditions – where medium barriers to entry are most likely to lead to predatory behavior – and the nature of market competition – where highly concentrated or localized markets are most conducive to predation, along with a two-tier approach comparable to that of Joskow and Klevorick's. This approach involves careful analysis of individual markets and competitive situations to determine whether claims of predatory behavior are valid or not. If they are, then the use of a rule to test for its existence might become appropriate, although very careful consideration should be given to estimating costs and revenues. The estimation of costs and revenues is critical because of the dichotomy of supply and demand (Belobaba, 1995), as previously discussed. Oster and Strong (2001) also stress the difficulty in applying cost-based test to the airline industry.

Numerous research efforts were therefore undertaken with respect to the impact of entry in the airline industry specifically. While many of these studies indicate a growing concern with respect to unfair competition and predatory pricing, the focus of these studies was on applying existing tests of predation or on analyzing the effect of entry on traditional aggregate measure of performance such as average fares

[10] Hub fares, although undefined, seem to refer to fares in origin-destination markets where the origin city is a hub for a network airline. For example, a fare in the Atlanta-Boston market would constitute a hub fare.

or revenues. For instance, Bailey, Graham and Kaplan (1985), Morrison and Winston (1990), Windle and Dresner (1995), Perry (1995) and Oster and Strong (2001) discuss the impact of entry on average fares and traffic and the distinction between entry by a low-fare carrier and a network carrier, and touch upon the issue of predation. Baumol (1982), Baumol, Panzar and Willig (1983), Hurdle, Johnson, Joskow, Werden and Williams (1989) and Whinston and Collins (1992) focus on the contestability of airline markets and how this might affect competition in the airline industry, but conclude that the hypothesis of contestability is inappropriate. Overall, while predation is clearly a concern, none of these studies has provided us with a satisfactory solution to evaluate the possibility of predation. Only Dodgson, Katsoulacos and Pryke (1991) actually focus on predation in the airline industry and offer an approach to testing for its existence, while remaining very cautious in recommending any particular test of predation. In particular, they advocate a careful analysis of individual markets on a case-by-case basis.

Finally, recent legal action against various carriers accentuates the concerns of regulatory bodies with respect to predatory behavior. For example, in the US, American Airlines was sued by the US Department of Justice (2001), while the Competition Tribunal in Canada attempted to determine whether Air Canada competed unfairly against CanJet (2000) and WestJet (2001). In 1998, the United States Department of Transportation (US DOT, 1998) proposed a policy attempting to identify predatory practices based on high-level market measures.

Unfair competition is therefore a growing concern in the airline industry, in particular given the growth of low-fare carriers. These concerns call for a careful analysis of the competitive dynamics in the airline industry in order to be able to identify predatory practices. As previously discussed, prior research on the topic of predatory pricing – whether in the airline industry or in a more general setting – does not provide a conclusive approach to testing for the existence of price predation, but rather advocates the use of the rule of reason. Furthermore, the added complexity of the airline industry (allocation of costs and revenues, frequent flyer programs, etc.) emphasizes the need for a careful and detailed understanding of the airline industry's competitive dynamics. Use of aggregate measures of airline performance does not offer sufficient detail and overlooks the effects of airline specific tools such as Revenue Management.

3.4. Revenue Management

In their analysis of the competitive impacts of low-fare entry in airline markets, previous research studies usually focus only on the effect of entry on aggregate measures of airline performance such as average fares, traffic or revenues. As we discuss in Chapters 4, 5 and 6, one of the important factors explaining the change in these aggregate measures of airline performance following low-fare entry is Revenue

Management. Airline Revenue Management, also referred to as Yield Management, spurred a lot of interest in the late 1980s, following US airline deregulation. Revenue management is the combination of forecasting and seat allocation algorithms that enable the airlines to maximize their revenues given a set of fares by dedicating part of the inventory (airline seats) to specific fare products based on forecasts of demand to come. The perishable nature of an airline seat, combined with the different booking patterns of leisure and business passengers, and the differentiated fare products, created the need for seat inventory control, and eventually Revenue Management tools. Given differential pricing, Revenue Management is the practice of determining how many seats to offer for each fare product on each flight. In addition, since the operating costs of a flight departure on a scheduled airline are essentially fixed in the very short term, the objective of Revenue Management is to maximize revenues, which is equivalent to maximizing profits. In the following sections, we briefly review three of the principal techniques of revenue management: Overbooking, fare class mix seat inventory control and origin-destination control.

3.4.1. Overbooking

Airlines have been overbooking (accepting more bookings than capacity) their aircraft for over two decades in an attempt to reduce the revenue loss associated with no-shows. The objective of overbooking algorithms is to determine the total number of seats to sell on a flight, while balancing the loss of revenue associated with an empty seat and the cost of "bumping" a passenger. Airline overbooking research dates back to the 1950s with Beckman's (1958) static optimization model. Later statistical models include the work of Taylor (1962), Simon (1968), Rothstein (1968, 1985), Vickrey (1972) and Smith (1984). Rothstein's (1968) Ph.D. thesis describes the first dynamic programming model for overbooking. His 1985 work is a survey of previous research on overbooking and discusses the customer service implications of overbooking. Vickrey's paper suggests the resolution of oversold situations using auctions, which was dismissed as unrealistic at the time. More recent research includes the work of Gallego (2004) on another approach to solving overbooked situations by preemptively contacting willing passengers and rebooking them on less demanded flights.

3.4.2. Fare Class Mix Seat Inventory Control

Fare class mix seat inventory control is the practice of determining the revenue maximizing number of seats to make available for each product (fare class) for each future flight-leg departure. All airline Revenue Management systems are designed with the purpose of optimizing the mix of seats available in each fare class in order to maximize revenues. These systems use forecasts of future demand as inputs to their optimizers. Littlewood (1972), L'Heureux (1986), Lee (1990) and Curry (1994) provide discussions of forecasting methods in the airline industry.

Fare class mix seat allocation algorithms use the demand forecasts to set booking limits in each fare class, that is the number of seats to protect for any given fare class from other classes. Most airline Revenue Management systems use "nested" seat allocations, as opposed to allocations within partitioned classes. The difference lies in the fact that in the nested approach, seat are protected for a given fare class relative to lower fare classes (cheaper products), but can also be sold in higher fare classes, in the unlikely event that the entire aircraft capacity can be sold in the highest priced fare class. Littlewood (1972) provided the basis for the initial research on the topic of seat inventory control. His rule for protecting seats in a dual fare class environment was extended by Belobaba (1987), who published the first leg-based seat inventory management algorithm in a nested fare class environment, known as the Expected Marginal Seat Revenue algorithm (EMSR). Building on this research, Belobaba (1989, 1992, 1994), Curry (1990), McGill (1995), Wollmer (1992) and others proposed and developed optimal formulations of the multiple nested class problem.

The general premise of fare class mix seat inventory control models relies on forecasts of average and standard deviation of demand for each fare class, along with the associated average fare in the class. Given these forecasts, the expected marginal revenue of each incremental seat is the product of the average fare in the class multiplied by the probability of selling that seat. The optimal number of seats to protect for that class is then the number of seats whose marginal revenue exceeds the average fare in the lower fare class. Because of the assumption that lower fare class traffic books earlier and because higher fare classes have access to lower fare class inventory in a nested structure, the model finds protection levels for higher fare classes, and booking limits for lower fare classes. Simulation and airline experience show that these fare class mix seat inventory allocation systems lead to revenue increases ranging from 2% to 4% (Belobaba, 1989).

3.4.3. Network Revenue Management: Origin-Destination Control

Network Revenue Management constitutes a significant improvement in the management of airline seat inventory. Origin-Destination (OD) control allows the airlines to allocate seats based on individual passengers' revenue contribution on the airline's network rather than based on the fare class requested on a single flight leg. These seat inventory management algorithms, currently used by the more advanced (network) airlines, provide a better control between local and connecting passengers and evaluate the tradeoff between blocking two local seats with a connecting passenger as opposed to potentially flying one empty seat and filling the other seat with a local passenger.

In a first step towards implementation of network Revenue Management, Smith, Leimkuhler and Darrow (1992) introduced the notion of "virtual nesting". This process maps each itinerary/fare combination to a hidden (or virtual) class within the airline's reservation system based on fare value. Initial implementation used total fares for both local and connecting passengers, which resulted in overprotection for connecting passengers with relatively higher fares than local passengers, and thus in sub-optimal protection levels. Later refinements introduced proration of connecting fares, or use linear programming tools to estimate the displacement cost of a connecting passenger. Smith, Leimkuhler and Darrow (1992) provide a detailed discussion of the implementation of virtual nesting at American Airlines and quantify the revenue gains attributable to Revenue Management as a whole as $1.4 billion over a three-year period.

Subsequent developments of OD control strategies include the application of linear programming methods and heuristic approaches to the maximization of network revenues. Williamson (1992) provides a detailed description of the application of mathematical programming and network flow models to the OD seat inventory control problem. More recent research focusing on the application of dynamic programming to Revenue Management includes the work of Gallego and van Ryzin (1997), de Boer (2003), and Bertsimas and Popescu (2003). McGill and van Ryzin (1999) provide a thorough review of the science of Revenue Management and its evolution since deregulation, as do Barnhart, Belobaba and Odoni (2003).

Even as Revenue Management research keeps developing, the growth of low-fare, low-cost carriers has put into question the traditional airline business model. Tretheway (2004) explains why he believes the traditional network airline business model is broken, while Franke (2004) discusses the effect of low-cost competition on network carriers, and the need for structural change within network carriers. Numerous additional newspaper articles also claim that traditional network carriers will have to adapt their pricing to that of low-cost carriers (USA Today (2004), New York Times (2003)). In this new competitive airline environment, we examine the effects of Revenue Management and flows of network passengers on the performance of network carriers as well as low-fare airlines, and focus on the impact on aggregate measures of airline performance, such as average fares, revenues and market share.

3.5. Implications for this Research

Unfair competition and predatory practices have occupied researchers since the 1950s, and led to the design of three different types of rules on testing for the existence of predatory pricing. Areeda and

Turner pioneered rules based on the comparison of revenues and costs, Williamson devised an output maximizing rule, while Joskow and Klevorick advocate the use of a two-tier approach where the "rule of reason" is applied in the first step. Among the most recent research, Spector concludes that "*no single rule, however carefully designed, can be applied to all predation claims*" and that the rule of reason is therefore the most reasonable approach to predation cases.

The airline industry has recently become concerned with unfair competition as low-fare new entrant carriers have become more present and successful all over the world. In studying the potential for unfair competition, most airline research (Perry, 1995; Oster and Strong, 2001) has focused on analyzing the effect of low-fare entry on aggregate measures of airline performance (on the incumbent carriers). Dodgson, Katsoulacos and Pryke (1991) recognize the challenges in testing for predatory pricing and advocate the use of the rule of reason. In addition, the difficulty in matching revenues and costs in the airline industry (as discussed in Section 3.2) further complicates the use of a cost-based rule (or any other rule) to assess the possibility of predation. While researchers agree that rules should not be used in assessing predatory practices, most of the airline-related research on the effect of low-fare entry on the airline industry has focused on traditional average measures of airline performance such as average fares or revenues. Regulatory bodies have taken this approach one step further in using this data as a means to determine whether incumbent carriers competed unfairly against low-fare new entrants (US DOT, 1998; US DOJ, 2001; Canadian Competition Tribunal, 2000 and 2001).

The consensus therefore is that no particular rule should be used in assessing the potential for predatory behavior in the airline industry. On the contrary, the "rule of reason" is generally admitted to offer the most reasonable approach to assessing the existence of predatory conduct. Previous research, however, generally relies on aggregate measures of performance to evaluate the performance of individual airlines, and overlooks the impact of flows of connecting passengers and Revenue Management. In particular, none of the previous research has identified the importance of Revenue Management in explaining changes in traditional measures of airline performance following low-fare entry. As we discuss in subsequent chapters, individual airline performance is dependent upon a set of factors that include Revenue Management, which has played a very important role in the airline business since deregulation.

CHAPTER 4

CASE STUDIES

Given the changing environment in the airline industry, as exemplified by the growth of low-fare new entrant carriers and the increasing concern of regulatory bodies regarding the potential for predatory behavior (discussed in Chapters 2 and 3), we now present a survey of the effects of entry on market and individual carrier performance based on historical data in a set of markets with low-fare entry (as identified in previous studies). In Section 4.1, we analyze the effects of entry in a set of markets with low-fare entry, based on available aggregate data (DB1A database, OD Plus survey), and highlight the general conclusions that can be reached based on this limited data. In the Section 4.2, the discussion centers on the detailed analysis of two markets (Atlanta-Orlando and Detroit-Boston) which represent two extremes in terms of low-fare new entrant success and failure. Findings show the limitations of aggregate data and aggregate measures of airline performance in assessing the response of incumbent carriers to entry.

The analysis provides two important results: First, it is impossible to understand the success or failure of a new entrant – or new entrants in general – by only focusing on high-level aggregate data. In addition, such aggregate data does not provide sufficient information to assess the nature of the competitive response of the incumbent carriers in the market. Second, more detailed market-level data, while providing better insights, ignores revenue management and network flows of passengers. This observation helps establish that both factors (revenue management and network flows) have a very important impact on network carrier revenues and traffic, as well as on the apparent response to entry of the incumbent network carriers. These effects are usually overlooked and therefore become the focus of the research in the remainder of this thesis, along with relative new entrant capacity.

4.1. A Survey of the Effects of Low-Fare Entry on Total Market and Individual Carrier Traffic, Revenues and Fares

4.1.1. Markets with Low-Fare Entry

Oster and Strong (2001) identify a set of twelve markets where a new entrant started operations at hub airports, and which represent "*examples of potential anti-competitive behavior in response to entry*". In another study, Perry (1995) shows the effect of entry in eight markets. Table 4.1 summarizes a collection of markets studied by either Oster and Strong or Perry, along with the detail of the entrant carrier and the incumbent airlines in the market. In addition, to reflect the changing environment created by the birth of such carriers as JetBlue, we also included some of the markets more recently served by this particular carrier.

MARKET	QUARTER OF ENTRY	INCUMBENT CARRIERS**	NEW ENTRANT**	DISTANCE	COMPETITIVE SITUATION	SOURCE
ATL-CLT	97-2	DL	J7	226	Exited	Oster & Strong
ATL-MCI	96-4	DL	NJ	691	Competing	Oster & Strong
ATL-MCO*	94-1	DL-TW	J7	404	Competing	Perry
CLE-BWI	93-3	US-CO	WN	313	Competing	Perry
DFW-ICT	95-2	AA-DL	NJ	329	Exited	Oster & Strong
DTW-BOS	96-2	NW	NK	630	Exited	Oster & Strong
DTW-PHL	95-4	NW-US	NK	452	Exited	Oster & Strong
MSP-MCI	95-2	NW-TW	NJ	393	Competing	Oster & Strong
PHX-BUR	92-2	HP	WN	368	Competing	Perry
PIT-BOS	95-3	CO-US	N5	494	Exited	Oster & Strong
PIT-PHL	95-1	US	N5	267	Exited	Oster & Strong
SLC-SAN	93-2	DL	KN/WN	626	Competing	Perry
STL-IND	89-2	TW	WN	227	Competing	Perry
SEA-GEG	93-2	AS	KN/WN	223	Competing	Perry
RNO-PDX	92-3	AA-HP	QQ	444	Exited	Perry
LAS-OAK		HP	WN	406	Competing	Perry
NYC-FLL	00-2	AA-CO-DL-US	B6	1,068	Competing	n/a
NYC-BUF	00-2	AA-CO-DL-US	B6	300	Competing	n/a

Table 4.1: Markets for case studies
(Source: OD Plus database, Perry (1994), and Oster and Strong (2001))
* data for these markets was estimated based on available data
** details of incumbent and new entrant carrier codes can be found in Table 4.2

In this section, we focus on this set of markets and attempt to highlight the similarities and differences in the strategies of entry of each individual entrant and in the responses of the established carriers within each market, from the aggregate data available for comparison. In particular, we focus on Perry's analysis, discuss her findings, and apply the same framework to the markets identified by Oster and Strong, and two additional JetBlue markets. In the second section (Section 4.2), we provide additional insights in two particular cases, the Detroit-Boston market and the Atlanta-Orlando market, where Spirit and ValuJet respectively chose to compete against major network carriers, Northwest Airlines and Delta Air Lines.

Table 4.2 summarizes the airlines involved in the study along with each individual airline code, as reported below.

INCUMBENT		LOW-FARE NEW ENTRANT	
AIRLINE	CODE	AIRLINE	CODE
American Airlines	AA	ValuJet Airlines	J7
Continental Airlines	CO	AirTran Airways	FL
Delta Air Lines	DL	Vanguard Airlines	NJ
Northwest Airlines	NW	Southwest Airlines	WN
United Airlines	UA	Reno Air	QQ
Trans World Airlines	TW	Morris Air	KN
US Airways	US	JetBlue	B6
America West Airlines	HP	Spirit Air Lines	NK
Alaska Airlines	AS	Nation's Air	N5

Table 4.2: Airlines names and associated IATA codes

4.1.2. High Level Study of the Impact of Entry: Perry's Approach

In her 1995 study, Perry focused her efforts on the annual number of passengers carried pre and post-entry and on the average fare before and after entry. Perry defined pre-entry local traffic (average local fare) as the sum of local traffic (average fare) over the four quarters immediately preceding entry, i.e. the full year preceding entry. Similarly, post-entry numbers refer to the sum (average) of local traffic (fare) over the one-year period immediately following entry. In the following paragraphs, we use Perry's definition of pre and post-entry measures of traffic and average fares to study the effects of entry on traffic and average fares.

From the outset, we notice advantages and disadvantages in using this approach to defining pre and post-entry traffic. The advantage of using a one-year period is that it corrects for seasonal effects. The disadvantage is that it does not pick up the short-term changes that might have happened. For instance, if the entrant leaves the market within a year, this will not be accounted for with this measure.

Perry attributes the differences in traffic stimulation between markets to the mix of airlines serving each market, the size of the market, the sensitivity of the market to changes in average airline fares, the existing level of airline service, and the competitive responses by the established airlines already serving each market. These factors can be grouped into two broader categories: market characteristics (including size and sensitivity of the market) and competitive response characteristics (including mix of airlines, level of service and competitive response to entry).

Perry also concludes that the key factors affecting the response of established airlines to low-fare entry are the following:

1. Size of the origin-destination market,
2. Significance of the market within the established airline's network,
3. New lower level of airline fares,
4. Number of daily departures of the new entrant carrier, and,
5. Availability of service at competing airports.

In the following paragraphs, we first discuss the effects of entry on the chosen markets, and then focus on the impact on traffic, fares and departures. Results show that in general, low-fare entry leads to an increase in total market traffic and incumbent carrier traffic, along with a decrease in average market fare and incumbent carrier average fare. Although these are the general trends, we also observe that markets that are affected similarly with respect to traffic may be affected quite differently in terms of average fares, thus indicating that differences between markets stem from additional factors.

Overview

Perry provides an analysis of the effect of entry at the market level in terms of passengers, aircraft departures and average fares. Table 4.3 shows the annual local traffic and average fares at the market level pre and post-entry, along with the distance between origin and destination in these particular markets.

MARKET	QUARTER OF ENTRY	INC. CARRIERS	NEW ENTRANTS	DIST.	ANNUAL LOCAL PAX Pre-Entry	ANNUAL LOCAL PAX Post-Entry	AVG ONE-WAY FARE Pre-Entry	AVG ONE-WAY FARE Post-Entry
ATL-CLT	97-2	DL	J7	226	147,570	185,680	$ 137.39	$ 122.98
ATL-MCI	96-4	DL	NJ	691	185,960	243,360	$ 120.58	$ 116.36
ATL-MCO*	94-1	DL-TW	J7	404	357,990	592,120	$ 148.44	$ 89.95
CLE-BWI	93-3	US-CO	WN	313	56,480	487,930	$ 179.17	$ 31.73
DFW-ICT	95-2	AA-DL	NJ	329	77,690	141,590	$ 104.16	$ 64.60
DTW-BOS	96-2	NW	NK	630	232,660	345,350	$ 211.86	$ 137.92
DTW-PHL	95-4	NW-US	NK	452	254,740	313,520	$ 163.03	$ 142.35
MSP-MCI	95-2	NW-TW	NJ	393	118,310	206,280	$ 192.32	$ 100.66
PHX-BUR	92-2	HP	WN	368	134,120	306,580	$ 62.54	$ 44.17
PIT-BOS	95-3	CO-US	N5	494	215,890	226,410	$ 148.46	$ 150.68
PIT-PHL	95-1	US	N5	267	298,430	452,220	$ 139.89	$ 94.73
SLC-SAN	93-2	DL	KN/WN	626	65,630	249,900	$ 128.00	$ 70.00
STL-IND	89-2	TW	WN	227	50,070	137,990	$ 122.00	$ 44.00
SEA-GEG	93-2	AS	KN/WN	223	251,510	509,990	$ 85.00	$ 47.00
RNO-PDX	92-3	AA-HP	QQ	444	64,300	105,100	$ 81.00	$ 68.00
LAS-OAK		HP	WN	406	187,640	295,670	$ 79.00	$ 56.00
NYC-FLL	00-2	AA-CO-DL-US	B6	1,068	1,885,450	2,503,830	$ 117.18	$ 112.64
NYC-BUF	00-2	AA-CO-DL-US	B6	300	425,200	706,350	$ 125.85	$ 90.22

Table 4.3: Pre- and post-entry annual local traffic and average one-way fares (Source: OD Plus database & Perry (1995))

Perry's first observation – in her 1995 paper – was that most of the markets involved were short-haul (less than 500 miles). This observation still applies to most markets, other than Atlanta – Kansas City, Detroit – Boston, Salt Lake City – San Diego, and New York – Fort Lauderdale. New entrant airlines traditionally enter short-haul markets with sufficient demand to allow for profitable operations with medium to small size, cost-efficient aircraft, which are used intensively throughout the day (as discussed in Chapter 2). JetBlue, in entering the New York – Fort Lauderdale market, chose to enter a market with one of the highest demands for air travel in the United States (ranked in the top 10 markets since 1998 and often the market with the highest demand) with medium-sized efficient A320 aircraft, thus not entirely deviating from the traditional approach of new entrant airlines. Let us add here that in computing the traffic and average fare values from New York City (NYC), we included the three major New York airports (Newark, JFK and La Guardia). By this approach, we attempt to capture the close substitutability of the three New York airports and to reflect the fact that JetBlue's goal is to get passengers from the New York area to fly out of (and into) JFK.

Our second observation is that the traditional consequence of entry is an increase in the total local traffic carried in the market, along with a decrease in the average local fare in the market. The only case that does not follow this pattern is Pittsburgh – Boston, where the average local market fare increased in the year following entry (while local traffic increased overall). Note that the same patterns also apply to the incumbents' traffic and average fares, with the same notable exception (c.f. Table 4.4 and Table 4.6). We dismiss this case (PIT-BOS) as an outlier, given the very slight increase in average fare, and the overwhelming evidence to the fact that entry is followed by an increase in local traffic and a drop in average local market fare.

Finally, in terms of departures, it appears that entry has a diverse effect on the number of incumbent departures (c.f. Table 4.7), in that there is no pattern emerging from the study of the change in the number of departures within a market following entry. Perry notes, however, that this may be a reflection of the fact that there can be changes in departures at competing airports serving the same markets that are not recorded in the local origin-destination market numbers. We did attempt to compensate for this in the case of the New York airports, but this can also be the case in other airports, such as Fort Lauderdale (as a substitute to Miami), Oakland (San Francisco), Portland (Seattle), etc. Total market departures however increase following entry, as shown in Table 4.7. Let us further note that departures are a measure of frequency but do not reflect capacity in the market: in longer-haul markets in particular, frequency of service has less effect on demand, as travel time is such that multiple daily departures do not add as much convenience as they do in shorter-haul markets.

Effects of Entry on Local Traffic

Table 4.4 shows the total local traffic carried in each of the markets described previously, along with the share of the traffic captured by incumbent network carriers and the relative impact of entry on these carriers. In most cases, entry was followed by an increase in traffic on the incumbent network carrier. Only in a few cases was entry followed by a decrease in incumbent local traffic, while in all cases, entry led to an increase in total local market traffic.

MARKET	NEW ENTRANT	ANNUAL LOCAL PASSENGERS Pre-Entry	Post-Entry	% Change	ANNUAL INCUMBENT PASSENGERS Pre-Entry	Post-Entry	% Change	POST-ENTRY MARKET SHARES Incumbent	Entrant
ATL-CLT	J7	147,570	185,680	**25.8%**	147,570	173,970	**17.9%**	93.7%	6.3%
ATL-MCI	NJ	185,960	243,360	**30.9%**	185,960	211,170	**13.6%**	86.8%	13.2%
ATL-MCO*	J7	357,990	592,120	**65.4%**	357,990	430,020	**20.1%**	72.6%	27.4%
CLE-BWI	WN	56,480	487,930	**763.9%**	56,480	320,470	**467.4%**	65.7%	34.3%
DFW-ICT	NJ	77,690	141,590	**82.2%**	77,690	78,330	**0.8%**	55.3%	44.7%
DTW-BOS	NK	232,660	345,350	**48.4%**	232,660	338,990	**45.7%**	98.2%	1.8%
DTW-PHL	NK	254,740	313,520	**23.1%**	254,740	270,340	**6.1%**	86.2%	13.8%
MSP-MCI	NJ	118,310	206,280	**74.4%**	118,310	175,860	**48.6%**	85.3%	14.7%
PHX-BUR	WN	134,120	306,580	**128.6%**	134,120	174,200	**29.9%**	56.8%	43.2%
PIT-BOS	N5	215,890	226,410	**4.9%**	215,890	217,340	**0.7%**	96.0%	4.0%
PIT-PHL	N5	298,430	452,220	**51.5%**	298,430	383,220	**28.4%**	84.7%	15.3%
SLC-SAN	KN/WN	65,630	249,900	**280.8%**	65,630	171,850	**161.8%**	68.8%	31.2%
STL-IND	WN	50,070	137,990	**175.6%**	50,070	84,470	**68.7%**	61.2%	38.8%
SEA-GEG	KN/WN	251,510	509,990	**102.8%**	251,510	271,980	**8.1%**	53.3%	46.7%
RNO-PDX	QQ	64,300	105,100	**63.5%**	64,300	47,360	**-26.3%**	45.1%	54.9%
LAS-OAK	WN	187,640	295,670	**57.6%**	187,640	84,580	**-54.9%**	28.6%	71.4%
NYC-FLL	B6	1,885,450	2,503,830	**32.8%**	1,885,450	2,137,840	**13.4%**	85.4%	14.6%
NYC-BUF	B6	425,200	706,350	**66.1%**	425,200	416,690	**-2.0%**	59.0%	41.0%

Table 4.4: Total local and incumbent market traffic pre- and post-entry (Source: OD Plus database & Perry 1995))

These cases include Reno – Portland, Las Vegas – Oakland and New York – Buffalo. In these particular cases, the effect of entry on total local traffic was positive overall, but local traffic on the incumbent network carriers decreased. The impact on incumbent traffic ranged between -2% and -55%. In these particular markets, the post-entry market share of the new entrant carrier ranged between 41% and 71%. As a comparison, in all the other markets, the new entrant's market share never reached more than 47%. Perry explains away the first two outliers by the fact that Reno Air had substantial market presence in the Reno – Portland market, while in the Las Vegas – Oakland market, America West chose to reduce its presence from Oakland and to consolidate its operations at San Francisco airport. Finally, the New York – Buffalo case appears to be behaving differently from the other markets, but the decrease in incumbent traffic in this case is quite small (2%) and can thus be considered as remaining constant.

Perry observes that, although new entrant airlines are responsible for the initial introduction of low-fares in the market, a portion of the increase in local traffic is related to the apparent response of the established carriers. In addition, Perry notes – as do we – that the established airlines' share of stimulated traffic[11]

[11] To compute stimulated traffic, we follow Perry's definition and subtract pre-entry total traffic from post-entry total traffic. The incumbent stimulated traffic is then the difference between stimulated traffic and post-entry new entrant traffic. The established airlines' share of stimulated traffic is calculated as the portion of the stimulated traffic that is carried by the established airlines in the market.

varies greatly by market, as shown in Table 4.5. On average, in those market where there is an increase in total traffic after entry, and the incumbents experience an increase in their local traffic from entry (i.e. all markets other then Reno – Portland, Las Vegas – Oakland, and New` York – Buffalo), the incumbent's average share of stimulated traffic[11] is about 41%, with extreme values at 1% and 94%.

MARKET	QUARTER OF ENTRY	INCUMBENT CARRIERS	NEW ENTRANT	TRAFFIC STIMULATION INCUMBENT	TRAFFIC STIMULATION NEW ENTRANT	SHARE OF TRAFFIC STIMULATION INCUMBENT	SHARE OF TRAFFIC STIMULATION NEW ENTRANT
ATL-CLT	97-2	DL	J7	26,400	11,710	**69%**	**31%**
ATL-MCI	96-4	DL	NJ	25,210	32,190	**44%**	**56%**
ATL-MCO*	94-1	DL-TW	J7	72,030	162,100	**31%**	**69%**
CLE-BWI	93-3	US-CO	WN	263,990	167,460	**61%**	**39%**
DFW-ICT	95-2	AA-DL	NJ	640	63,260	**1%**	**99%**
DTW-BOS	96-2	NW	NK	106,330	6,360	**94%**	**6%**
DTW-PHL	95-4	NW-US	NK	15,600	43,180	**27%**	**73%**
MSP-MCI	95-2	NW-TW	NJ	57,550	30,420	**65%**	**35%**
PIT-BOS	95-3	CO-US	N5	1,450	9,070	**14%**	**86%**
PIT-PHL	95-1	US	N5	84,790	69,000	**55%**	**45%**
SLC-SAN	93-2	DL	KN/WN	106,220	78,050	**58%**	**42%**
STL-IND	89-2	TW	WN	34,400	53,520	**39%**	**61%**
PHX-BUR	92-2	*HP*	*WN*	44,430	132,380	**25%**	**75%**
SEA-GEG	93-2	AS	KN/WN	20,470	238,010	**8%**	**92%**
RNO-PDX	92-3	AA-HP	QQ	(16,940)	57,740		**100%**
LAS-OAK		HP	WN	(103,060)	211,090		**100%**
NYC-FLL	00-2	AA-CO-DL-U	B6	252,390	365,990	**41%**	**59%**
NYC-BUF	00-2	AA-CO-DL-U	B6	(8,510)	289,660		**100%**

Table 4.5: Share of stimulated traffic between incumbent and new entrant carriers (Source: OD Plus database & Perry 1995)

As mentioned earlier, Perry attributes the difference in traffic stimulation by market, to market characteristics (including size and sensitivity of the market) and competitive response characteristics (including mix of airlines, level of service and competitive response to entry). From this high-level study of the impact of entry on traffic (and fares), it is impossible to conclude whether market characteristics were a driver of the response to entry in each market. We can however conclude that entry usually benefits all carriers in terms of local passengers carried in the local market. An increase in traffic does not necessarily lead to increased revenues or profits at the network level (or even at the local market level if fares are lower), as some of the additional local passengers can be displacing connecting passengers and thus lead to lower revenues or profits. We highlight the impact on average fares in the next paragraph.

Effects of Entry on Average Local Fares

The other measure Perry focuses on is average local market fare. Table 4.6 shows the average local market fare for the entire market before and after entry, the average local market fare on the incumbent carriers before and after entry (as defined previously), and the average market fare for the new entrant upon entry. We now observe that in all but one case, the average local market fare decreased after entry, on a yearly basis. The only exception to this observation appears in the Pittsburgh – Boston market where the post-entry average market fare slightly increased overall (as did traffic), as discussed earlier.

		AVG. ONE-WAY FARES			ANNUAL INCUMBENT AVG ONE-WAY FARE			ANNUAL POST-ENTRY ENTRANT AVG FARE	FARE DIFFERENTIAL: NEW ENTRANT - INCUMBENT	
MARKET	NEW ENTRANT	Pre-Entry	Post-Entry	Percent Change	Pre-Entry	Post-Entry	Percent Change		Absolute	Relative
ATL-CLT	J7	$ 137.39	$ 122.98	-10.5%	$ 137.39	$ 127.90	-6.9%	$49.87	$78.03	61.0%
ATL-MCI	NJ	$ 120.58	$ 116.36	-3.5%	$ 120.58	$ 122.28	1.4%	$77.47	$44.81	36.6%
ATL-MCO*	J7	$ 148.44	$ 89.95	-39.4%	$ 148.44	$ 99.82	-32.8%	$63.78	$36.04	36.1%
CLE-BWI	WN	$ 179.17	$ 31.73	-82.3%	$ 179.17	$ 35.46	-80.2%	$24.60	$10.87	30.6%
DFW-ICT	NJ	$ 104.16	$ 64.60	-38.0%	$ 104.16	$ 79.66	-23.5%	$45.96	$33.70	42.3%
DTW-BOS	NK	$ 211.86	$ 137.92	-34.9%	$ 211.86	$ 139.20	-34.3%	$69.35	$69.86	50.2%
DTW-PHL	NK	$ 163.03	$ 142.35	-12.7%	$ 163.03	$ 155.40	-4.7%	$60.69	$94.71	60.9%
MSP-MCI	NJ	$ 192.32	$ 100.66	-47.7%	$ 192.32	$ 109.92	-42.8%	$47.14	$62.78	57.1%
PHX-BUR	WN	$ 62.54	$ 44.17	-29.4%	$ 62.54	$ 49.59	-20.7%	$37.04	$12.55	25.3%
PIT-BOS	N5	$ 148.46	$ 150.68	1.5%	$ 148.46	$ 153.36	3.3%	$86.38	$66.99	43.7%
PIT-PHL	N5	$ 139.89	$ 94.73	-32.3%	$ 139.89	$ 101.46	-27.5%	$57.33	$44.14	43.5%
SLC-SAN	KN/WN	$ 128.00	$ 70.00	-45.3%	$ 128.00	$ 71.00	-44.5%	$67.80	$3.20	4.5%
STL-IND	WN	$ 122.00	$ 44.00	-63.9%	$ 122.00	$ 51.00	-58.2%	$32.95	$18.05	35.4%
SEA-GEG	KN/WN	$ 85.00	$ 47.00	-44.7%	$ 85.00	$ 68.00	-20.0%	$23.00	$45.00	66.2%
RNO-PDX	QQ	$ 81.00	$ 68.00	-16.0%	$ 81.00	$ 68.00	-16.0%	$68.00	$0.00	0.0%
LAS-OAK	WN	$ 79.00	$ 56.00	-29.1%	$ 79.00	$ 66.00	-16.5%	$51.99	$14.01	21.2%
NYC-FLL	B6	$ 117.18	$ 112.64	-3.9%	$ 117.18	$ 113.02	-3.5%	$110.38	$2.64	2.3%
NYC-BUF	B6	$ 125.85	$ 90.22	-28.3%	$ 125.85	$ 108.01	-14.2%	$64.63	$43.38	40.2%

Table 4.6: One-way average fares for total market, incumbent and new entrant (Source: OD Plus, Perry, Official Airline Guide)

When studying the average market fare on the incumbent carrier, we find that it usually decreases after entry. Once again, there is a single exception to this observation, namely the Atlanta – Kansas City market. In this market, the average local fare on the incumbent carrier remained stable (increased very slightly) from the year prior to entry to the year following entry. The average market fare decreased overall, however, consistent with other market observations.

Finally, when comparing the average fare on the incumbents and on the new entrant, we observe that in all markets (other than Reno – Portland) the average fare on the incumbent was higher, and in most cases substantially higher, than on the new entrant carrier. On average, the local fare on the new entrant carrier was 36% lower than on the incumbent carrier, and as much as 66% lower in the Seattle – Spokane market.

Comparing the effects of entry on average fares and on total local traffic in the sample markets described earlier shows that, upon entry, similar changes in local traffic can be accompanied by very different effects on average fares. As a result, we conclude that, while average fares and total traffic are directly linked, the analysis of the effect of entry on average fares and total traffic overlooks the effect of very important additional factors. For example, the Pittsburgh – Philadelphia and Salt Lake City – San Diego markets exhibited similar patterns in terms of the incumbent's share of post-entry local traffic stimulation (55% and 57% respectively, as shown in Table 4.5). The average market fare on the new entrant in the Pittsburgh – Philadelphia market, however, was 43.5% lower than that of the incumbent carrier, compared to 4.5% lower in the Salt Lake City – San Diego market. Furthermore, the overall traffic stimulation was 52% in the Pittsburgh – Philadelphia market, compared to 281% in the Salt Lake City – San Diego market. We therefore conclude that there must be external factors affecting these differences, be they market related or linked to the preference of passengers for a particular carrier. This further supports the observation that average fares and local traffic paint a very incomplete picture of the effects of entry.

Overall, the general conclusion from the analysis of fares in response to entry is that average market fares tend to decrease after entry, as do average market fares on the incumbent. Furthermore, incumbent average fares are likely to remain higher than those of the new entrant carrier. These observations do not explain the impact that flows of connecting passengers might have had in influencing the number of seats made available to various passengers (local market or connecting passengers), and therefore do not lead to the conclusion that the incumbent carriers' fares remained higher than those of the new entrant.

Effects of Entry on Local Market Capacity and Departures

In an attempt to provide additional information, Perry studied the change in nonstop aircraft departures before and after entry in each market. Let us note here that nonstop aircraft departures are a useful measure to evaluate frequency of service, but that it does not give enough detail as to the available capacity in the market.

In the following discussion, we use Perry's data on nonstop aircraft departures in the market, along with estimated aircraft departure gathered from Official Airline Guides (OAGs) and ASQP data. Perry notes that, in response to entry, incumbent carriers behaved very differently in all of the markets studied. As shown in Table 4.7, in some markets (such as Phoenix – Burbank), incumbent carriers responded with an increase in the frequency of service, while in other markets, the incumbents did not change their number of departures (e.g. Salt Lake City – San Diego) or even decreased their frequencies (e.g. Las Vegas – Oakland).

MARKET	NEW ENTRANT	ANNUAL INCUMBENT A/C DEPARTURES Pre-Entry	Post-Entry	% Change	ANNUAL POST-ENTRY NEW ENTRANT A/C	TOTAL MARKET-LEVEL DEPARTURES Pre-Entry	Post-Entry	SHARE OF DEPARTURES Incumbents	New Entrant
ATL-CLT	J7	2,822	2,860	1.4%	368	2,822	3,228	89%	11%
ATL-MCI	NJ	2,509	2,564	2.2%	822	2,509	3,386	76%	24%
ATL-MCO*	J7	4,963	4,200	-15.4%	1,500	4,963	5,700	74%	26%
ATL-MCO	estimated by Perry w/ 6mo data - Jan-Jun 1994								
CLE-BWI	WN	1,940	3,096	59.6%	1,344	1,940	4,440	70%	30%
DFW-ICT	NJ	5,241	5,449	4.0%	939	5,241	6,387	85%	15%
DTW-BOS	NK	3,246	3,421	5.4%	183	3,246	3,604	95%	5%
DTW-PHL	NK	3,493	3,304	-5.4%	365	3,493	3,669	90%	10%
MSP-MCI	NJ	2,086	2,935	40.7%	801	2,086	3,736	79%	21%
PHX-BUR	WN	1,400	1,989	42.1%	1,290	1,400	3,279	61%	39%
PIT-BOS	N5	3,181	3,325	4.5%	600	3,181	3,925	85%	15%
PIT-PHL	N5	4,671	3,961	-15.2%	1,329	4,671	5,290	75%	25%
SLC-SAN	KN/WN	1,427	1,448	1.5%	635	1,427	2,083	70%	30%
STL-IND	WN	1,750	1,792	2.4%	1,614	1,750	3,406	53%	47%
SEA-GEG	KN/WN	1,315	907	-31.0%	1,258	1,315	2,165	42%	58%
RNO-PDX	QQ	678	800	18.0%	1,332	678	2,132	38%	62%
LAS-OAK	WN	1,486	834	-43.9%	758	1,486	1,592	52%	48%
NYC-FLL	B6	6,272	6,680	6.5%	1,602	6,272	8,282	81%	19%
NYC-BUF	B6	6,256	6,994	11.8%	1,473	6,256	8,467	83%	17%

Table 4.7: Pre- and post-entry aircraft departures (each way) (Source: OAG and ASQP databases, and Perry)

Perry also stresses that these observations are valid only for the local origin-destination markets, and do not take into consideration the fact that other flights might have been available at competing airports, and might therefore have changed as a consequence of entry. For example, a parallel market to the Las Vegas – Oakland market could be Las Vegas – San Francisco. Thus, the numbers discussed in this paper do not reflect the impact of entry at Oakland airport on the San Francisco area as a whole.

Conclusions

As evidenced by the highly variable relationships between total traffic, average fares and departures in a specific market, it is clearly insufficient to only study aggregate measures of entry to understand how incumbent revenues and traffic are affected by entry and to assess the incumbent carrier's response to entry. Indeed, for the set of markets studied in this sample, additional information would be required to fully explain the relationship between total market traffic, average fares and departures, and why they differ from market to market. The only conclusions that such a high-level analysis provides are that, in general, low-fare entry leads to:

1. An increase in total local market and incumbent local traffic (c.f. Table 4.4)
2. A decrease in average fares, both at the market level and on the incumbent carriers (c.f. Table 4.6)
3. An increase in total market aircraft departures (c.f. Table 4.7).

In addition, revenue numbers are easily derived from our analysis of average fares and traffic in each market, and shown in Table 4.8. In particular, total pre and post-entry annual market revenues and incumbent annual market revenues show that, again with the exception of a few markets (Detroit-Boston, Minneapolis-Kansas City, and Saint Louis-Indianapolis), total market revenues increased after entry. Looking at incumbent revenues, we note that in more than half the cases, entry led to a decrease in revenues. Although the data indicates that incumbent average fares and revenues decreased, while local incumbent traffic increased, it would be incorrect to conclude that the incumbents competed unfairly. Such a conclusion implies that the decrease in average incumbent local market fare was designed to stimulate traffic, which, in an elastic market, should have led to a relatively greater increase in traffic and eventually in an increase in revenues. Reaching such conclusion would pose two major problems: First and foremost, these are local revenues that completely overlook the impact of entry on network flows and network revenues. Second, revenues are a direct consequence of the changing consumer choice and can therefore have decreased as a result of the diversion of high fare passengers towards the new entrant or cheaper seats on the incumbent.

	OF	NEW	TOTAL LOCAL MARKET REVENUES			INCUMBENT LOCAL MARKET REVENUES		
MARKET	ENTRY	ENTRANT	Pre-Entry	Post-Entry	% Change	Pre-Entry	Post-Entry	% Change
ATL-CLT	97-2	J7	$ 20,274,127	$ 22,834,531	**13%**	$ 20,274,127	$ 22,250,579	**10%**
ATL-MCI	96-4	NJ	$ 22,423,788	$ 28,316,249	**26%**	$ 22,423,788	$ 25,822,531	**15%**
ATL-MCO*	94-1	J7	$ 53,139,688	$ 53,263,942	**0%**	$ 53,139,688	$ 42,925,458	**-19%**
CLE-BWI	93-3	WN	$ 10,119,711	$ 15,483,664	**53%**	$ 10,119,711	$ 11,364,939	**12%**
DFW-ICT	95-2	NJ	$ 8,091,829	$ 9,147,057	**13%**	$ 8,091,829	$ 6,239,665	**-23%**
DTW-BOS	96-2	NK	$ 49,290,481	$ 47,630,159	**-3%**	$ 49,290,481	$ 47,189,099	**-4%**
DTW-PHL	95-4	NK	$ 41,530,168	$ 44,630,118	**7%**	$ 41,530,168	$ 42,009,524	**1%**
MSP-MCI	95-2	NJ	$ 22,753,459	$ 20,765,046	**-9%**	$ 22,753,459	$ 19,331,016	**-15%**
PHX-BUR	92-2	WN	$ 8,387,341	$ 13,542,754	**61%**	$ 8,387,341	$ 8,639,270	**3%**
PIT-BOS	95-3	N5	$ 32,052,015	$ 34,115,744	**6%**	$ 32,052,015	$ 33,332,314	**4%**
PIT-PHL	95-1	N5	$ 41,747,228	$ 42,837,805	**3%**	$ 41,747,228	$ 38,882,312	**-7%**
SLC-SAN	93-2	KN/WN	$ 8,400,640	$ 17,493,000	**108%**	$ 8,400,640	$ 12,201,350	**45%**
STL-IND	89-2	WN	$ 6,108,540	$ 6,071,560	**-1%**	$ 6,108,540	$ 4,307,970	**-29%**
SEA-GEG	93-2	KN/WN	$ 21,378,350	$ 23,969,530	**12%**	$ 21,378,350	$ 18,494,640	**-13%**
RNO-PDX	92-3	QQ	$ 5,208,300	$ 7,146,800	**37%**	$ 5,208,300	$ 3,220,480	**-38%**
LAS-OAK		WN	$ 14,823,560	$ 16,557,520	**12%**	$ 14,823,560	$ 5,582,280	**-62%**
NYC-FLL	00-2	B6	$ 220,935,754	$ 282,024,698	**28%**	$ 220,935,754	$ 241,626,800	**9%**
NYC-BUF	00-2	B6	$ 53,511,045	$ 63,729,035	**19%**	$ 53,511,045	$ 45,006,972	**-16%**

Table 4.8: Total local market and incumbent revenues pre- and post-entry (Source: OD Plus database)

In the next section, we therefore take a more detailed look at the data for two specific markets, Detroit – Boston and Atlanta – Orlando. The former market was classified by Oster and Strong as potentially reflecting anticompetitive behaviors. The latter market was listed by Perry as a market with a new entrant airline in 1995, but not classified as potentially anticompetitive by Oster and Strong in their 2001 paper.

We therefore chose to compare these presumably different markets, with respect to the competitive behaviors of the carriers operating in these markets.

4.2. Two Case Studies: Atlanta-Orlando and Detroit-Boston

In order to better understand Oster and Strong's claims that low-fare competition has led to a decrease in fares on short-haul routes, and to bring more depth and understanding into the mechanisms of entry described by Perry, we study two specific origin-destination markets, Atlanta-Orlando and Detroit-Boston. Both markets are mentioned by Perry as having low-fare competition, while the latter is further described by Oster and Strong as potentially exhibiting anticompetitive practices from established network carriers.

In the following subsections, we study each market individually and in detail. We then compare the observations made for each market to determine whether we can actually conclude that one is significantly different from the other and exhibits anticompetitive behavior from the incumbent carriers. Results show that while the outcome of entry in these markets was significantly different (AirTran is still competing in the Atlanta-Orlando market, while Spirit failed in the Detroit-Boston market), measures of (and changes in) average fares, total traffic and revenues are comparable for both incumbent carriers, and therefore provide very little insight as to the relative performance of individual carriers and the response of incumbent carriers.

4.2.1. Atlanta-Orlando

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) with a DC9-32 aircraft (with a capacity of about 115 seats). ValuJet entered the market with substantially lower fares than those offered by the other nonstop carriers in the market (Delta Airlines and Trans World Airlines). In the quarter before entry, Delta and TWA were both offering nonstop service in the market, at an average one-way fare of $118 and $88 respectively. In terms of market share, Delta carried about 80%-90% of the nonstop local traffic, while TWA carried the remaining 10%-20%.

At the end of the second quarter of 1994, Kiwi entered the market with as many as two daily flights, effectively providing additional low-fare competition in the market and directly competing with ValuJet in the low-fare segment in the this market.

Almost ten years later, ValuJet is still operating in the market (under the name AirTran), as is Delta. TWA, on the other hand, left the market during the third quarter of 1994, and was eventually purchased by American Airlines in 2001. Similarly, Kiwi exited the market in the first quarter of 1998, as it ceased operations.

In the following paragraphs, we first look at an overview of the changes engendered by ValuJet's entry in the market, then focus on incumbent carrier data, and finally look at entry data for ValuJet. We do not focus on Kiwi as it behaved as a follower while ValuJet was the carrier that "challenged" the established carriers, but we do show numbers relative to its performance in Table 4.10.

Market Overview

Total traffic numbers, as reported in Table 4.10, began increasing slowly in the last quarter of 1993, before increasing by almost 70% upon entry by ValuJet. Generally speaking, entry by ValuJet in this market led to an increase in traffic, and a change in the base traffic for this market, as shown on Figure 4.1. Before entry, total local one-way traffic ranged in the 80,000 passengers per quarter. After entry, this number more than doubled as Delta's share of traffic plummeted to less than 50% by 1995, while ValuJet and Kiwi shared the remainder of traffic.

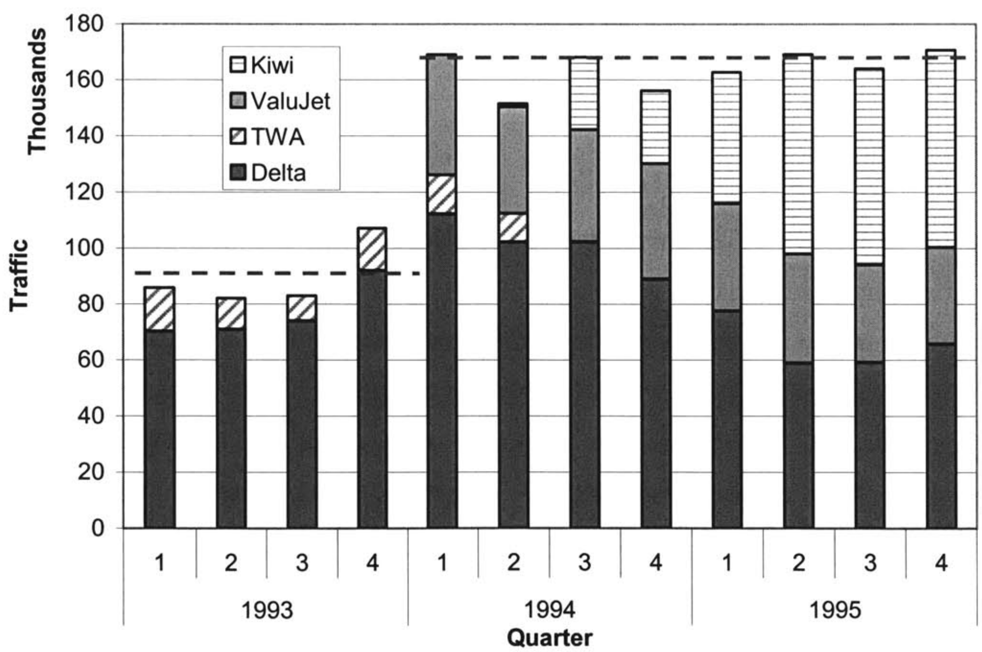


Figure 4.1: Total local traffic (nonstop) before and after ValuJet entry

The one-way average market fare, on the other hand, sharply decreased after entry as shown in Table 4.6, from about \$150 to just below \$90 (~ -40%). In the two years following entry, the average market fare remained at this lower level.

Finally, let us note that after entry, TWA quickly exited the market within a couple of quarters.

Incumbent Network Carriers: Delta and TWA

While Atlanta is a hub for Delta Airlines, it was, at the time, also a mini-hub on TWA's network – between 1992 and 1996, TWA attempted to establish itself in Atlanta. Before entry by ValuJet, Delta carried between 70% and 90% of the nonstop local traffic, while TWA carried the remainder of the local passengers on this route. In terms of frequencies, Delta offered between 9 and 10 daily departures each way, compared to TWA's 3 daily departures, in the quarters preceding ValuJet's entry.

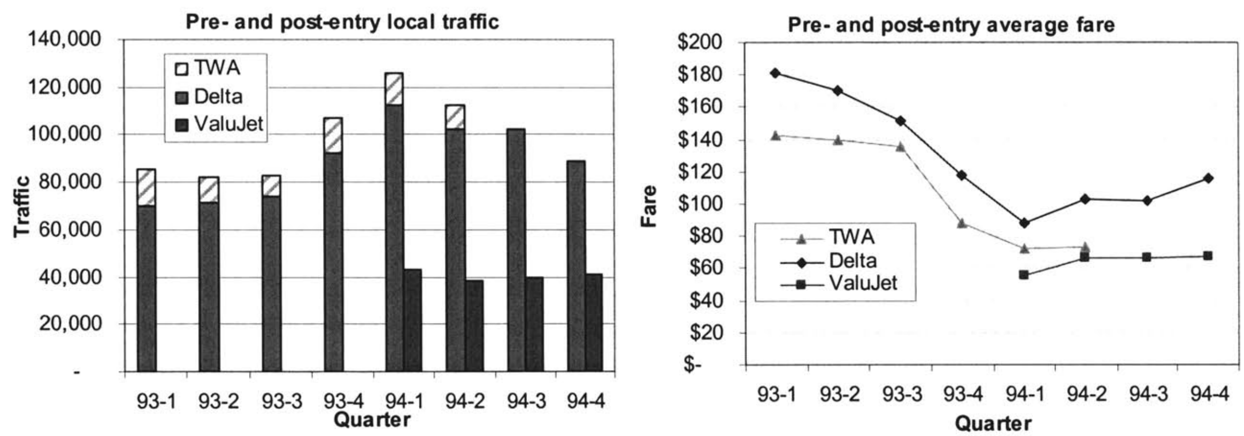


Figure 4.2: Change in local traffic and average market fares pre- and post-entry

In the quarter of entry by ValuJet, Delta's average one-way fare dropped from \$117.60 down to \$88.09 (-25%) while TWA's average fare decreased from \$88.13 to \$72.54 (-18%). Figure 4.2 also shows the change in local market traffic between the first quarter of 1993 and the last quarter of 1994. It appears that, while traffic on Delta and TWA combined seemed to remain relatively constant in the quarters prior to entry, it increased significantly in the last quarter of 1993 and in the first quarter of 1994, and then slowly began to decrease to come back down to its pre-entry levels. Note that as traffic started to decrease on the incumbents, the average fare on these same airlines began to increase slowly while the average fare on the ValuJet remained relatively constant. By the fourth quarter of 1994, Delta's average market fare was back up to pre-entry levels, and rising. In the meantime, TWA had exited the market.

In terms of total incumbent traffic, we observe that, while it is hard to make inferences from previous years in this particular market, the fourth quarter is traditionally not the strongest quarter for air travel. It is therefore unusual to see an increase in local traffic by almost 30% from the previous quarter during the last quarter of 1993. Furthermore, correcting for seasonality, on a year over year basis the increase was close to 50%. Similarly, in 1992 and 1993, the increase in traffic between the last quarter of the previous year and the first quarter of that year ranged in the 8%-9%. In 1994, the increase in traffic on the incumbent carriers was much greater (~18%). Finally, our last comment goes to the decrease in local market traffic during the entire 1994 year. This is again somewhat unusual in that the second quarter is traditionally among the strongest quarters of the year in this particular market and one would therefore have expected an increase in local traffic during that quarter. Instead, traffic steadily decreased by 11% between quarters 1 and 2 and 9% between quarters 2 and 3.

The decrease in total incumbent traffic between quarters 1 and 2 (of 1994) coincides with an increase in the average fare on Delta, and a reduction in TWA's presence in the market. The decrease in traffic between quarters 2 and 3 is more easily explained by the entry of Kiwi in the market, which further diverted traffic from the remaining incumbent carrier, Delta. Overall, traffic therefore increased compared to pre-entry levels. Furthermore, it appears that low-fare entry absorbed some of the seasonal effects, as traffic did not appear to follow traditional seasonal variations after entry.

Looking at market shares, we observe in Table 4.9 that Delta's share of local traffic was always above 80% in the year before entry, while TWA captured the remaining 10%-20% of traffic. Upon entry by ValuJet, Delta's market share decreased to 66%, while that of TWA dropped below 10%. This pattern further developed as TWA exited the market, and Delta's share of traffic dropped below 50% as ValuJet and Kiwi captured over 50% of total market shares (from the first quarter of 1995 and on).

	ONE-WAY DATA	93-1	93-2	93-3	93-4	94-1	94-2	94-3	94-4	95-1	95-2	95-3	95-4
DL	NS Flights/day each way	n/a	10.00	n/a	9.00	9.29	9.00	n/a	9.00	10.32	11.38	12.07	11.64
	Avg Fare	$ 180.85	$170.60	$ 151.15	$117.60	$ 88.09	$ 103.19	$ 101.96	$115.51	$ 137.30	$ 146.79	$141.66	$ 119.55
	Traffic	70,320	71,050	74,110	92,100	112,290	102,390	102,380	89,040	77,640	59,050	59,250	65,850
	Market Share (NS Pax)	82.0%	86.6%	89.3%	85.9%	66.4%	67.6%	60.9%	57.0%	47.7%	34.9%	36.1%	38.6%
	Market Share	81.3%	86.0%	88.7%	85.6%	66.2%	67.2%	60.6%	56.7%	47.5%	34.8%	36.0%	38.5%
TW	NS Flights/day each way	n/a	3.00	n/a	3.00	3.00	-						
	Avg Fare	$ 142.37	$139.64	$ 135.73	$ 88.13	$ 72.54	$ 73.48						
	Traffic	15,460	10,980	8,860	15,110	13,880	10,030						
	Market Share (NS Pax)	18.0%	13.4%	10.7%	14.1%	8.2%	6.6%						
	Market Share	17.9%	13.3%	10.6%	14.0%	8.2%	6.6%						

Table 4.9: Summary of pre-entry and post-entry effects on average fares, traffic, market share and departures for Delta and TWA

Focusing on departures and capacity, as shown in Table 4.9, we note that in the quarter of entry, Delta's number of departures increased from 9 daily departures each way to slightly over 10 daily departures each way (i.e. as many as 11 departures on certain days of the week). In addition, compared to the quarter before entry, we estimated the increase in capacity to be about 4% (from 2,270 seats per day each way to 2,350 seats per day each way, based on OAG aircraft type information).

	ONE-WAY DATA	93-1	93-2	93-3	93-4	94-1	94-2	94-3	94-4	95-1	95-2	95-3	95-4
DL-TW	NS Flights/day	n/a	13.00	n/a	12.00	12.29	9.00	n/a	9.00	10.32	11.38	12.07	11.64
	Avg Fare	$ 173.91	$ 166.46	$ 149.50	$ 113.45	$ 86.38	$ 100.54	$ 101.96	$ 115.51	$ 137.30	$ 146.79	$ 141.64	$ 119.55
	Traffic	85,780	82,030	82,970	107,210	126,170	112,420	102,390	89,040	77,640	59,050	59,260	65,850
	Market Share	99.2%	99.2%	99.3%	99.6%	74.4%	73.8%	60.6%	56.7%	47.5%	34.8%	36.0%	38.5%
J7	NS Flights/day each way					4.00	3.86	n/a	5.00	5.00	5.14	5.14	5.29
	Avg Fare					$ 55.50	$ 66.40	$ 66.42	$ 67.40	$ 66.56	$ 66.10	$ 67.75	$ 69.77
	Traffic					42,840	38,060	40,000	41,200	38,370	39,030	34,900	34,580
	Market Share					25.3%	25.0%	23.7%	26.3%	23.5%	23.0%	21.2%	20.2%
KP	NS Flights/day each way						n/a	n/a	2.00	3.00	5.00	6.00	8.00
	Avg Fare						$ 51.45	$ 57.23	$ 56.44	$ 68.85	$ 70.85	$ 69.90	$ 68.35
	Traffic						1,050	25,720	25,910	46,700	71,110	69,810	70,220
	Market Share						0.7%	15.2%	16.5%	28.6%	41.9%	42.5%	41.1%
Total	NS Flights/day	n/a	13.00	n/a	12.00	16.29	12.86	n/a	16.00	18.32	21.53	23.21	24.93
	Avg Fare	$ 173.54	$ 165.89	$ 149.27	$ 113.67	$ 78.80	$ 91.86	$ 86.93	$ 93.23	$ 101.12	$ 96.37	$ 95.46	$ 88.49
	Traffic	86,510	82,660	83,570	107,620	169,540	152,400	168,950	156,920	163,300	169,700	164,450	171,050

Table 4.10: Summary of pre-entry and post-entry effects on average fares, market share and traffic

Table 4.10 summarizes traffic, average fares, daily departures and market share for the incumbent carriers (Delta and TWA combined when both were operating nonstop service in the market, and Delta only after Q4-94), ValuJet, Kiwi, and the entire market. Total market numbers include connecting traffic on other carriers, but only nonstop flights in the market. Table 4.10 shows that, after entry, total traffic and total nonstop departures increased, while average fares dropped.

Aggregate measures of airline performance presented and discussed here for the incumbent carriers show that the apparent effect of entry on the incumbent carriers was a decrease in market share and average fare, accompanied by an increase in traffic. The implications for the incumbent carriers' response to low-fare entry are that they responded by adapting to the changing market conditions without necessarily aggressively matching the new entrant's fares, or further undercutting these fares. These observations are only based on aggregate measures of airline performance and, as mentioned in previous chapters, do not provide any detail as to the actual response of the incumbent carriers.

ValuJet

In the first quarter of 1994, ValuJet entered the Atlanta – Orlando market with up to four daily roundtrips (25 roundtrips per week), at an average fare of $55.50, roughly 51% lower than that of Delta and TWA combined in the quarter before entry. Furthermore, even compared to post-entry average fares, ValuJet's average fare was 36% lower than Delta and TWA's combined average fare, and even lower compared to Delta's average fare.

Figure 4.2 shows the result of ValuJet's strategy of entry, and in particular its rather stable average market fare and traffic in the four quarters following entry. Table 4.10 further confirms this observation for the year 1995 when the average fare on ValuJet remained relatively constant, while its traffic decreased slightly, as Kiwi entered the market and garnered market shares.

Figure 4.3 shows traffic and average market fare on ValuJet in the 10 quarters following entry. Starting in the second quarter of 1996, traffic on ValuJet began decreasing as a result of the crash of flight 592 (May 11, 1996) in the Everglades. However, in the period before then, traffic and average market fares remained relatively stable. ValuJet's market share ranged between 20% and 27% in the same period.

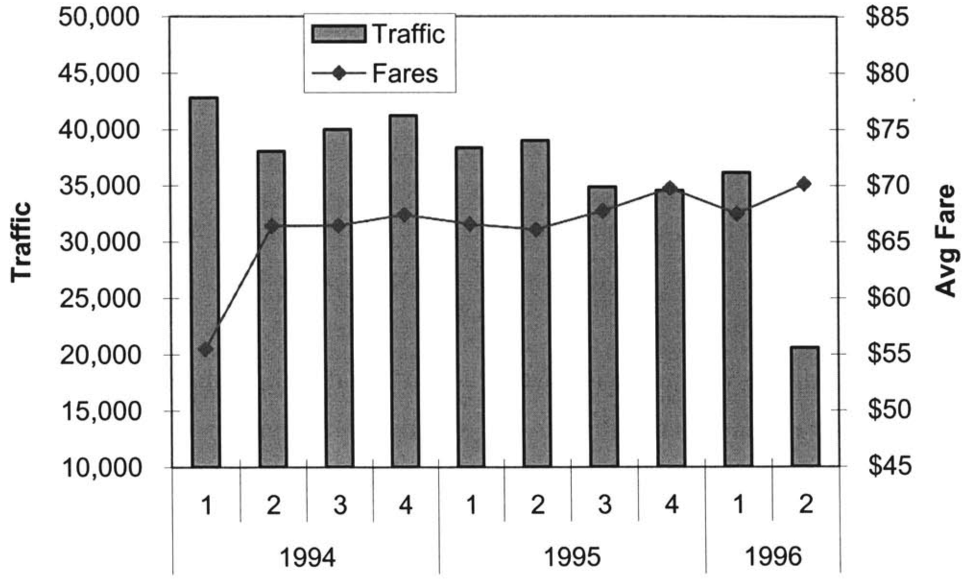


Figure 4.3: ValuJet traffic and average fares (Source: OD Plus database)

Finally, based on the OD Plus numbers for traffic and OAG data for nonstop flights, we find that the average number of local passengers per flight on ValuJet in the quarter of entry was 60 passengers. This number does not include any connecting traffic that might have been traveling on these particular flights and originating from (or heading to) cities beyond Atlanta. It does however provide an indication of the ability of each of the airlines to attract local market traffic, and the effect of the new entrant competition on the incumbent carrier's local traffic.

Local OD Pax/Flight	93-1	93-2	93-3	93-4	94-1	94-2	94-3	94-4	95-1	95-2	95-3	95-4
DL	n/a	34.7	n/a	48.6	57.1	68.6	n/a	53.8	41.8	28.5	26.7	30.7
J7					59.5	54.2	n/a	44.8	42.6	41.7	36.9	35.6
KP						n/a	n/a	70.4	86.5	78.1	63.2	47.7

Table 4.11: Local passenger loads per nonstop flight (does not include connecting traffic)

Other Competing Carriers

Other carriers also offered service in the market. In particular, American Airlines, Continental Airlines and US Airways carried passengers in the market, but only on connecting flights. In previous paragraphs, we also mentioned that Kiwi was operating in the market: Kiwi started offering nonstop service late in the second quarter of 1994, as TWA exited the market. Kiwi maintained a strong presence in the market (stronger than ValuJet starting in 1995) until the third quarter of 1996 when the FAA restricted its operations. At the peak of its presence, Kiwi offered as many as eight daily departures between Atlanta and Orlando, at an average fare comparable to that of ValuJet. In addition, as shown in Table 4.11, on average, Kiwi carried more passengers per flight than ValuJet. We note here that this is likely a reflection of the fact that Kiwi offered true origin-destination service in this particular market, while both Delta and ValuJet carried connecting passengers between and beyond Atlanta and Orlando.

In conclusion, the Atlanta-Orlando market appears to have been a very competitive market where new entrants prospered. As a result, TWA left the market and Delta substantially suffered in terms of market share. Traffic was however stimulated as a result of the decrease in average market fare. In addition, aggregate measures of airline performance give very little information as to the response of the incumbent carriers. We observed for instance that Delta's average market fare plummeted following ValuJet's entry into the market, while Delta's traffic increased. Within a few quarters, the average fare on Delta began increasing again, and traffic decreased. Our analysis show that these effects are related to Kiwi's increased presence in the market, but another analysis could also conclude that Delta increased its fares once it determined that it could not compete on price with ValuJet. In short, traffic and average fare variations do not explain the incumbent's response to entry.

4.2.2. Detroit-Boston

On April 15, 1996, Spirit Airlines started operating one daily roundtrip between Detroit and Boston with a DC9-21 aircraft (90 seats). This low cost, low fare carrier entered the market with substantially lower fares than those formerly offered by Northwest, the only airline previously offering nonstop service. Spirit's average one-way fare in the first quarter of operations was $68 compared to Northwest's previous quarter average one-way fare of $257. On September 8, 1996, Spirit exited the market, less than five months after its entry.

Total Market

Figure 4.4 summarizes the total traffic and average fare in the market in years 1995 and 1996, by quarter. We observe a substantial increase in year-over-year traffic, particularly in quarters 2 and 3. In addition, the average market fare appeared to be much more volatile with a sharp decrease coinciding with Spirit's entry in the market, and followed by a gradual increase after Spirit's exit from the market.

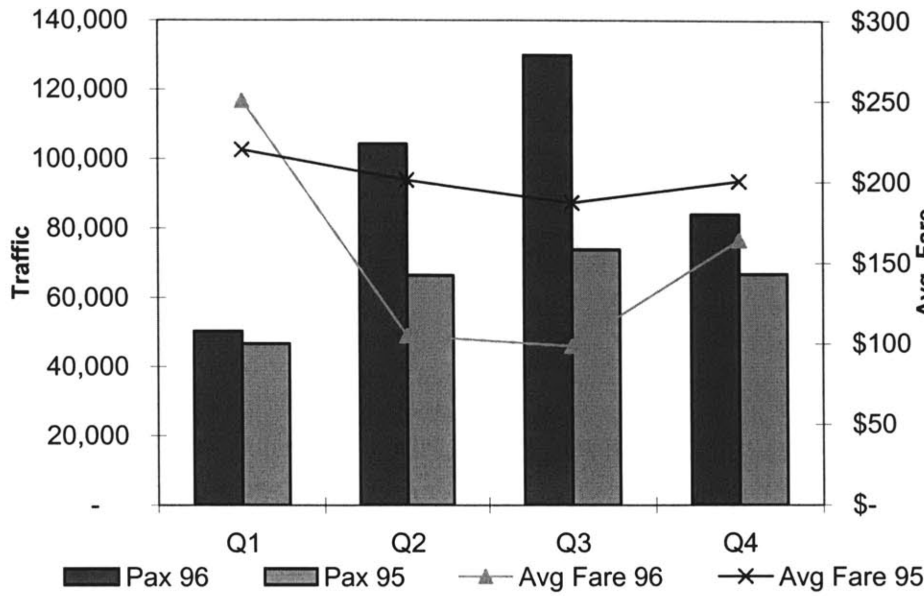


Figure 4.4: Total traffic and average fares

Generally speaking, entry by Spirit and Northwest's response led to a doubling of the total traffic in the market. Northwest's relative increase in traffic (113%) was even greater than the relative increase in total traffic (108%). Spirit's traffic, on the other hand, represented less than three percent of the total traffic in both of its quarters of operation in the market.

A substantial decrease in the average market fare accompanied entry by Spirit: The average market fare decreased from $250 to $105, as shown in Table 4.12. This decrease in average fare continued in quarter 3 of 1996, when the average market fare further decreased to $99 and finally started increasing again after Spirit exited the market. Note that Northwest's average market fare was consistently above the average total market fare by a few dollars, except in the second quarter of 1996 when Spirit started to compete (c.f. Table 4.12).

Within two quarters after entry, Spirit had exited the market (September 8, 1996), and, by the fourth quarter of 1996, Northwest recovered its position as the only nonstop carrier. Following Spirit's exit, Northwest's average fares as well as the average total market fares increased while traffic decreased in the market. By the first quarter of 1997, Northwest's average market fare was back up to its original level and the total traffic had decreased to its initial levels (Q1-1996).

Northwest Airlines

Detroit is a hub of Northwest Airlines. In the quarter of entry by Spirit, Northwest's average one-way fares dropped from $257 to $105 (-59%). One possible explanation to the dramatic reduction in

Northwest's average fares is that Northwest matched Spirit's fares. However, without actual fare information, such a conclusion cannot be reached with only aggregate data. The decrease in average fare on Northwest could also be the consequence of a dilution of local revenues because of the increase in capacity in the local market, or because of a change in consumer behavior.

Figure 4.5 shows Northwest traffic and average fare in 1995 and 1996, by quarter. In particular, Figure 4.5 illustrates the fact that traffic increased significantly more from Q1 to Q2 of 1996 than it did in 1995. The relative increase in traffic was 51% in 1995 between quarters 1 and 2 compared to the 113% increase in 1996 over the same period. Similarly, Figure 4.5 shows the change in average fare over the same periods, and highlights the greater decrease in average fares in 1996 compared to 1995. From quarter 1 to quarter 2, the average fare decreased by 10% in 1995 compared to 59% in 1996. Between quarters 3 and 4, after the exit of Spirit, a reverse pattern is illustrated in Figure 4.5: Traffic generally decreased while average fares increased slightly. Once again, the magnitude of the change was greater in 1996 than in 1995: Traffic decreased by 12% in 1995 compared to 40% in 1996. Fares increased by 9% in 1995 compared to 19% in 1996 over the same period.

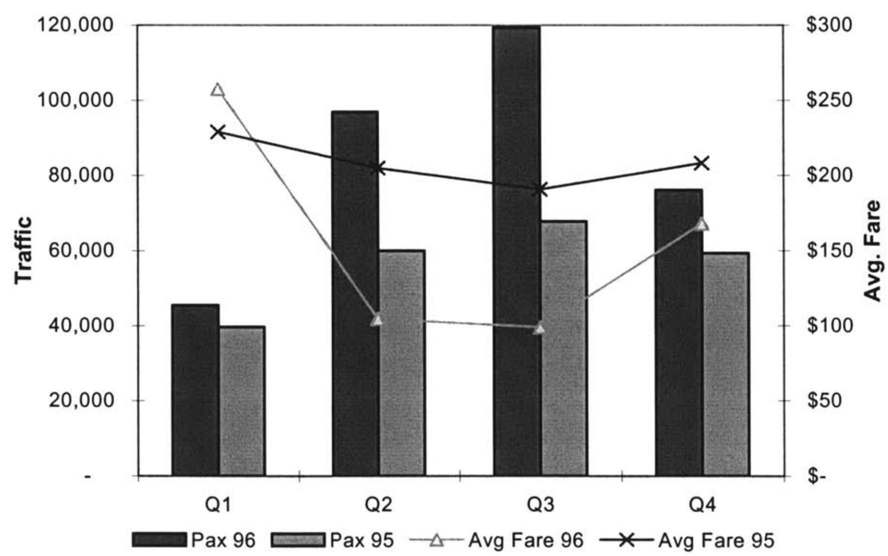


Figure 4.5: Northwest traffic and average fares by quarter in 1995 and 1996

Table 4.12 further summarizes the traffic, average fares and revenues in the market for the period from the first quarter of 1995 until the fourth quarter of 1997, by quarter, and for each of the aforementioned carriers as well as the totals for the market. Table 4.12 shows that Northwest's market share was always quite high – always above 85% and below 90% only in the first and fourth quarters of 1995 and the fourth quarter of 1997. This shows the overwhelming dominance of Northwest in this market, even when Spirit was competing. Note that Northwest's market share actually peaked during the two quarters when Spirit was competing. This last observation suggests that Northwest was a fierce competitor and responded quite aggressively to Spirit's entry. Northwest's response strategy succeeded and the airline was able to maintain and even increase its market share. However, it is once again only one of many possible explanations and cannot be confirmed by aggregate measures of performance.

ONE WAY DATA		Pre-Entry					Post-Entry / Competing		Post-Exit					
		95-1	95-2	95-3	95-4	96-1	96-2	96-3	96-4	97-1	97-2	97-3	97-4
NW	NS Flights/day	7.88	8.94	9.93	8.74	7.93	10.23	9.69	8.92	8.64	9.46	9.76	8.62
NW	Avg Fare	$228.81	$ 204.78	$190.71	$ 208.17	$ 257.45	$104.75	$ 99.14	$167.99	$ 266.61	$217.32	$201.83	$221.60
NW	Traffic	39,770	59,970	67,770	59,380	45,540	96,840	119,440	76,170	46,540	65,020	70,790	63,330
NW	Market Share	85.2%	90.2%	91.7%	88.8%	90.6%	92.9%	92.0%	90.5%	90.7%	91.4%	90.7%	89.3%
NK	NS Flights/day						1.00	1.00					
NK	Avg Fare						$ 68.49	$ 70.06					
NK	Traffic						2,880	3,480					
NK	Traffic						2.8%	2.7%					
Total	NS Flights/day	7.88	8.94	9.93	8.74	7.93	11.23	10.69	8.92	8.64	9.46	9.76	8.62
Total	Avg Fare (mkt)	$219.98	$ 201.07	$187.30	$ 200.64	$ 250.23	$105.09	$ 98.66	$164.28	$ 256.57	$212.03	$196.51	$213.46
Total	Traffic (mkt)	46,680	66,450	73,910	66,850	50,250	104,260	129,870	84,140	51,320	71,140	78,020	70,920

Table 4.12: Summary of pre-entry and post-exit effects

Table 4.12 also shows that the average number of daily flights operated by Northwest increased from quarter 1 to quarter 2 of 1996 by 2.3 daily flights (and by as much as three daily flights on some days), then slightly decreased in quarter 3 by 0.54 flights per day (which corresponds to almost 4 weekly flights) and finally settled down to about nine daily flights. It is interesting to compare this number to the pre-entry number of flights in the market for Northwest. After exit by Spirit, the total number of flights offered by Northwest was higher than in 1995-96 (before entry) in the fourth quarter of 1995 and first quarter of 1996, by about one daily frequency. The frequency of service did not increase in the second quarter of 1997, hence becoming comparable to that of the second quarter of 1995. Finally, unlike in 1995, the frequency of service still did not increase in the third quarter of 1997 and therefore became lower by about one flight, compared to the same quarter in 1995. In terms of capacity, compared to the year before entry, capacity (as measured using OAG data and generic aircraft capacity) increased by 12% on Northwest from 1,600 to 1,800 seats per day. Compared to the quarter before entry, the increase in capacity is even more dramatic, from 1,430 seats per day to 1,800, that is, a 25% increase in daily capacity.

Finally, we can compute the average number of local passengers per flight on Northwest, as shown in Table 4.13. We point out the substantial increase in the number of local market passengers carried by Northwest in the period of competition by Spirit, compared to the same time periods in 1995 (and 1997). Northwest carried 41% more local passengers per flight in the second quarter and 81% more local passengers in the third quarter, compared to 1995. Note once again that these numbers do not include connecting traffic that was also traveling on Northwest (or Spirit) flights, and therefore does not reflect load factors on either airline.

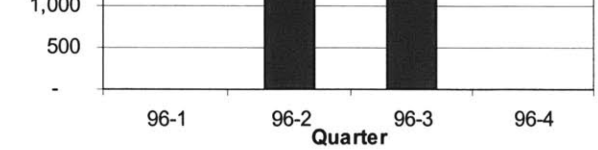
Local OD Pax/Flight	95-1	95-2	95-3	95-4	96-1	96-2	96-3	96-4	97-1	97-2	97-3
NW	28.05	36.84	37.08	36.91	31.89	52.00	67.00	46.40	29.91	37.78	39.44
NK						18.95	24.86				

Table 4.13: Local passenger loads per nonstop flight (days/quarter on NK: 76 and 70)

Spirit Airlines

Spirit entered the market with one daily roundtrip flight between Detroit and Boston at an average fare of $68, much lower than Northwest's average fare of $257 before entry (74% lower), and $105 after entry (35% lower). Figure 4.6 shows the traffic and fare of Spirit while it operated in the market and illustrates the increase in traffic (+21%) and average fare (+2%) from quarter 2 of 1996 to quarter 3 of 1996. In particular, we observe that the total traffic carried by Spirit in the quarter of entry represented just about 3% of the traffic carried by Northwest in the same quarter, but also only the equivalent of 6% of Northwest's traffic in the quarter before entry (Q1, 1996). In quarter 2 of 1996, Spirit had a 2.8% market share and a 2.7% market share in the third quarter of 1996.

Spirit exited the market in the fourth quarter of 1996, after having operated for less than two quarters.



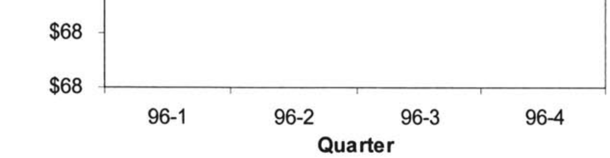


Figure 4.6: Spirit traffic and average fare by quarter, in 1996

Table 4.13 shows that Spirit carried fewer than 25 local passengers per flight, compared to Northwest's 50 to 70 local passengers per flight over the same period. This corresponds to average load factors below 28% on a DC9-21 with 90 seats in an all coach configuration.

Other Competing Carriers

In this market, between 1995 and 1997, there was no nonstop competition to Northwest Airlines, other than Spirit. In the last quarter of 1995 and the first quarter of 1996, Continental operated one weekly one-stop flight on Sundays. In the second quarter of 1996, America West offered six weekly one-stop flights. US Airways also offered six weekly one-stop flights in the fourth quarter of 1996, five weekly one-stop flights in the first quarter of 1997 and one daily one-stop flight in the third quarter of 1997. Altogether, competition in this market was always very limited, including when Spirit entered the market.

In conclusion, in the Detroit-Boston market, Spirit's attempt at competing with Northwest was unsuccessful. As a result, Spirit quickly withdrew from the market. Once again, aggregate measures of performance, such as average fares and traffic, do not provide much information as to the response of Northwest to entry by Spirit. While Spirit was unsuccessful in competing with Northwest in this market, and although Northwest's market share and traffic increased while its average fare decreased, it remains unclear whether these changes are a consequence of traffic stimulation and healthy competition, or rather the illustration of unfair competition from Northwest. In the following paragraphs, we compare the two markets and discuss the performance of individual carriers within the markets. We show that relative changes in average fares, traffic, revenues and market shares were comparable, which further highlights the inappropriateness of aggregate measures of performance in assessing the nature of an incumbent's response to entry.

4.2.3. Comparison of the Two Markets

From the above discussion, we conclude that the Detroit-Boston and Atlanta-Orlando markets were quite different in the way the entrant made price and schedule entry decisions, in the way the incumbents responded to these decisions, and in the way the markets responded to the changes in the competitive environment. The first and most obvious difference between these two markets is that ValuJet survived in the Atlanta-Orlando market, while Spirit ceased operations very quickly in the Detroit-Boston market. Another obvious distinction between the two markets is that ValuJet entered the Atlanta-Orlando market with four daily roundtrips, whereas Spirit only offered a single daily roundtrip in the Detroit-Boston market. Other differences include the effect on incumbent average fare, local market traffic and market share.

Using our revised version of Perry's classification of factors influencing new entrant performance, we respectively focus on the market and competitive response characteristics to clarify the differences in performance and success of each new entrant. We first discuss external factors that could have influenced the apparent performance of the new entrants, and that are not included in the market and competitive characteristics advocated by Perry.

External Factors influencing the Results

A few obvious factors play an important role in understanding some of the events in these markets. They should be accounted for when explaining the success and failure of each individual low-fare entrant. In particular, seasonality is a very important part of airline traffic, as traffic generally increases in the summer. Therefore, an increase (or decrease) in traffic should not be attributed to any particular factor without accounting for seasonality. We carefully took seasonality into consideration when studying each of these two markets.

Other external effects should also be considered: For example, our analysis focuses on the comparison of the period when Spirit was competing against Northwest as opposed to the period when Spirit did not operate in the market. However, other new entrants or economic effects (downturn, high oil prices, etc.) might have created similar conditions in the market at other times. Therefore, the analysis requires knowledge of the market as well as other external factors. Note that, in the case of the Detroit-Boston market, there was no other nonstop competition in the market during the period of interest. In the Atlanta – Orlando market, we mentioned Kiwi's entry as one of the factors that might have precipitated TWA's exit from the market and the success of ValuJet.

Market Characteristics

We first note that the market sizes were quite different, in that the Atlanta-Orlando market had a size of roughly 360,000 passengers per year before entry, compared to 233,000 passengers per year in the Detroit-Boston market. In addition, the market distance was 404 miles for Atlanta-Orlando compared to 630 miles for Detroit-Boston, a 50% greater distance in the latter market. Average fares followed similar patterns in that the average fare in the Detroit-Boston market was substantially higher (43%) than in the Atlanta-Orlando market. In short, the two markets had quite different pre-entry traffic and fare levels, with different distances between origin and destination cities.

These differences in market characteristics had an impact on each of the two new entrant carriers' operations and success in the market. A shorter distance in the Atlanta-Orlando market allowed ValuJet to achieve greater aircraft utilization, and thus might explain its greater frequencies than Spirit's. In addition, the stronger customer base in that market might have played in favor of ValuJet, but could also indicate greater potential for traffic increase in the Detroit-Boston market. Similarly, average fare levels – lower in the Atlanta-Orlando market – are indicative of a more competitive market where opportunities to reduce fares even further might have been limited, but where the threat of unfair competition might also have been smaller (given the existing competition).

Competitive Characteristics

Detroit-Boston was a monopoly market where Northwest had been the only airline flying nonstop (and charging higher fare since 1991), therefore carrying over 90% of the local traffic. In addition, Northwest was offering between 8 and 10 flights per day. By comparison, in the Atlanta-Orlando market, Delta and TWA had been competing since 1992 and were both offering nonstop service. Delta was flying roughly three times as many flights as TWA, and accordingly carrying 70%-80% of the local traffic. Altogether, the two carriers were offering between 11 and 13 daily departures.

In addition, the strategy of entry and the ensuing response appeared to be quite different in the two markets. First, Spirit entered the market with single daily flight, while ValuJet started service with as many as four flights per day on certain days of the week. Furthermore, Northwest appeared to more aggressively match the fares offered by Spirit, unlike Delta and TWA whose average fares decreased, but relatively less (-25% on DL compared to -60% on NW, on a quarterly basis).

A major similarity between the two markets worth noting here is that after a few quarters (four in the Atlanta – Orlando market, three in the Detroit – Boston market), average fares on the incumbent climbed back to their pre-entry level while traffic on the incumbent network carriers decreased back to pre-entry level. To better understand what happened, we can get even more detailed data on fare distributions (from raw DB1A data), as discussed in the following paragraphs.

Fare Distributions within each Market

Figure 4.7 highlights the change in average fare pre and post-entry in both markets used as case studies, and indicates a profound change in the competitive market environment. However, these pictures should not be used as the sole explanation of success or failure of an entrant. For example, the fact that Northwest's fare distribution clearly shifted towards lower fares after entry is not a reflection of a change in the pricing structure at Northwest or an indication that Northwest's strategy was more aggressive than Delta's. As a matter of fact, the actual range of fares offered (as reported in the DB1A database) did not appear to change. The real change occurred in the number of passengers traveling at low fares. For example, pre-entry, the total number of passengers flying on Northwest at fares between $50 and $100 was 200 during the first quarter of 1996. Post-entry, this number increased to 38,140 during the second quarter of 1996. In comparison, the total number of high fare passengers ($200 or more) decreased from 10,270 to 5,270 over the same time period.

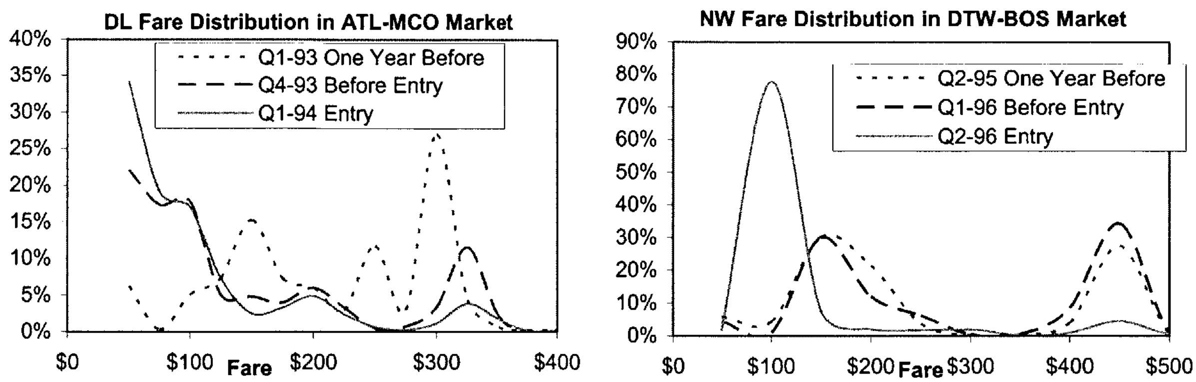


Figure 4.7: Fare distribution before and after entry in both markets (ATL-MCO and DTW-BOS) – Source: DB1A database

In the Atlanta-Orlando market, where it appears that the fare distribution shifted prior to entry, the pattern is similar, if not as pronounced: passengers traveling at fare at or below $100 increased from 23,620 to 36,660 while passengers traveling at fare greater than $100 decreased from 17,680 in the fourth quarter of 1993 to 15,460 in the first quarter of 1994. Once again the range of fares purchased by passengers remained the same from one quarter to the next.

This example of changes in fare distributions, as a function of passenger traffic rather than pricing decisions, reflects the effect of revenue management in allocating available seats to the range of fares offered within a particular market. This further highlights the relationship between revenue management and network flows of passengers in that the decision to sell more seats to low-fare local passengers should have been linked to the level of connecting traffic on the route.

We have therefore established a difference in structural market characteristics and in the strategy of entry of the two new entrant carriers: The Atlanta-Orlando market was a much larger market with exiting competition and lower fares than the Detroit-Boston market, and ValuJet entered the market with much higher frequencies than Spirit. In addition, we noted that the response of the two network carriers was quite different in terms of average fares, capacity increases and local traffic increases, when looking at a change from the quarter before entry to the quarter of entry. Lastly, the analysis of the change in fare distributions within each market highlighted the importance of revenue management and flow of network passengers in explaining the changes in average fares on incumbent network carriers.

4.3. Discussion and Conclusions

Based on annual aggregate numbers (e.g. Table 4.3), we concluded that there are great differences between various markets with new entrant competition, with respect to the success of entry and the response from the incumbents. These differences, according to Perry, stem from either market attributes, or from competitive characteristics.

However, this high-level market analysis of the effects of entry did not allow us to completely explain the differences between the responses of various incumbents to entry by diverse new entrants or the success of some entrants and not of others. We therefore studied in more detail two specific cases. The analysis of the Detroit-Boston and Atlanta-Orlando markets suggested that there were differences between the two markets, and pointed to market level differences and entry strategy differences along with potential differences in the response by incumbent carriers. The markets were quite different at the time of entry in that the Atlanta-Orlando market had a stronger customer base on a shorter length of haul and more competition. The strategies of entry were different in that ValuJet entered the Atlanta-Orlando market with more frequencies than Spirit in the Detroit-Boston market. In addition, as previously discussed, the response of Northwest appeared more aggressive than that of Delta.

Market level analyses allowed us to get more detail than the high-level analysis performed by Perry, and in particular to observe the differences between changes immediately after entry and year-over-year changes. In particular, we observed changes in market fares, traffic and departures that varied greatly depending on the date of the observation: In the Atlanta-Orlando market, we get a very different picture if we focus on immediate changes or on changes happening on a year-over-year basis. Year-over-year comparisons arguably give a better picture of the changes in the market, in that these measures account for seasonality various and thus allow unbiased comparisons of the effects of entry.

Table 4.14 summarizes the relative changes in each market, at the year-over-year level. The important conclusion from these numbers is that although we identified substantial differences between the two markets (structural and competitive), the response of incumbent carriers in terms of traffic, fares and revenues are not substantially different. Indeed, as shown in Table 4.14, the relative annual changes are very similar for both incumbents.

Airline	**Year-Over-Year Percent Change**			
	Traffic	Average Fare	Flights	Revenues
Delta ATL-MCO	+59.7%	-51.3%	Not available	-22.2%
Northwest DTW-BOS	+63.3%	-48.8%	+14.4%	-17.4%

Table 4.14: Relative change in quarterly traffic, average fare, departures and revenues on the incumbent

Table 4.14 shows these numbers in both markets, and highlights two important points:

1. Year-over-year trends were comparable in both markets: Increase in total local traffic, increase in total number of departures (and capacity) and decrease in average fares.
2. Year-over-year numbers could misleadingly tend to indicate that both markets were very similar with respect to competition and entry, even though we have shown that these markets are quite different. This further illustrates the fact that aggregate numbers do not provide a complete picture of the effect of entry. Furthermore, the more we aggregate the numbers, the less we learn about the market.

In conclusion, the survey and case studies have shown that, while previous analytical research efforts provided interesting insights on the effect of low-fare entry in a market (with respect to the impacts on total traffic, incumbent and new entrant traffic and revenues, average fares, etc.), the level of aggregation usually provided in these documents does not allow for a full analysis of the effects of entry beyond the local market. More specifically such analyses overlook the critical role of network flows of passengers for network carriers who rely on traffic beyond the local market to ensure profitable operations. As a result, focusing on local market numbers ignores the role of network flows for major network carriers as well as overstates the importance of local traffic for these carriers.

In particular, the relationship between revenue management and network flows is often ignored. Network flows typically allow the incumbents to maintain a higher frequency of service between small cities, even though local traffic may not be sufficient to support such service. However, when combined with high local traffic demand, revenue management becomes a necessary tool to adequately balance the available seats between local and connecting passengers in order to maximize revenues. Network revenue management tools therefore allow network carriers to tailor their resources – airplane seats – to the best mix of local and connecting passengers, not only as a function of the market demand, but also very importantly as a function of the competitive situation within its network. In particular, this last capability allows network carriers to maximize their revenues in response to entry in any particular market. For example, a decrease in a particular market's average fare might lead the revenue management system to determine that it is not an appropriate decision to carry any more low-fare leisure passengers in that market and thus decrease the availability of its seat inventory for this type of passengers. In this case, entry might have an adverse effect on incumbent local market traffic.

The performance and impact of entry on incumbent and new entrant carriers alike is determined not only by competitive responses from the incumbents, but also substantially by structural market differences and the relationship between revenue management and network flows of traffic. It is these last two effects that we explain and study in the remainder of the thesis, along with their impact on aggregate measures of airline performance such as average fares.

CHAPTER 5

SIMULATION OF ENTRY IN A COMPETITIVE ENVIRONMENT: THE SINGLE MARKET CASE

In previous chapters, we highlighted the growing presence of low-fare new entrant carriers, and the concerns of regulatory bodies around the world with respect to predatory behavior. We demonstrated through a survey of markets with low-fare competition and with an in-depth study of two particular markets that aggregate measures of airline performance (average market fares, local market revenues and market share) do not provide sufficient information to determine the nature of a response to entry. In addition, we also identified revenue management, passenger flows on the network, and relative new entrant capacity as critical factors affecting aggregate measures of airline performance in the case of low-fare entry.

Using the Passenger Origin Destination Simulator (PODS), we now simulate the impact of entry on various network situations, and focus the discussion on the effect of relative new entrant capacity, revenue management and flows of network passengers. To isolate the effect of network flows from the effect of revenue management and relative capacity, we first simulate entry in a single market case. The single-market case further limits the impacts of revenue management to those between the extremes of no revenue management and simple fare class revenue management. In this chapter, we first focus on the impacts of entry on incumbent carrier performance, as well as new entrant performance, under the assumption of leg-based fare class revenue management on all carriers and variable new entrant capacity. In Chapter 6, we allow for the competitive revenue management situation to range from first-come, first-served acceptance of seat requests to leg-based fare class revenue management, and thus assess the impact of revenue management on individual carrier performance. In a second set of simulations (Chapter 7), a network environment is simulated in order to assess both the effect of network flows of passengers as well as the impact of more advanced network revenue management methods on aggregate measures of airline performance.

5.1. The Passenger Origin Destination Simulator (PODS)

The remainder of the thesis presents results from the Passenger Origin Destination Simulator (PODS), a simulator of competitive airline networks. The simulator was originally developed by Hopperstad, Berge and Filipowski at the Boeing Company and is an extension of the Boeing Decision Window Model (Boeing Airplane Company, 1997) used to study the impact of flight schedules on airline market share. PODS simulates the choices by individual air travelers flying over a network of origin-destination markets served by several airlines. In the following sections, we first briefly introduce the simulator and its components, and then discuss the details of the passenger choice model used in PODS.

5.1.1. PODS Architecture

PODS simulates multiple repetitions (a.k.a. "samples") of the same departure day. The initial simulations of this departure day allow the airlines to progressively build the historical database they need to operate the forecasting component of their revenue management systems. Each PODS simulation consists of 5 independent sets of samples ("trials"), each composed of 600 successive (and thus correlated) simulations of departure days ("samples"). The initial 200 samples of each trial are discarded to eliminate the initial condition effects, and the results from the 5 trials are averaged to give stable and statistically significant results. For any given flight departure, on any given day in PODS, passengers start booking 63 days before departure. This 63 day period is divided into 16 time frames. The simulation outputs are the result of individual passenger choices and lead to airline performance measures, including airline traffic, revenues and loads.

Briefly described, the Passenger Origin Destination Simulator can be broken into four separate components, as illustrated in Figure 5.1. The first component is the historical database, which records passenger bookings from the beginning of the simulation. Historical bookings are then used by the forecaster to estimate future bookings on flights that have not yet departed. The forecasting component of PODS is composed of two sub-components: The detruncation sub-component and the forecasting sub-component. While the forecaster uses historical observed bookings to estimate bookings to come for a future flight departure and fare class, aircraft capacity constraints lead to constrained observations of demand (through passenger bookings) for any particular flight and fare class. Indeed, when a class closes down (i.e. becomes unavailable for booking) because of capacity constraints (or because the revenue management optimizer closed the class), the bookings recorded for that class are truncated bookings, constrained by the lack of remaining capacity to sell. As a result, it is necessary to estimate the "unconstrained" demand for that particular flight and class, that is, the total demand that would have been recorded had there been neither capacity nor revenue management constraints. This is the role of the detruncator. Given the unconstrained historical demand, the forecaster then estimates the demand for future flights. Skwarek (1996) and Zickus (1998) provide a detailed discussion of the forecasting models used in PODS.

Given the demand forecasts, the revenue management and seat inventory control component of PODS allocates seats for each fare class on future flights. The seat allocation process is performed using booking limits, which determine the maximum number of seats that can be sold within each fare class, and availability is set according to a nesting strategy. Nesting ensures that a minimum number of seats are made available within each fare class, but that additional seats can also be sold in higher fare classes, provided that the availability of lower fare classes is reduced by the amount of additional seats sold. A discussion of seat allocation strategies and nesting can be found in Belobaba (1987). The reader is referred to Lee (1998) and Darot (2001) for a detailed discussion of the seat allocation and revenue management algorithms used in PODS.

Finally, the booking limits and availability levels set by the revenue management system feed into the passenger choice component, which then determines individual passenger choices based on available seats for each fare class on any given flight. Passenger choices then loop back into the revenue management and seat allocation component which leads to a booking (if the passenger's choice is available) which is then recorded into the historical database. We discuss in more detail the passenger choice model used in PODS in the following section.

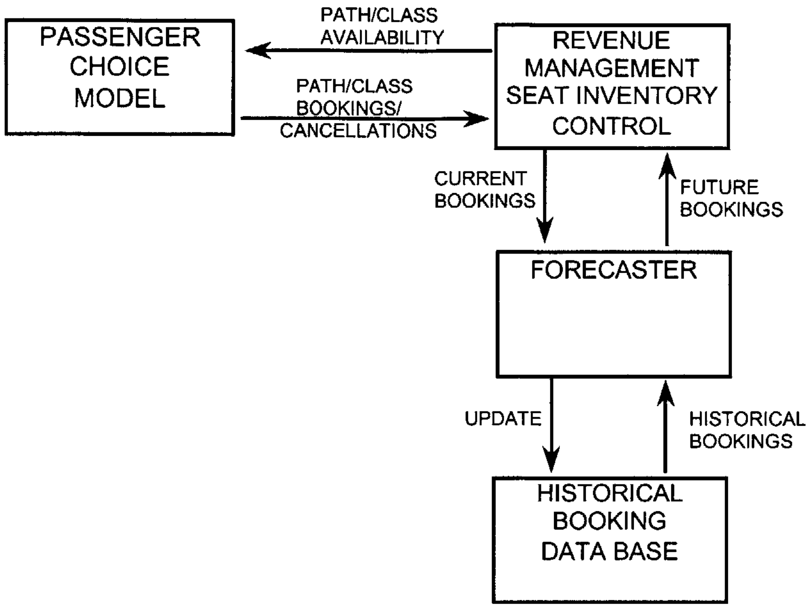


Figure 5.1: PODS architecture (Source: Hopperstad and The Boeing Company)

5.1.2. The Passenger Choice Model in PODS

The passenger choice model in PODS can be divided into four separate components or steps. In the first step, demand for air travel within a market on a particular day is generated. Second, individual passenger characteristics are then produced to reflect their preferences in terms of schedule, willingness to pay and disutilities of fare restrictions and other parameters. Third, the passenger choice set is defined based on passenger characteristics in relation to airline availability, and, in the fourth and final step, each passenger makes a decision within the alternatives available, based on individual preferences. Figure 5.2 illustrates the structure of the passenger choice model and its integration within the PODS simulator.

In the following paragraphs, we briefly discuss each of the four steps and focus on passenger characteristics which explain individual passenger choices. The reader is referred to Carrier (2003) for an extensive discussion of the passenger choice model in PODS.

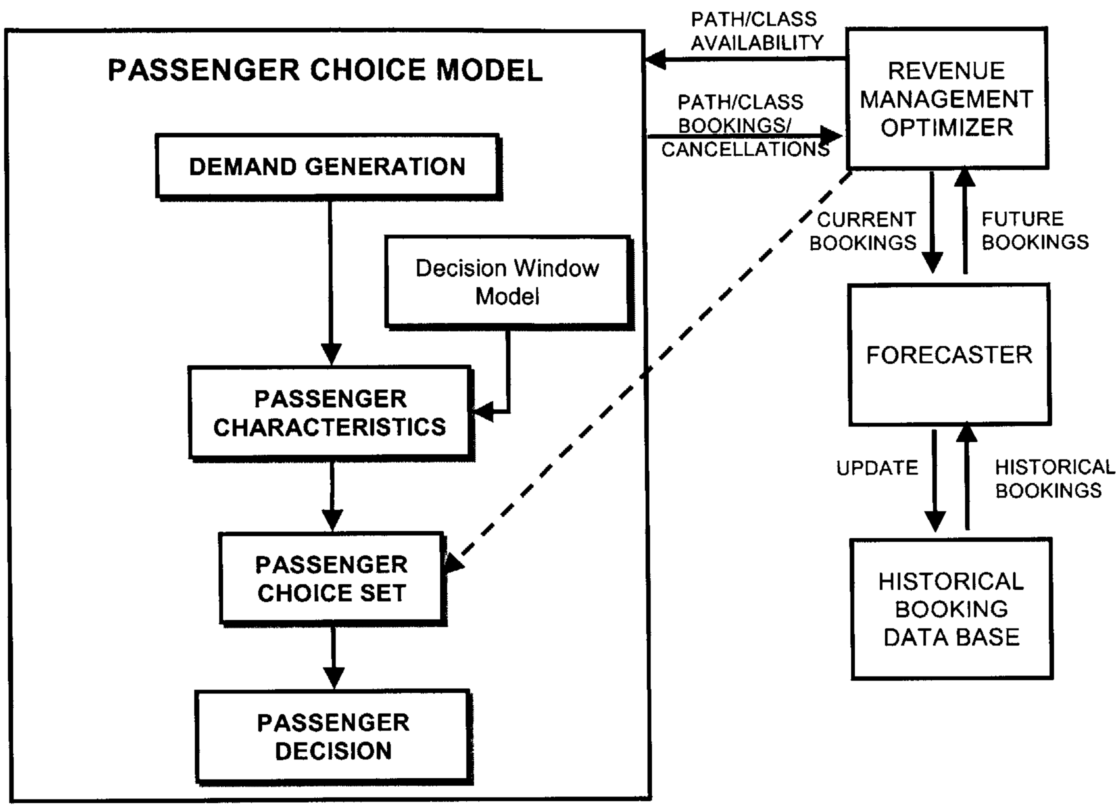


Figure 5.2: The passenger choice model in PODS

Demand Generation

In the first step of the passenger choice model in PODS, demand for air travel is determined. Average total daily demand for air travel is input for each of the markets simulated (based on airline data provided by the PODS Consortium airline members). This total demand is split between leisure and business passengers according to airline industry data, with 35% of business travelers and 65% of leisure travelers. Given this average total demand within each market, the simulator then incorporates random deviations around the average demand, according to the common industry practice of assessing a variability measure that depends on the magnitude of the mean. Two alternative forms have been suggested to represent this stochastic variation referred to as k- and z-factors. PODS uses a combination of the two methods to determine the deviation from the mean on any given day in a particular market and for a given passenger type (business or leisure), as explained by Wilson (1995). Finally, given the demand for each market and passenger type, the arrival of passengers of each type is set according to booking curves (which are inputs to the model).

Passenger Characteristics

Once demand has been determined, individual passenger characteristics are generated, according to three categories: Schedule preference (decision window), willingness to pay, and disutilities associated with fare restrictions and other parameters. Each passenger is assigned a decision window, which can conceptually be viewed as the combination of an earliest allowable departure time and a latest allowable arrival time. In PODS, the decision window is defined by its width (difference between the earliest departure time and latest arrival time) and its position during the day. The width of the decision window is determined as the sum of the minimum travel time in the market and a random parameter, the schedule tolerance. The value of the schedule tolerance is defined randomly for each individual traveler but depends on the market stage length and the passenger trip purpose. Decision windows are on average shorter for business travelers than for leisure travelers to reflect the importance of time and schedule on business passengers. Given the decision window, all paths and fare class combinations that fit within the window are equally attractive to the passenger, while all other paths are equally unattractive and incur a replanning disutility, as discussed below.

The maximum willingness to pay represents the maximum fare value a passenger is willing to pay to travel. As a result, any fare above the maximum willingness to pay of the passenger will be excluded from his choice set. Maximum willingness to pay values are assigned randomly for each passenger, but drawn from a price-demand curve for each passenger type, which represent the total passenger demand (or proportion of passengers) willing to pay a given price for travel within a particular market, as illustrated in Figure 5.3.

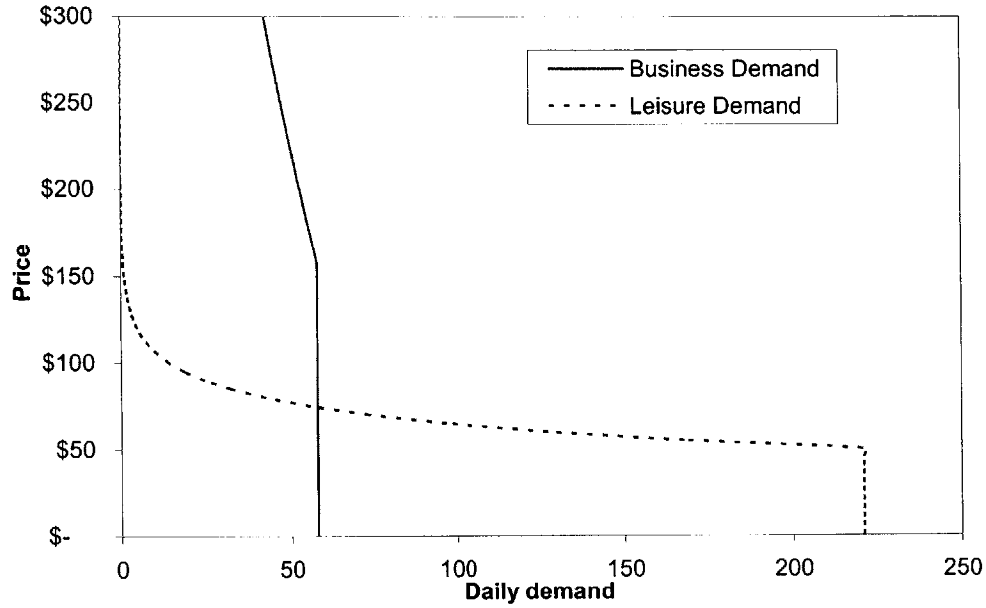


Figure 5.3: Sample business and leisure demand curves in PODS

The equations for the demand curves are the following:

$D = D_0 \times \min\left(1, e^{-\ln(2)\frac{f-basefare}{(emult-1)\times basefare}}\right)$, where D_0 is the average demand in the market for a given passenger type, basefare is the fare at which all of D_0 is willing to travel, and emult is the elasticity multiplier representing the fare value ($basefare \times emult$) at which half of the demand would be willing to travel. Once again, the reader is referred to Carrier (2003) for more detail.

Finally, each passenger has a set of disutility values representing his/her sensitivity to fare product restrictions (restriction disutilities), schedule preference (replanning disutility, if the path is outside of the previously defined time window), path quality (nonstop vs. connecting) and airline preference. All disutilities are defined randomly and independently for each passenger and passenger type, but their average values are a linear function of the market basefare. The intercept and the slope of the disutility functions were calibrated through a survey of airline representatives, as explained by Lee (2000). All disutilities are higher on average for business passengers: The underlying assumption is that business passengers place more importance on the overall quality of the trip (schedule, path quality, unrestricted fare) than on the actual price of the ticket and are therefore more inconvenienced by restrictions than leisure passengers. Finally, all disutilities are assumed to be independent and to follow a normal distribution with a 0.3 k-factor, typical of air transportation demand according to marketing research conducted by Boeing (The Boeing Commercial Airplane Company, 1978).

For example, each fare product comes with a set of restrictions. The purpose of these restrictions is to achieve market segmentation and force business passengers to purchase less restricted but higher fares that they are willing to pay for. Examples of fare product restrictions include Saturday night stay requirement, non-refundability and change fee. Given such restrictions, prices are set so that leisure passengers typically prefer the more restrictive, but cheaper fares, while business passengers prefer less restrictive, but more expensive fares. Table 5.1 shows an example of the average total cost of individual fare products when accounting for their associated restrictions, and illustrates how more restrictive products have a lower total cost for leisure passengers, but a higher total cost for business passengers.

Passenger Type	Fare Class / Avg. Cost	Y	B	M	Q
Business	Avg. Rest. 1	None	$225.00	$225.00	$225.00
	Avg. Rest. 2	None	None	$75.00	$75.00
	Avg. Rest. 3	None	None	None	$75.00
	Fare	$400.00	$200.00	$150.00	$100.00
	Average Total Cost	**$400.00**	**$425.00**	**$450.00**	**$475.00**
Leisure	Avg. Rest. 1	None	$175.00	$175.00	$175.00
	Avg. Rest. 2	None	None	$25.00	$25.00
	Avg. Rest. 3	None	None	None	$25.00
	Fare	$400.00	$200.00	$150.00	$100.00
	Average Total Cost	**$400.00**	**$375.00**	**$350.00**	**$325.00**

Table 5.1: Average total cost of individual fare products by passenger type (accounting for restrictions disutility costs)

For more detail on passenger characteristics, the reader is once again referred to Carrier (2003).

Passenger Choice Set

Given individual passenger characteristics, the simulator defines the choice set of each individual passenger. Depending on the competitive situation, the network size and the number of fare products available, passengers have a maximum number of alternatives to consider equal to the product of the number of paths (in the market where they want to fly) and the number of fare class products, along with the "no-go" alternative. For example, with two competitors each offering four fare classes and flying three times daily in the market, passengers have a maximum of 24 "go" alternatives to choose from, and the "no-go" alternative, for a total of 25 choices. Some of the 24 "go" alternatives will be excluded from the choice set based on the following conditions:

- The revenue management system has closed down a particular set of fare classes and paths in the market.
- The passenger does not meet the advance purchase requirements for some of the fare products.
- The passenger's willingness to pay is lower than some fare class product prices.

Passenger Choice

Finally, given the passenger choice set, the passenger makes a decision from all the available alternatives, including the "no-go" alternative. The choice set of any passenger thus contains at least one alternative, the "no-go" alternative. If there is at least one feasible "go" alternative available in the passenger choice set besides the "no-go" alternative, the latter is never chosen and PODS chooses the alternative with lowest generalized cost. The total generalized cost of each alternative is computed as the sum of the fare and associated disutilities, including disutilities from:

- The characteristics of this specific air traveler (O-D market, business or leisure, time window)
- The fare/class (restrictions)
- The path (airline, quality of the path, schedule)

Once the passenger has chosen a path/class, the seat availability is updated by decreasing the airline inventory by one seat on the legs traversed by the path/class. In addition, this travel decision is recorded in the historical database that feeds into the forecaster and the optimizer components of the simulator used to set revenue management controls at the end of each time frame.

As a result, PODS distinguishes between monetary elements (willingness to pay, fare) and non-monetary elements (disutilities) when modeling passenger choice. The choice of a particular path/class is based on both considerations but is conditional on each passenger's maximum willingness to pay.

5.1.3. Conclusion

As discussed in the previous section, the Passenger Origin Destination Simulator (PODS), is a simulator of competitive airline networks which can be broken into four separate components. These four components – historical database, forecasting, revenue management and passenger choice – provide the necessary elements to run a simulation of competitive interactions involving revenue management in the airline industry. Of these four components, the passenger choice model occupies a very important part upon which depend most of the results.

In the following sections, we present the results of the simulation of a single market case, and examine the effect of revenue management and relative new entrant capacity on individual carrier performance.

5.2. Single Market Case

In this single market case, our purpose is to highlight the impact of entry on incumbent revenues, loads and average fares on the one hand, and, on the other hand, the impact of revenue management on the same measures of incumbent performance, when a new entrant begins operations in a single market environment.

To illustrate the impact of entry, we simulate a single market network, with a set of competing airlines offering service in this market. We start with two incumbent carriers, Airline 1 offering nonstop service, and Airline 2 offering connecting service. The new entrant carrier (Airline 3) comes in with a schedule identical to that of the nonstop incumbent carrier and diverse pricing and capacity strategies.

Our simulation results show that incumbent revenues and traffic are greatly impacted by entry and more specifically by the choice of fares and capacity by the new entrant, as well as by the competitive revenue management situation. In particular, we demonstrate that average fares on the nonstop incumbent carrier generally decrease following entry, as do revenues and traffic, regardless of the response of the incumbent carrier. These results support previous arguments that average fares, traffic and revenues give a very incomplete picture of the effects of entry in a market (as suggested by Perry and Oster and Strong). Rather, we show that average fares, revenues and traffic are a direct consequence of other factors such as new entrant capacity, response of the incumbent to entry, and the use of revenue management by both airlines.

For instance, we show that, while the nonstop incumbent carrier usually suffers from entry (loss of revenues), depending on the entrant's strategy of entry, the response that maximizes revenues varies between matching the new entrant's strategy and only matching the lower fare on the new entrant. The reason for this lies in the effects of capacity share and revenue management on traffic, including diversion of high-fare passengers or capacity constraints. In addition, results show that airline and market-level performance are greatly affected by product differentiation[12]: The more product differentiation, the greater the market-level and airline-level revenues.

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[12] **Product differentiation** is the modification of a product to make it more attractive to the target market and to differentiate it from other products (competitor's products, or, in the case of airline pricing, other

As previously mentioned, this chapter focuses on the effect of entry given a fixed competitive revenue management situation. In Chapter 6, we will show that, even in the absence of network effects, the effects of entry on traditional aggregate measures of airline performance are greatly affected by the competitive revenue management situation. In addition, we illustrate the revenue implications (on all competitors) when the new entrant uses leg-based fare class revenue management (FCRM) as compared to First-Come, First-Served (FCFS) seat allocation.

5.2.1. Competitive Settings and Market Parameters

Table 5.2 shows the major variables used to define the characteristics of a market in PODS. As we discuss in the following sections, we simulate changes in airline parameters rather than external parameters in the simulator. The purpose of the research being to study the effects of entry on incumbent carriers, we assume that the market does not change structurally 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, his (her) preference between airlines 1 and 2 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.

VARIABLES	
AIRLINE	EXTERNAL
Number of Flights	Airline Preference
Aircraft Size	Disutility Values
Pricing	Demand Stimulation/Curves
Number of Fare Classes	

Table 5.2: Important variables in the competitive simulation

The following sections discuss the details of the market parameters and individual scenario settings with respect to the airline variables shown in Table 5.2.

We describe four scenarios, scenarios 0 through 3, and discuss the results of the simulation of each of these individual scenarios before actually simulating various revenue management situations and studying

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fares on the same airline). Successful product differentiation will move the product from competing based primarily on price to competing on non-price factors (such as product characteristics, including advance purchase requirements, restrictions, frequency, etc. in the case of airline markets).

the impact of revenue management on these results in Chapter 6. We use Scenario 0 as the benchmark case for comparison, but also compare scenarios amongst themselves.

Market Parameters

In this first set of simulations, airlines operate in a short-haul market (283 miles) with a demand of 165 one-way passengers per day at the current lowest available fare level (c.f. Table 5.5). Of this passenger demand, 35% is business oriented and the remaining 65% is leisure demand. The difference between leisure and business passengers resides in business passengers' willingness to pay a higher fare, sensitivity to fare restrictions, and booking behavior, as discussed in 5.1.2.

Revenue Management Systems

To study the effect of entry and new entrant capacity on individual carrier performance, we chose to limit the simulations to a single type of revenue management system on all carriers operating in the market. The airlines use fare class revenue management (FCRM) to determine how many seats to make available in each of the four fare classes offered to passengers. As discussed in 5.1.2, each of these fare classes represent differentiated fare products with different prices and associated restrictions (Y class is the most expensive unrestricted fare class, while B, M and Q classes have more restrictions but are less restricted). Given these fare classes, FCRM uses forecasts of demand to come for each of these fare products to set the booking limits within each fare class for future departures. Under the assumption of stochastic demand, the booking limits are designed to maximize the expected revenue on each flight. FCRM is a combination of Booking Curve detruncation, Pick-up forecasting, and Expected Marginal Seat Revenue algorithm (Belobaba, 1987 and 1992a), as extensively described in the PODS and revenue management literature (e.g. Gorin, 2000) and used by many airlines. Under the application of fare class revenue management, revenue management controls are used to protect seats for later-booking high-fare passengers, in turn limiting seats made available to early-booking low-fare passengers.

5.2.2. Scenario 0: No New Entrant Competition – Standard Fare Structure

Characteristics

In this case, we simulate a single market where initially two incumbent carriers compete. One of these two carriers 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.

CARRIER	CAPACITY	FREQUENCY	SCHEDULE	PRICING
Airline 1	90 seats (3x30)	Three daily flights	11:30am – 3:00pm – 6:30pm (1h16m travel time)	Four fare classes with four different fare levels Y, B, M and Q (see Table 5.5)
Airline 2	90 seats (3x30)	Three daily flights	8:08am – 11:38am – 3:08pm (5h43m travel time)	

Table 5.3: Scenario 0 capacity, frequency, schedule and pricing overview

The rationale for modeling two carriers, one of which offers nonstop service and the other offering connecting service, is the following:

1. We are interested in low-fare entry, where a new entrant carrier starts operating in a short-haul market and offers nonstop service. Since the purpose of the thesis is to evaluate the impact of entry on incumbent carriers, we assume that an airline is already serving the market with nonstop flights.

2. 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.

3. Such short-haul markets are rarely served exclusively by a single carrier operating in a monopoly situation. Rather, US DOT data shows (Table 5.4) that in the fourth quarter of 2000, out of 2,882 short-haul markets (<500 miles) with nonstop service, only 715 were served by a single carrier (25%), leaving 75% of them to be served by two or more carriers. In addition, of these same 2,882 markets, 1,740 of them had a competing airline offering connecting service (60%). In the second quarter of 2002, the numbers were similar, with 72% of the markets with nonstop service being also served by at least one additional carrier, and 58% of the markets served by a connecting carrier in addition to the nonstop carrier.

Thus, in our situation of interest where a low-fare carrier enters a market previously served by a network carrier (with nonstop service), 60% of the time there is an alternative carrier offering connecting service, and 75% of the time there is an alternative to the carrier offering nonstop service, be it nonstop or connecting. As such, it is important in our simulations to have a second airline operating in the market with connecting service, as an alternative to the existing nonstop carrier. Finally, capacity on this additional carrier is of small importance as long as it can accommodate the overflow of demand from the carriers offering nonstop service in the market and thus ensure that passengers wanting to travel can travel, even though they might have to travel on a far less desirable itinerary.

	Q4-2000		Q2-2002	
Number of Airlines	Markets with Nonstop Service	Percent of Total	Markets with Nonstop Service	Percent of Total
1	715	25%	722	27%
2	518	18%	425	16%
3	408	14%	374	14%
4	334	12%	279	11%
5	222	8%	204	8%
6 or more	685	24%	647	24%
Total	**2,882**	**100%**	**2,651**	**100%**

Table 5.4: Number of competitors in short haul markets with nonstop service (< 500 miles) - Source: US DOT DB1A database, fourth quarter 2000 and second quarter 2002

All other characteristics are exactly the same for both airlines. In particular, we note that airline preferences are set to be the same for both airlines, as are fares. The only difference between the two competitors is therefore the fact that one carrier offers nonstop service while its competitor offers connecting service, as shown in Figure 5.4. As a result, travel times are greater on the carrier offering connecting service (c.f. Table 5.3 – 1h16 on the nonstop carrier compared to 5h43 on the connecting carrier). Sensitivity of the simulation results to these parameters will be discussed in Chapter 6, Section 6.3.

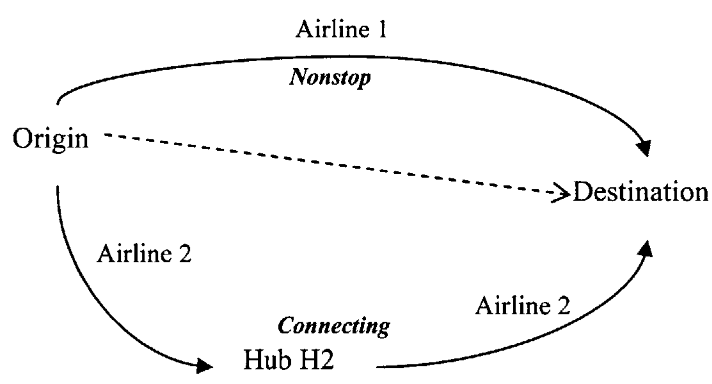


Figure 5.4: Single market (hub H1 to spoke S) with two competing carriers

Finally, the prices for each fare class are set as shown in Table 5.5, along with the restrictions associated with each individual fare class in this particular scenario (0). Y class is the unrestricted fare class in the market, B, M and Q classes have more severe restrictions and advance purchase requirements. We refer to this fare structure as the standard fare structure, as fare classes have increasing associated restrictions as their individual fare values decrease.

		Restrictions			
Fare Class	Fare	Saturday Night Stay	Change Fee	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 5.5: Fare classes, associated fares and restrictions for the standard fare structure in Scenario 0

Table 5.6 summarizes the characteristics of Scenario 0 with respect to service, frequency and capacity, and fares by fare class. Individual fare values by fare class were selected to represent realistic one-way fares in a market with comparable attributes as the one simulated here, based on airline data. In addition, we also assume that both incumbent carriers use fare class revenue management to control the allocation of seats between passengers (as described in Section 5.2.1). This last assumption reflects the fact that airlines generally perform revenue management to maximize their revenues.

Scenario 0	Service	Frequency & Capacity	Fares by Fare Class				Revenue Management
			Y	B	M	Q	
Airline 1	Nonstop	3x30	$261	$135	$92	$63	FCRM
Airline 2	Connecting	3x30	$261	$135	$92	$63	FCRM

Table 5.6: Scenario 0 summary

We use Scenario 0 as our base case in the remainder of this chapter, that is, as a benchmark for pre-entry revenues, loads and average fares.

Simulation Results

The purpose of this first study is to describe the initial situation in which the incumbent carriers find themselves without competition. From this base case, we will then be able to quantify the additional impact of the new entrant carrier on incumbent revenues, loads and average fares, as a function of the choice of a pricing strategy by the new entrant.

Table 5.7 shows loads and revenues by fare class for the entire market, along with average load factor and average fare for Scenario 0. We observe that the average load factor for the market is 68% while 122 passengers out of a demand of 165 passengers are carried by the two competitors in the market, that is, 78% of the total demand is satisfied. The remainder of the demand (43 passengers) is willing to pay the lowest available market fare, but unable to travel because of unmet advance purchase requirements or lack of available seats given revenue management controls on both airlines. In addition, the distribution of passengers by fare class (fare class mix) has about 50% of passengers traveling in Q class, 10% in B and M class respectively, and the remaining 30% in Y class. In terms of revenue distribution, however, the 30% of passengers in Y class generate about 60% of the total market revenues, while the 50% of Q class passengers only account for 25% of total market revenues.

Measure	Rev. Mgt	*Total*	Y	B	M	Q	
Loads	FCRM	*122.38*	34.68	13.30	12.49	61.90	Avg. Load Factor 68%
	Relative		28%	11%	10%	51%	
Revenues	FCRM	*$15,914*	$9,061	$1,798	$1,150	$3,905	Avg. Fare $130
	Relative		57%	11%	7%	25%	

Table 5.7: Total loads and revenues by fare class, average load factor and average fare for the entire market – Scenario 0

Figure 5.5 shows each of the two airlines' revenues under Scenario 0. We first notice an apparent asymmetry in terms of revenues. This is essentially due to the fact that Airline 2 does not offer nonstop service in the market. As a result, the path utility on Airline 2, all else being equal, will necessarily be worse and passengers will book on Airline 1, if it is available. Furthermore, path preference might even induce passengers into booking a higher fare on Airline 1 rather than the lower fare on Airline 2, if the added restrictions on Airline 2's lower price ticket further decrease its utility beyond that of the more expensive ticket on Airline 1.

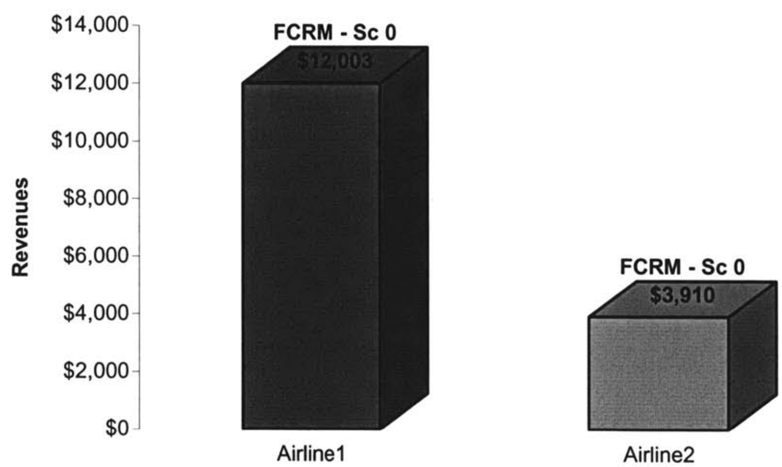


Figure 5.5: Incumbent carrier revenues in the case of no new entrant competition

Table 5.8 highlights the asymmetry between the two carriers in terms of loads by fare class and average load factors. As previously explained, due to the preference of passengers for Airline 1, we observe greater loads for Airline 1 in Y, B and M class, the higher fare classes. In Q class, however, loads are far greater on Airline 2. This observation is the consequence of the fact that Airline 1 is the preferred airline in terms of path quality and of the fact that both carriers are practicing revenue management. Indeed, Airline 1 is protecting seats for later-booking high-fare passengers, while Airline 2 is less heavily loaded, thus allowing all passengers access to its seats, including low-fare passengers.

			Passengers by fare class				
Rev. Mgt	Airline	*Total Traffic*	Y	B	M	Q	ALF
FCRM	Airline 1	*74.99*	30.42	12.69	11.40	20.48	83%
	Airline 2	*47.39*	4.26	0.62	1.09	41.42	53%

Table 5.8: Fare class mix, average load factor by airline, Scenario 0

Figure 5.6 shows revenues by fare class for airlines 1 and 2 and highlights the substantial difference in the source of revenues for each of the airlines, as well as the magnitude of the revenues of each airline. Most of Airline 1's revenues come from Y class traffic (66%) while 67% of Airline 2's revenues come from Q class traffic.

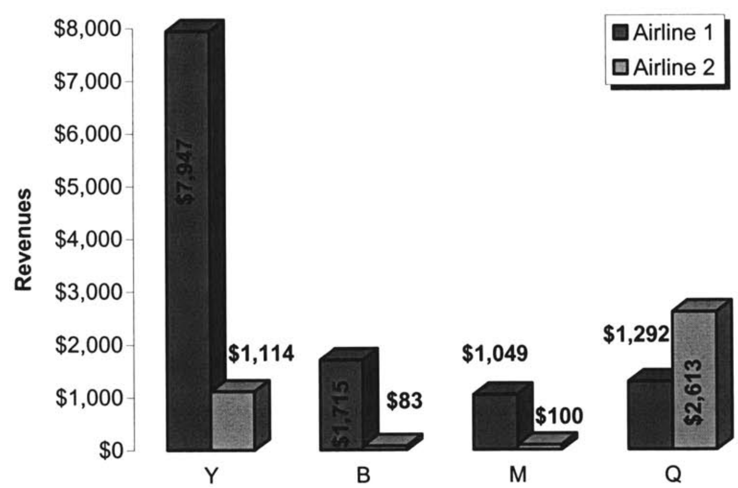


Figure 5.6: Airline 1 and 2 revenues by fare class, Scenario 0

In summary, in Scenario 0, there is asymmetry in the revenues earned by each airline due to the fact that Airline 1 offers nonstop service while Airline 2 only offers connecting service in the market. The asymmetry in revenues is a direct consequence of passenger loads and translates into very high Y class revenues on Airline 1, coming primarily from business travelers. On Airline 2, revenues come mostly from Q class, and are overall substantially lower than on Airline 1.

The result of this asymmetry is a disproportionate share of traffic and revenues in favor of Airline 1, as shown in Table 5.9. In particular, in this case greater market share leads to disproportionately greater revenue share.

	Market Share	Revenue Share
Airline 1	61%	75%
Airline 2	39%	25%

Table 5.9: Market and revenue share in Scenario 0

5.2.3. Scenarios 1 – 3: Competitive Simulations of Entry

To study the impact of entry, we add a new entrant carrier to this single market case. The new entrant offers nonstop service directly competing with the incumbent carrier offering nonstop service (Airline 1). In addition, we schedule the new entrant to offer the exact same departure times as the nonstop incumbent carrier in order to duplicate the behavior of airlines matching each other's schedule, and to further eliminate the effect of schedule preference on passenger choice.

As shown in Table 5.2, there are a number of airline parameters that we can set in this competitive situation. In the case of this new entrant carrier, we choose to keep the number of flights, the number of fare classes and the schedule as fixed, but allow the aircraft size and pricing strategy to change from one simulation to the next. We define scenarios 1 through 3 to reflect three different pricing strategies on the new entrant carrier. Within each of these scenarios, we also allow for two sub-levels of scenarios respectively reflecting different choice of capacity on the new entrant, and pricing response of the incumbent carriers.

In this first study, we assume that all carriers use fare class revenue management (FCRM). The underlying rationale is that most airlines practice some form of revenue management in order to maximize their revenues. In addition, while it is sometimes the case that network carriers rely on more advanced network revenue management, in our single market case, there are no network traffic flows, thus eliminating the need for network revenue management.

Scenario 1: Entry with the Standard Fare Structure and Low-Fare Stimulation of Traffic Characteristics

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). In addition, the new entrant offers the same standard fare structure as the incumbents in that the entrant offers four fare classes with the same standard restrictions and advance purchase requirements as the incumbent carriers.

Upon entry, however, the entrant stimulates traffic by offering a lower price level in the most heavily restricted Q class, priced at $10 below the original Q fare in Scenario 0. Note that the decrease in Q class fare leads to an increase in potential leisure demand from the initial 107 passengers to 187 one-way passengers per day, for a new total market demand of 245 one-way passengers per day (including business demand which does not change). In all scenarios, we assume that the incumbent carriers match this lower fare, and thus offer a standard fare structure (with a different Q fare than in Scenario 0).

Scenario 1	Service	Frequency & Capacity	Fares by Fare Class				Revenue Management
			Y	B	M	Q	
Airline 1	Nonstop	3x30	$261	$135	$92	$53	FCRM
Airline 2	Connecting	3x30	$261	$135	$92	$53	FCRM
Airline 3 (New Entrant)	Nonstop	3x15-25-30 or 50	$261	$135	$92	$53	FCRM

Table 5.10: Scenario 1 summary

Table 5.10 summarizes the major settings for Scenario 1, and highlights the lower fare in Q class, along with the various capacity settings for the new entrant carrier. As mentioned previously, we allow for various entrant capacities and incumbent fare responses for each scenario. In this particular scenario, the incumbent carriers match the new entrant's fares. Furthermore, while the incumbent carriers are assumed to have fixed aircraft capacities (30 seats), we allow for variation of the new entrant's aircraft capacity to better assess the effect of entrant capacity on post-entry incumbent revenues, loads and average fares. The new entrant will therefore enter the market with four possible capacities: 15, 25, 30 or 50 seats per flight. We indicate the sub-scenario with a superscript index reflecting the entrant's capacity. For example, in the case of Scenario 1 with 25 seats per aircraft on the new entrant, we write Scenario 1^{25}.

Note that when referring to Scenario 1, we will be referring to the general class of Scenario 1, thus allowing us to make general comments and draw general conclusions that are independent of the capacity level on the new entrant.

Simulation Results

In Scenario 1, the new entrant carrier offers the same service as the nonstop incumbent carrier in the market. That is, the new entrant carrier comes into the market with three daily flights scheduled to depart at the exact same time as the flights on the incumbent carrier, and with the exact same fares (but with a new lowest market fare to stimulate demand).

Market-Level Changes

Figure 5.7 shows total market revenues for Scenario 1 as a function of new entrant capacity, along with Scenario 0 revenues (where there is no new entrant carrier and therefore no entrant capacity). We observe that with a new entrant carrier competing in the market, total market revenues are always greater than without a new entrant carrier, regardless of the new entrant's capacity (i.e. Scenario 1 revenues are always greater than Scenario 0 revenues). Furthermore, the greater the capacity on the new entrant carrier, the higher the total market revenues.

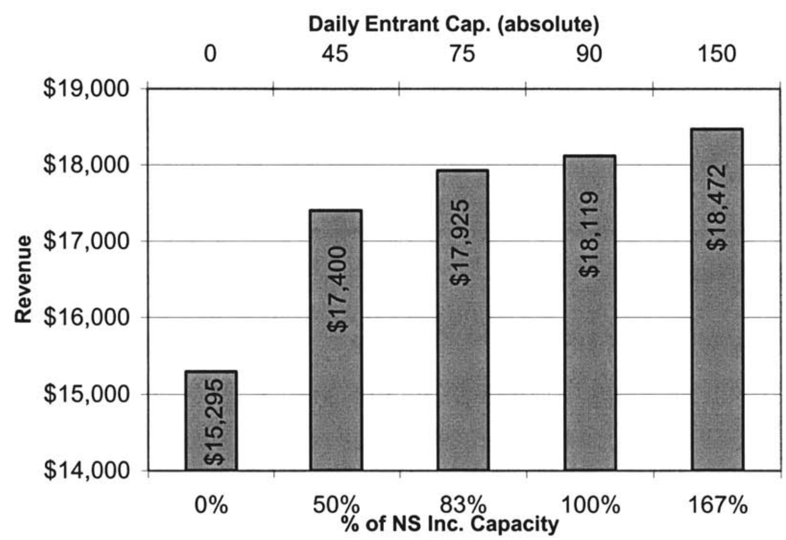


Figure 5.7: Total market revenues for Scenario 1 as a function of new entrant capacity

Adding a new entrant with the exact same fare structure and frequency as the incumbent carriers has a positive impact on total market revenues for the following two reasons:

1. The new entrant adds capacity in the market and allows for more passengers to travel. Without competition (Scenario 0), the average load factor on Airline 1 was 83% with, on average, 43 passengers unable to travel on a daily basis, as we observed that out of the daily demand of 165 passengers per day, only 78% actually traveled. This suggests that even without stimulation of

traffic, there was unmet demand that could be accommodated by the new entrant carrier and therefore lead to increased revenues in the market.

2. In addition, while adding capacity by itself could lead to revenue dilution by opening up lower fare classes, the fact that all carriers also stimulate demand by lowering their Q fare and continue to use revenue management to ensure that late-booking high-fare passengers always find seats, leads to an overall increase in revenues.

In short, adding a carrier in the market with nonstop service and with the same fare structure as the incumbent carriers (Scenario 1) leads to increased market revenues. These revenues increase with the capacity of the new entrant carrier, until all demand is met and adding more seats in the market has no additional effect on total revenues. Table 5.11 shows the total market average load factors[13] and also highlights the decrease in average load factor at high new entrant capacity, along with the increase in average load factor from Scenario 0 to scenarios 1^{15} and 1^{25}, which is a consequence of the stimulation of low-fare traffic combined with the relatively low entrant capacity.

			Entrant capacity: absolute (% of nonstop incumbent)				
Scenario	Pricing	Measure	No entrant (0%)	3x15 (50%)	3x25 (83%)	3x30 (100%)	3x50 (167%)
Sc. 1	Standard fares	ALF (incl. cnx carrier)	68%	74%	70%	65%	56%
		Avg. fare	$124.98	$104.32	$101.96	$101.36	$100.01

Table 5.11: Total market average load factor[13] and average fare as a function of new entrant capacity

Finally, in terms of average fare, we note that the average fare at the market level decreases with increasing new entrant capacity. It drops from $125 in Scenario 0 down to as low as $100 in Scenario 1^{50}. Table 5.11 shows the detail of the decrease in average fare and in particular the fact that as soon as the new entrant enters the market, the average market fare decreases sharply. As the entrant's capacity increases, the average fare continues to decrease, but the relative decrease is much smaller than that caused by entry. The decrease in average fare is a consequence of the change in passenger mix between fare classes, which is the outcome of the new entrant's entry or increase in capacity. Indeed, when the

[13] Total Market Average Load Factor is defined as the average load factor at the market level, i.e. total revenue passenger miles in the market – summed over all three competitors – divided by total available seat miles in the market – again summed over all three competitors. In this single market case, it is the same as total market traffic divided by total market capacity.

entrant operates in the market, the increase in total market capacity relative to pre-entry capacity leads to a greater availability of lower fare classes, thus allowing a greater proportion of passengers to book in these lower fare classes and consequently leading to a decrease in average market fare.

Carrier-Level Changes

At the carrier level, we observe that incumbent revenues decrease after entry, and relatively more when the entrant's capacity increases, as shown on Figure 5.8. Conversely, new entrant revenues increase with entrant capacity.

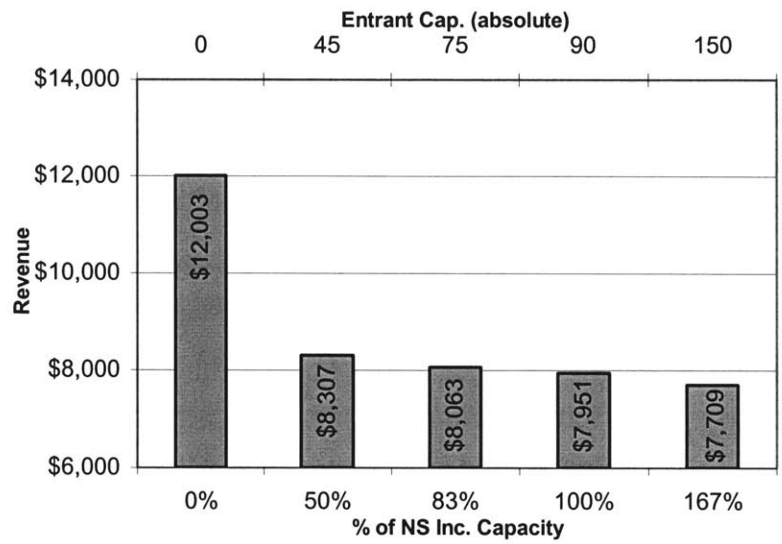


Figure 5.8: Airline 1 revenues as a function of new entrant capacity

Upon entry, the nonstop incumbent carrier loses some of its traffic to the new competitor. In addition, the loss of traffic generally occurs in the higher fare classes, as passengers now have the option of traveling on the competing carrier. As a result, we observe that Y, B and M classes suffer losses following entry as entrant capacity increases, while loads in Q class increase compared to Scenario 0 for Airline 1. Table 5.12 shows that, as new entrant capacity increases, loads in all fare classes decrease compared to Scenario 1[15] on Airline 1. The decrease is approximately equivalent in all fare classes as the average fare on Airline 1 tends to remain relatively constant as a function of the new entrant's capacity. In the case of Scenario 1[15], the initial increase in loads is a consequence of the increase in demand (demand stimulation) resulting from the lower Q fare level. Loads in the higher fare classes decrease substantially however, thus leading to the observed decrease in revenues (Figure 5.8).

Entrant Capacity		Airline 1 Loads					
Absolute	% of nonstop inc.	Total	Y	B	M	Q	ALF
No Entrant	0%	75	30.4	12.7	11.4	20.5	83%
3x15	50%	77	16.6	6.8	5.0	48.8	86%
3x25	83%	74	16.4	6.6	4.2	47.2	83%
3x30	100%	73	16.2	6.4	3.9	46.9	82%
3x50	167%	72	15.7	6.1	3.1	46.9	80%

Table 5.12: Airline 1 total loads, loads by fare class and average load factor as a function of entrant capacity

Conversely, on the new entrant (Airline 3), total revenues and loads increase with its capacity. It is important to note here that while revenues increase with increasing new entrant capacity, this increase in entrant capacity also affects its unit revenues (or revenue per ASM, RASM). For example, in this scenario, entrant revenues increase from $5,774 at 15 seats per flight to $9,811 at 50 seats per flight on the entrant. Airline 3's RASM, on the other hand, decreases from $0.454 at 15 seats per flight to $0.231 at 50 seats per flight on the entrant. The decrease in RASM is a consequence of the increase in capacity and the decrease in average fare with increasing new entrant capacity. Average fare and average load factor also decrease (c.f. Table 5.13) as the new entrant's capacity increases, due to the fact that:

1. Total capacity in the market becomes greater than total potential demand
2. The additional passengers carried with the added capacity on Airline 3 are mostly low-fare passengers who were previously unable to travel for lack of available seats

	Entrant capacity: absolute (% of nonstop incumbent)			
Airline 3 (entrant)	3x15 (50%)	3x25 (83%)	3x30 (100%)	3x50 (167%)
Revenues	$5,774	$7,279	$7,957	$9,811
Loads	37.6	62.9	73.5	100.8
Avg. Load Factor	84%	84%	82%	67%
Avg. Fare	$153.39	$115.63	$108.25	$97.30

Table 5.13: Revenues, loads, average load factor and average fare on Airline 3 as a function of capacity

Finally, looking at average fares also provides additional insight into the impact of entry in the case of Scenario 1. Figure 5.9 shows that between airlines 1 and 3, the <u>carrier that has the greater capacity also has the lower average fare</u>. This important observation comes from the fact that the airline with greater capacity is more likely to have seats available for lower fare passengers as the high-fare passengers are already forecast (by the revenue management system) by all carriers and therefore traveling in all cases of entry (regardless of entrant capacity). As a result, the airline with greater capacity will keep its lower fare classes available longer and thus get more low-fare passengers. This in turn will negatively impact its average fare, but increase its revenues.

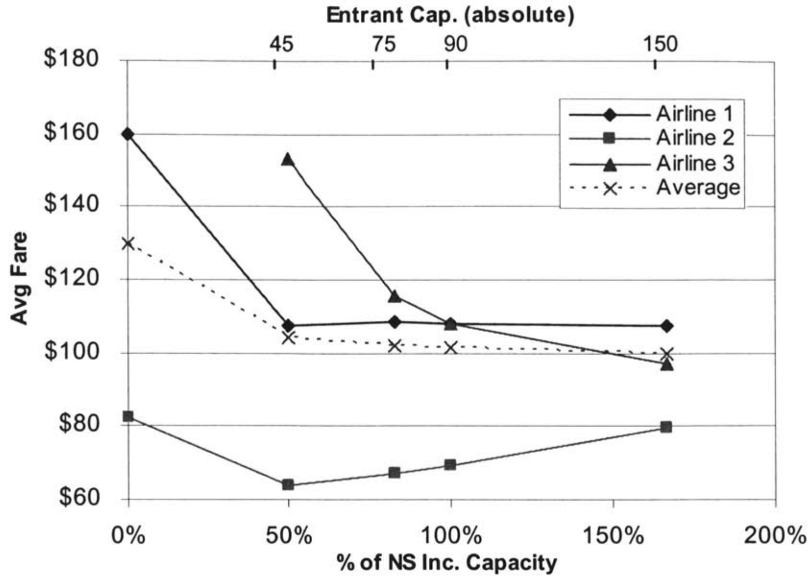


Figure 5.9: Average fare by airline as a function of entrant capacity – Scenario 1

The above-discussed changes lead to a decrease in Airline 1's market and revenue share as the entrant's capacity increases. The relative impact is greater on revenues, as shown in Table 5.14.

Entrant capacity		Market share (traffic)			Revenue share		
Absolute	% of nonstop incumbent	Airline 1	Airline 2	Airline 3	Airline 1	Airline 2	Airline 3
No Entrant	0%	61%	39%	0%	75%	25%	0%
3x15	50%	46%	31%	23%	48%	19%	33%
3x25	83%	42%	22%	36%	45%	14%	41%
3x30	100%	41%	18%	41%	44%	12%	44%
3x50	167%	39%	6%	55%	42%	5%	53%

Table 5.14: Market and revenue share by airline - Scenario 1

In conclusion, in Scenario 1, both incumbent carriers suffer from Airline 3's entry in the market. Airline 1 remains competitive and ahead of Airline 3 in terms of revenues as long its capacity is greater than that of Airline 3. In addition, between the two head-to-head nonstop carriers (airlines 1 and 3), the airline with the greater capacity has the lower average fare, which remains higher than that of Airline 2, which mostly carries low-fare passengers unable to get their initial choice of carrier for lack of availability. Finally, upon entry the nonstop incumbent carrier's average fare and revenue numbers decrease compared to Scenario 0, as shown in Table 5.15.

Airline 1 (nonstop inc.)	Entrant capacity: absolute (% of nonstop incumbent)			
% change	3x15 (50%)	3x25 (83%)	3x30 (100%)	3x50 (167%)
Revenues	-31%	-33%	-34%	-36%
Traffic	3%	-1%	-2%	-2%
Avg. Fare	-33%	-32%	-32%	-33%

Table 5.15: Scenario 1 – relative effect of entry on traditional measures of airline performance for Airline 1 compared to Scenario 0

Table 5.16 shows the details of the impact of entry on daily traffic, average fare, revenues, load factors, market share and revenue share for the nonstop incumbent carrier and the new entrant, as well as the numbers in the case where there is no new entrant competition.

Scenario 1	Airline	Pax/Day	Avg Fare	Revenues	ALF	Market Share	Revenue Share
No Entrant (Sc. 0)	NS Incumbent	75	$160.07	$12,003	83%	61%	75%
3x15	NS Incumbent	77	$107.67	$8,307	86%	46%	48%
	New Entrant	38	$153.39	$5,774	84%	23%	33%
3x25	NS Incumbent	74	$108.41	$8,063	83%	42%	45%
	New Entrant	63	$115.63	$7,279	84%	36%	41%
3x30	NS Incumbent	73	$108.27	$7,951	82%	41%	44%
	New Entrant	74	$108.25	$7,957	82%	41%	44%
3x50	NS Incumbent	72	$107.22	$7,709	80%	39%	42%
	New Entrant	101	$97.30	$9,811	67%	55%	53%

Table 5.16: Scenario 1 summary table

With low capacity, the new entrant carrier's average market fare is substantially higher (42%) than the average fare on the nonstop incumbent carrier. This is a direct consequence of the combination of lower capacity and fare class revenue management on the new entrant. As the new entrant's capacity increases, its average fare decreases, until incumbent and new entrant reach the same capacity when the new entrant's average fare decreases to the level of the incumbent's average fare. As the new entrant's capacity keeps increasing, its average fare further decreases. The nonstop incumbent carrier's average fare, after having sharply decreased following entry, initially increases very slowly, as the new entrant captures more traffic, and relatively more low fare traffic (as supplies of high-fare traffic decrease), and diverts a few low-fare passengers away from Airline 1. The result is a slight increase in average fare. As the new entrant's capacity increases even more, dilution of traffic begins to appear, which explains the slight decrease in average fare on the nonstop incumbent and more apparent decrease on the new entrant.

Even in this scenario with symmetric pricing and schedules, we observe that relative new entrant capacity plays a very important role in the observed effect of entry on aggregate measures of airline performance.

Average fares, revenues and loads are greatly affected by the new entrant's capacity, without any change in pricing on the incumbent carriers.

Scenario 2: Entry with a Single Unrestricted Low-Fare Priced $10 Lower than the Q Fare in Scenario 0

Characteristics

In this scenario, we also assume that the new entrant carrier offers three daily nonstop flights that directly compete with the nonstop incumbent carrier's flights. In this case, however, the new entrant carrier only offers a single unrestricted low-fare priced $10 below the Q fare in Scenario 0. As was the case in Scenario 1, the incumbent carriers always match this fare, at least in their most restricted Q class.

As in Scenario 1, the new entrant carrier has various aircraft capacity options. Since the new entrant carrier only offers a single fare class, it does not use revenue management and allocates seats in a first-come first-served (FCFS) manner. Both incumbent carriers still use fare class revenue management (FCRM).

Given the low-fare structure used by the new entrant carriers, the incumbent carriers now have the options of either matching the new low fare only their Q class, or of fully matching the entrant's fare structure by offering a single unrestricted low-fare priced at the same level as the new entrant's fare. We will thus either refer to Scenario 2 with limited match (LM), reflecting the fact that the incumbent carriers lowered their Q fare in response to the entrant's unrestricted low fare but maintained their standard fare structure and restrictions, or Scenario 2 with full match (FM), reflecting the fact that the incumbent carriers fully matched the new entrant's unrestricted fare structure. The notation will reflect the LM or FM as a subscript index. For example, Scenario 2_{FM}^{50} refers to the Scenario 2 with three flights with 50-seat capacity on the new entrant, where the incumbent carriers fully match the fare structure on the new entrant. Table 5.17 summarizes the details of Scenario 2 characteristics.

Scenario $2_{LM/FM}$		Service	Frequency & Capacity	Fares by Fare Class Y	B	M	Q	Revenue Management
Airline 1	LM	Nonstop	3x30	\$261	\$135	\$92	\$53	FCRM
	FM			\$53	Not offered	Not offered	Not offered	Not Applicable
Airline 2	LM	Connecting	3x30	\$261	\$135	\$92	\$53	FCRM
	FM			\$53	Not offered	Not offered	Not offered	Not Applicable
Airline 3 (New Entrant)		Nonstop	3x15-25-30 or 50	\$53	Not offered	Not offered	Not offered	Not Applicable

Table 5.17: Scenario 2 summary (including Limited Match and Full Match sub-scenarios)

Note that again, we can omit the sub and superscripts in the notation so as to refer to the entire class of scenarios, regardless of the capacity on the new entrant and response of the incumbents.

Simulation Results

Scenario 2_{LM}

In this case, we assume that the incumbent carriers maintain their existing standard fare structure and match the new entrant's fare only in their most restricted fare class (Q). As previously described, the new entrant carrier comes in with three daily nonstop flights scheduled at the exact same time as that of the nonstop incumbent.

Focusing on market level impacts of entry, we first note that revenues increase upon entry, but comparatively much less than in Scenario 1. Even though Scenario 2_{LM} revenues are higher than Scenario 0 revenues, they decrease with increasing entrant capacity, and, in the case of Scenario 2^{50}_{LM} , revenues are back down to levels comparable to those of Scenario 0 (Table 5.18). Looking at revenues by fare class, it appears that upon entry, revenues generated by Y class passengers increase but those generated by B, M and Q class passengers decrease. Market level Y class revenues are also affected by the fact that Airline 3's Y class fare is much lower than that of Airline 1, in Scenario 2_{LM}.

There is an initial increase in load factor between Scenario 0 and scenarios 2^{15}_{LM} and 2^{25}_{LM} but, as capacity on the new entrant increases, average load factors decrease and drop below Scenario 0 levels.

Sc. 2_{LM} Entrant Cap.	Loads Total	Y	B	M	Q	Revenues Total	Y	B	M	Q	Avg. Fare	Avg. Load Factor
0 (0%)	*122*	35	13	12	62	*$15,914*	$9,061	$1,798	$1,150	$3,286	$130	68.0%
3x15 (50%)	*168*	75	11	8	73	*$16,534*	$10,342	$1,541	$770	$3,881	$98	74.7%
3x25 (83%)	*177*	102	10	6	59	*$16,411*	$11,359	$1,350	$591	$3,111	$93	69.5%
3x30 (100%)	*181*	115	9	6	50	*$16,291*	$11,839	$1,257	$523	$2,672	$90	67.0%
3x50 (167%)	*194*	163	6	3	21	*$15,485*	$13,200	$853	$291	$1,141	$80	58.9%

Table 5.18: Scenario 2_{LM} market loads and revenues by fare class, average market fare and load factor

At the airline level, Table 5.19 shows that Airline 1's revenues decrease substantially following entry. But, compared to Scenario 1, Airline 1's revenues are higher in the case of entry under Scenario 2_{LM} assumptions (Figure 5.10), except at high new entrant capacity where diversion and revenue dilution is such that revenues on Airline 1 decrease beyond those of Scenario 1[50].

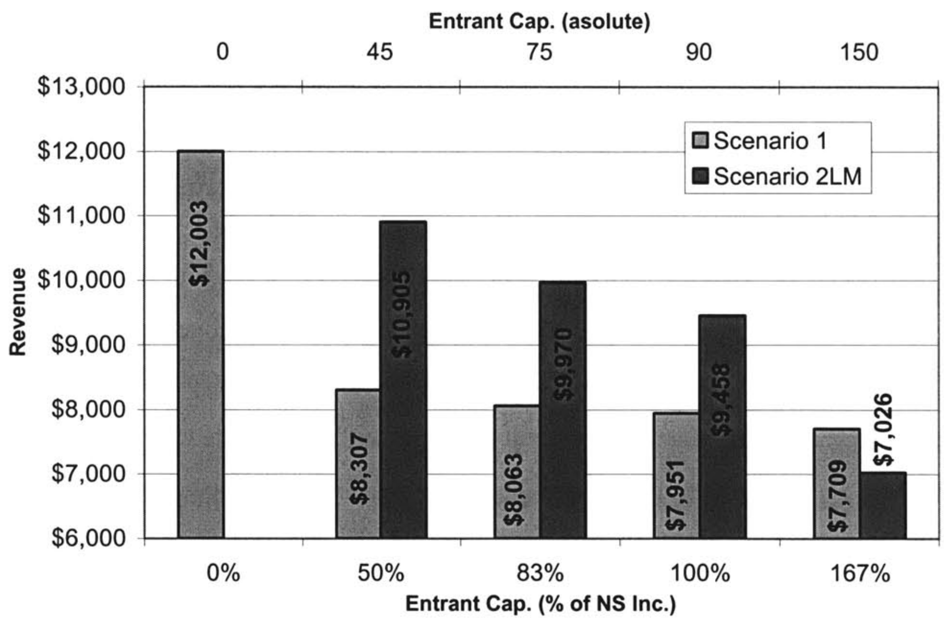


Figure 5.10: Airline 1 revenues under Scenario 1 and Scenario 2_{LM}

The explanation for the decrease in Airline 1 revenues as the new entrant's capacity increases is the same as in Scenario 1: Upon entry, Airline 3 diverts some of Airline 1's passengers and revenues. The explanation for the relatively smaller loss in revenues in Scenario 2_{LM} (at entrant capacity levels below 50 seats) as compared to Scenario 1 lies in the fact that Airline 3 offers a single fare. As mentioned before, this implies that Airline 3 cannot perform revenue management (since passengers cannot be differentiated) and is accepting passengers on a first-come, first-served basis. As a result, Airline 3 tends to fill-up with relatively more "naturally low-fare" passengers, and therefore diverts fewer full-fare passengers from Airline 1. That is, Airline 3 fills up with early-booking passengers, who are traditionally price sensitive passengers. Airline 3 thus fills up relatively sooner than Airline 1 which can protect seats for later-booking, high-fare passengers. At high entrant capacity, the diversion is such that numerous passengers travel on Airline 3, which leads to great dilution of revenues from Airline 1's high fare classes towards Airline 3's single fare class, ultimately leading to total market revenue losses compared to Scenario 0.

Scenario 2_{LM}	Absolute capacity	% of nonstop incumbent	Airline 1	Airline 2	Airline 3	*Total*
No Entrant	0	0%	$12,003	$3,910		*$15,914*
3x15	45	50%	$10,905	$3,258	$2,371	*$16,534*
3x25	75	83%	$9,970	$2,524	$3,917	*$16,411*
3x30	90	100%	$9,458	$2,158	$4,675	*$16,291*
3x50	150	167%	$7,026	$937	$7,521	*$15,485*

Table 5.19: Scenario 2_{LM} revenues by airline

With respect to loads, Airline 1 suffers from entry in all classes, and increasingly so as the entrant's capacity increases. The greatest relative impact of entry occurs in the intermediate fare classes B and M, because they have the smaller absolute loads. In absolute terms, the greatest impact occurs in Y class, followed by M, B and finally Q class. All fare classes are affected by entry as follows: Upon entry, passengers who were formerly traveling on Airline 1 are now given the opportunity to book an unrestricted fare on Airline 3, at a much lower price. Given this choice, all passengers will generally prefer to travel on Airline 3. Capacity constraints, however, limit the number of seats available on the new entrant, which consequently affects the opportunities for Airline 1's passengers to be diverted towards the new entrant. In addition, since Airline 1 is forecasting late-booking, high fare passengers in its revenue management system, it is able to protect seats for these passengers, and while Airline 3 fills up with early-booking lower fare traffic, Airline 1 limits the impacts of entry on higher fare class loads. At high new entrant capacity, the greater availability of the lower unrestricted fare on the new entrant leads to a widespread decrease in loads from all fare classes on Airline 1.

Entrant cap. (% of nonstop inc.)	Airline 1 Loads *Total*	Y	B	M	Q	ALF	Relative Decrease (compared to Sc. 0) *Total*	Y	B	M	Q
No Entrant	*75*	30.4	12.7	11.4	20.5	83%					
3x15 (50%)	*68*	29.1	11.2	8.1	19.6	76%	*-9%*	-4%	-11%	-29%	-5%
3x25 (83%)	*62*	27.0	9.8	6.2	19.0	69%	*-17%*	-11%	-22%	-45%	-7%
3x30 (100%)	*59*	25.9	9.2	5.5	18.0	65%	*-22%*	-15%	-28%	-52%	-12%
3x50 (167%)	*41*	20.3	6.2	3.1	11.4	46%	*-45%*	-33%	-51%	-73%	-44%

Table 5.20: Scenario 2_{LM} – Airline 1 loads by fare class and relative load variation compared to Scenario 0

Airline 3's revenues increase with its capacity and are lower than in the case of Scenario 1. This result is expected since Airline 3 offers a single low-fare which leads to a lower average fare ($53 in Scenario 2_{LM} compared to $97-$153 in Scenario 1 depending on the capacity on the new entrant). This lower average fare, despite greater loads, still leads to lower revenues. In addition, the increase in entrant revenues (with increasing entrant capacity) is also accompanied by a decrease in entrant RASM, from $0.186 to $0.177 at the extremes of tested entrant capacity).

As shown in Figure 5.11, airline-level average fares are affected differently by entry. Indeed, Airline 3's average fare remains constant at $53, given the new entrant's choice of a pricing structure. Airline 1's average fare is relatively unaffected by entry, but tends to increase as new entrant capacity increases. The relative stability of Airline 1's average market fare can be explained by the fact that entry leads to diversion of traffic from all of Airline 1's fare classes in comparable numbers, which therefore has minimal effect on Airline 1's average market fare. As new entrant capacity increases, relatively more traffic gets diverted from Airline 1's lower fare classes (since Airline 3 has more capacity and is not forecasting late booking, high fare passengers), thus leading to a slight increase in Airline 1's average fare. Airline 2's average fare initially decreases upon entry and increases afterwards as new entrant capacity increases, and the new entrant begins diverting low-fare traffic from Airline 2. The average market fare, on the other hand, decreases after entry. This is a consequence of the shift in passengers between airlines and more precisely from Airline 1 to Airline 3: More passengers booking on Airline 3 at a lower average fare has the effect of decreasing the average market fare, even though none of the airlines' average fares change very much.

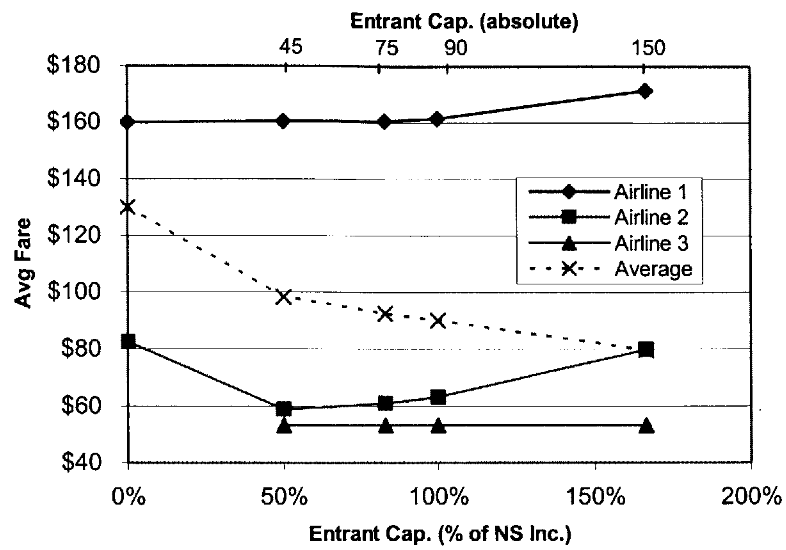


Figure 5.11: Average fare by airline as a function of entrant capacity – Scenario 2_{LM}

Finally, the effect of entry on the market and revenue shares of Airline 1 is a negative one: The impact on Airline 1's market share is greater than it is on revenue shares in this case (unlike in Scenario 1). As new entrant capacity increase, Airline 1's market share decreases substantially, while Airline 1's revenue share remains greater than 45%. The explanation lies again in the fact that Airline 3 offers only a single low-fare.

Entrant cap: absolute (% of nonstop incumbent)	Market Share (Traffic)			Revenue Share		
	Airline 1	Airline 2	Airline 3	Airline 1	Airline 2	Airline 3
No Entrant (0%)	61%	39%	0%	75%	25%	0%
3x15 (50%)	40%	33%	27%	66%	20%	14%
3x25 (83%)	35%	23%	42%	61%	15%	24%
3x30 (100%)	32%	19%	49%	58%	13%	29%
3x50 (167%)	21%	6%	73%	45%	6%	49%

Table 5.21: Market and revenue shares by airline - Scenario 2_{LM}

In summary, in the case of entry with Scenario 2_{LM}, the incumbent carrier's revenues and loads are negatively affected by low-fare entry. The average fare of the nonstop incumbent appears to remain relatively constant following entry, and if anything, to increase slightly as the entrant's capacity increases, as more and more low-fare passengers are diverted from the nonstop incumbent towards the new entrant, as shown in Table 5.22.

Airline 1	Entrant capacity: absolute (% of nonstop inc)			
% change	3x15 (50%)	3x25 (83%)	3x30 (100%)	3x50 (167%)
Revenues	-9%	-17%	-21%	-41%
Traffic	-9%	-17%	-22%	-22%
Avg. Fare	0%	0%	1%	7%

Table 5.22: Scenario 2_{LM} – effect of entry on traditional measures of airline performance (revenues, traffic and average fares) for Airline 1 compared to Scenario 0

Scenario 2LM	Airline	Pax/Day	Avg Fare	Revenues	ALF	Market Share	Revenue Share
No Entrant (Sc. 0)	NS Incumbent	75	$160.07	$12,003	83%	61%	75%
3x15	NS Incumbent	68	$160.37	$10,905	76%	40%	66%
	New Entrant	45	$53.09	$2,371	99%	27%	14%
3x25	NS Incumbent	62	$160.66	$9,970	69%	35%	61%
	New Entrant	74	$53.09	$3,917	98%	42%	24%
3x30	NS Incumbent	59	$161.52	$9,458	65%	32%	58%
	New Entrant	88	$53.09	$4,675	98%	49%	29%
3x50	NS Incumbent	41	$171.52	$7,026	46%	21%	45%
	New Entrant	142	$53.09	$7,521	94%	73%	49%

Table 5.23: Scenario 2_{LM} summary table

Table 5.23 shows the impact of entry on traffic, average fare, revenues, load factors, market and revenue shares for the nonstop incumbent and the new entrant carrier. In particular, it illustrates the very high load factors on the new entrant carrier when it offers a single unrestricted low-fare while the incumbent carriers maintain a standard fare structure. The new entrant's market share is severely constrained at low capacity, and, as its capacity increases, the new entrant quickly garners a large share of traffic, with as high as 73% market share at 3x50 capacity.

These results show (as we discuss in Section 5.2.4) that the pricing structure of the new entrant, along with its capacity, have a great impact on aggregate measures of Airline 1's performance. For example, the average fare on Airline 1 is affected quite differently than in Scenario 1, even though the response of the incumbent carriers to entry was the same, that is, they only matched the lowest available fare in the market (with restrictions). Similarly, the effect on revenues and traffic is also quite different.

Scenario 2_{FM}

The incumbent carriers now match the new entrant's unrestricted low fare structure (priced at $53) and shift from the structured fares to the exact same fare structure as the new entrant carrier, as described earlier.

Sc. 2_{FM}	Loads					Revenues					Avg. Fare	Avg. Load Factor
Entrant Cap.	*Total*	Y	B	M	Q	*Total*	Y	B	M	Q		
0 (0%)	*122*	35	13	12	62	*$15,914*	$9,061	$1,798	$1,150	$3,286	$130	68.0%
3x15 (50%)	*195*	195	0	0	0	*$10,354*	$10,354	$0	$0	$0	$53	86.7%
3x25 (83%)	*210*	210	0	0	0	*$11,172*	$11,172	$0	$0	$0	$53	82.5%
3x30 (100%)	*217*	217	0	0	0	*$11,508*	$11,508	$0	$0	$0	$53	80.3%
3x50 (167%)	*234*	234	0	0	0	*$12,449*	$12,449	$0	$0	$0	$53	71.1%

Table 5.24: Scenario 2_{FM} market loads and revenues by fare class, average market fare and load factor

As shown in Table 5.24, when all carriers match the fare structure on the new entrant, total market loads increase compared to Scenario 0, and increasingly so with increasing new entrant capacity. Furthermore, the passenger mix shifts completely to Y class – the single fare class now offered in the market. Compared to any of the other scenarios studied so far, Scenario 2_{FM} has the highest loads. However, recall that while passengers all purchase Y class, they pay far less than they used to, as shown in Table 5.24. This explains the decrease in total market revenues compared to Scenario 0: In previously discussed scenarios (0, 1 and 2_{LM}) total market revenues increased compared to Scenario 0, whereas in this scenario, they decrease. Within Scenario 2_{FM}, revenues increase with new entrant capacity, but remain lower than Scenario 0's total market revenues (-20% to -35%). In addition, average load factors increase compared to Scenario 0 but decrease with increasing entrant capacity compared to Scenario 2_{FM}^{15}, as total market capacity increases faster than traffic.

At the airline level, we note that Airline 1's revenues decrease by more than 50% upon entry in Scenario 2_{FM}, compared to Scenario 0 (c.f. Table 5.25), and continue to decrease slightly as a function of increasing entrant capacity. The greatest impact on revenues is the impact of entry combined with the lower fares (-62% relative to Scenario 0, as shown in Table 5.28), followed by a smaller impact of increasing new entrant capacity on Airline 1 revenues. The lesser impact of increasing new entrant capacity (compared to the initial effect of entry) is due to the fact that the initial effect of entry includes the change in fares on the incumbent carriers. Furthermore, there is a surplus in total demand such that even when the new entrant's capacity increases, there remain enough passengers willing to travel to still fill up both airlines' planes. In addition, since all carriers are offering the same fare structure, passengers continue to book on both nonstop carriers. A similar conclusion applies to Airline 1's loads (c.f. Table 5.26), in that after entry, since the fare has dropped substantially on the nonstop incumbent carrier, both in terms of lowest fare available and in terms of unrestricted fare, loads increase between Scenario 0 and Scenario 2_{FM}^{15} and then tend to decrease slightly when capacity increases on Airline 3. Finally, the average fare on Airline 1 naturally drops to the single available fare, $53 while Airline 1's average load factor increases from 83% in Scenario 0 to over 90% in Scenario 2_{FM}, regardless of entrant capacity.

Scenario 2_{FM}	Absolute capacity	% of nonstop incumbent	Airline 1	Airline 2	Airline 3	*Total*
No Entrant	0	0%	$12,003	$3,910		*$15,914*
3x15	45	50%	$4,516	$3,510	$2,328	*$10,354*
3x25	75	83%	$4,418	$3,013	$3,740	*$11,172*
3x30	90	100%	$4,383	$2,742	$4,382	*$11,508*
3x50	150	167%	$4,331	$1,689	$6,428	*$12,449*

Table 5.25: Scenario 2_{FM} revenues by airline

Entrant cap. (% of nonstop inc.)	Airline 1 Loads						Airline 3 Loads					
	Total	Y	B	M	Q	ALF	*Total*	Y	B	M	Q	ALF
No Entrant	*75*	30.4	12.7	11.4	20.5	83%						
3x15 (50%)	*85*	85.1	0.0	0.0	0.0	95%	*44*	43.8	0.0	0.0	0.0	97%
3x25 (83%)	*83*	83.2	0.0	0.0	0.0	92%	*70*	70.4	0.0	0.0	0.0	94%
3x30 (100%)	*83*	82.5	0.0	0.0	0.0	92%	*83*	82.5	0.0	0.0	0.0	92%
3x50 (167%)	*82*	81.6	0.0	0.0	0.0	91%	*121*	121.1	0.0	0.0	0.0	81%

Table 5.26: Loads by airline and fare class - Scenario 2_{FM}

On the new entrant (Airline 3), the picture is similar because all carriers in the market have the same fare structure. In terms of passenger loads, however, the airline with the greater capacity gets the higher market share. When the new entrant carrier has less capacity, it gets less traffic than Airline 1; when it has the same capacity, both carriers have similar traffic numbers; and when Airline 3 offers more capacity than Airline 1, it then carries more passengers. Table 5.27 shows the detail of market share and revenue share by carrier, and the fact that again, revenue shares are more affected than market share on Airline 1, as revenue shares were higher in Scenario 0. Since both airlines are offering a single fare structure, they have the same average market fare, and each airline consequently has equal market and revenue share. These results are a consequence of the symmetry of the pricing structure of the competing nonstop carriers, as well as the lack of differentiation between these carriers with respect to revenue management, and reflect expected competitive results under perfectly symmetric competitive offers between the two competing carriers.

Entrant cap: absolute (% of nonstop incumbent)	Market Share (Traffic)			Revenue Share		
	Airline 1	Airline 2	Airline 3	Airline 1	Airline 2	Airline 3
No Entrant (0%)	61%	39%	0%	75%	25%	0%
3x15 (50%)	44%	34%	22%	44%	34%	22%
3x25 (83%)	40%	27%	33%	40%	27%	33%
3x30 (100%)	38%	24%	38%	38%	24%	38%
3x50 (167%)	35%	14%	52%	35%	14%	52%

Table 5.27: Market and revenue share by airline - Scenario 2_{FM}

In summary, entry has somewhat different effects in the case of Scenario 2_{FM}: Airline 1 traffic increases compared to Scenario 0 and is less affected by entrant capacity than was the case previously. However, while traffic does increase, revenues decrease substantially for Airline 1 and at the total market level, compared to pre-entry levels, as summarized in Table 5.28.

Airline 1	Entrant capacity: absolute (% of nonstop inc)			
% change	3x15 (50%)	3x25 (83%)	3x30 (100%)	3x50 (167%)
Revenues	-62%	-63%	-63%	-64%
Traffic	13%	11%	10%	10%
Avg. Fare	-67%	-67%	-67%	-67%

Table 5.28: Scenario 2_{FM} – effect of entry on traditional measures of performance for Airline 1 compared to Scenario 0

Scenario 2FM	Airline	Pax/Day	Avg Fare	Revenues	ALF	Market Share	Revenue Share
No Entrant (Sc. 0)	NS Incumbent	75	$160.07	$12,003	83%	61%	75%
3x15	NS Incumbent	85	$53.09	$4,516	95%	44%	44%
	New Entrant	44	$53.09	$2,328	97%	22%	22%
3x25	NS Incumbent	83	$53.09	$4,418	92%	40%	40%
	New Entrant	70	$53.09	$3,740	94%	33%	33%
3x30	NS Incumbent	83	$53.09	$4,383	92%	38%	38%
	New Entrant	83	$53.09	$4,382	92%	38%	38%
3x50	NS Incumbent	82	$53.09	$4,331	91%	35%	35%
	New Entrant	121	$53.09	$6,428	81%	52%	52%

Table 5.29: Scenario 2_{FM} summary table

Table 5.29 shows the impact of entry in the case of Scenario 2_{FM}, and highlights the effect of capacity on revenues, loads, market and revenue share, when both the nonstop incumbent and the new entrant carrier offer a single unrestricted low-fare. In particular, the carrier with the greater capacity achieves the higher revenues, traffic, revenue share and market share, but the lower average load factor.

This scenario illustrates the impact of a full match response to a new entrant coming in with a single low-fare. It shows the impact of the full match response on incumbent traffic and revenues, and in particular that the increase in incumbent traffic comes at the expense of revenues, as a consequence of low-fare entry in the market. Relative to Scenario 2_{LM}, Airline 1 suffers greater revenue losses, but increases its share of post-entry local traffic. We discuss in more detail the effect of incumbent response to entry in Section 5.2.4.

Scenario 3: Entry with a Two-Tier Fare Structure

Characteristics

In this last scenario, the new entrant carrier still offers the same schedule as the nonstop incumbent carrier, but with a two-tier fare structure as follows (c.f. Table 5.30):

1. Fully unrestricted Y class fare set at $135 (the same fare as the B class fare on the incumbent carrier in Scenario 0, or 48% lower than the incumbents' baseline Y fare)
2. Restricted M class fare (roundtrip and Saturday night stay requirements with 14 days advance purchase) priced $10 below the Q fare in Scenario 0 at $53

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

Table 5.30: Two-tier fare structure details

In this scenario, there is once again a set of sub-scenarios, defined by the variability in the entrant's aircraft capacity, and indicated as previously by a superscript index, and the response of the incumbent carriers who once again have the option to maintain a standard fare structure with a lower Q fare reflecting the $10 decrease or of fully matching the two-tier structure on the new entrant carrier.

The notation will therefore either not mention any sub-setting, which thus designates the entire class of Scenario 3, or reflect all or part of these sub-scenarios indices. For example, Scenario 3_{FM}^{30} refers to Scenario 3 with 30 seats per aircraft on the new entrant and full match of the fare structure by the incumbent. Scenario 3_{FM} refers to the entire set of scenarios where the new entrant uses a two-tier fare structure matched by the incumbent carriers, all carriers using FCRM, at all capacity levels tested on the new entrant (15, 25, 30 and 50 seats per aircraft).

Scenario $3_{LM/FM}$		Service	Frequency & Capacity	Fares by Fare Class				Revenue Management
				Y	B	M	Q	
Airline 1	LM	Nonstop	3x30	$261	$135	$92	$53	FCRM
	FM			$135	Not offered	$53	Not offered	
Airline 2	LM	Connecting	3x30	$261	$135	$92	$53	FCRM
	FM			$135	Not offered	$53	Not offered	
Airline 3 (New Entrant)		Nonstop	3x15-25-30 or 50	$135	Not offered	$53	Not offered	FCRM

Table 5.31: Scenario 3 summary (including Limited Match and Full Match sub-scenarios)

Simulation Results

Scenario 3_{LM}

Table 5.32 shows a summary of some of the measures characterizing the impact of entry, at the market level (i.e. summed or averaged over all three airlines operating in the market). We first note that total market revenues vary slowly after entry and tend to increase slightly (up to 3.5% increase between Scenario 3_{LM}^{15} and Scenario 3_{LM}^{50}) with entrant capacity (after initially decreasing by 4.3% compared to Scenario 0). This differs from scenarios 1 and 2 where revenues increased or decreased more noticeably.

The impact on revenues is due to the combined effect of the new entrant carrier offering only two fares priced lower than comparable fare classes on the incumbent carriers and stimulation in overall demand (due to the lower Q class fare). The result is a change in passenger mix at the market level: Passengers revise their fare class preference following entry and the introduction of the new entrant's fares, priced relatively lower than similar fares on the incumbent carrier. More intuitively, since less restricted fare classes are now cheaper on the new entrant, more passengers are likely to purchase these less restricted fare classes and to switch to the new entrant. In addition, the change in passenger mix is accompanied by a decrease in the average fare paid within Y, M and Q classes. For example, passengers buying Y class on Airline 1 pay more than passengers booking in the same fare class on the new entrant carrier (as shown in Table 5.31), which affects the average fare paid by fare class at the market level. In B class, however, the fare remains the same (since the new entrant does not offer a B class fare, and the fare has not changed on the incumbent carriers).

The re-distribution of passengers among fare classes (a.k.a. change in passenger mix) combined with the low-fare traffic stimulation generated by a lower Q class fare, lead to a decrease in the average market fare, an increase in total traffic, an initial increase in average load factor followed by a decrease in load factor (as new entrant capacity increases), and a slow increase in total market revenues (after an initial decrease following entry), as shown in Table 5.32.

Note that B class traffic almost entirely disappears, as it shifts to Y class on Airline 3: Indeed, former B class passengers have very little incentive to continue to buy B class, as long as Y class on Airline 3 is available, since there are fewer restrictions and advance purchase requirements on Y class, while the fare is the same as B class on the incumbents. M class on the new entrant carrier is priced at the same fare level as Q class on the incumbent carriers and is thus more attractive to leisure passengers, as it has fewer restrictions and advance purchase requirements than Q class on the incumbent carriers. Airline 3 is however using revenue management and therefore more likely to close down M class to keep seats available in its Y class for later-booking passengers who generate more revenues. As a consequence, passengers who would be interested in M class on Airline 3 are likely to be turned down (at lower entrant capacity) when requesting a seat, and thus to book on airlines 1 and 2. This explains the increase in Q class loads following entry, as well as the initial decrease in M class loads.

Sc. 3_{LM}	Loads					Revenues					Avg. Fare	Avg. Load Factor
Entrant Cap.	*Total*	Y	B	M	Q	*Total*	Y	B	M	Q		
0 (0%)	*122*	35	13	12	62	*$15,914*	$9,061	$1,798	$1,150	$3,286	$130	68.0%
3x15 (50%)	*163*	54	2	7	100	*$15,237*	$9,037	$292	$590	$5,318	$94	72.4%
3x25 (83%)	*178*	57	0	20	100	*$15,247*	$8,689	$51	$1,196	$5,311	$86	69.6%
3x30 (100%)	*182*	57	0	33	90	*$15,420*	$8,680	$46	$1,894	$4,800	$85	67.2%
3x50 (167%)	*190*	58	0	83	49	*$15,775*	$8,671	$28	$4,484	$2,592	$83	57.7%

Table 5.32: Scenario 3_{LM} total market loads and revenues by fare class, average market fare and load factor

At the airline level, we note that Airline 1's revenues are severely impacted by entry, as shown in Table 5.33. In the case of Scenario 3_{LM}^{15}, Airline 1's revenues decrease by 48% compared to Scenario 0, and the decrease in revenues becomes increasingly severe as the new entrant's capacity increases. At the highest capacity on the new entrant (3x50), the relative decrease in Airline 1's revenues reaches 72% of Scenario 0 revenues. The explanation for the decrease in Airline 1 revenues lies in the fact that Airline 3 is:

1. Offering more attractive Y and M products than airlines 1 and 2
2. Differentiating between Y and M class products

Practicing revenue management to maximize Y class loads, consequently increasing the revenue diversion from Airline 1 towards Airline 3 – unlike the previous case (Scenario 2) where Airline 3 was offering a single fare product and therefore not using revenue management.

As a result, Airline 1 loses most of its Y, B and M class traffic to the new entrant: Former Y (resp. M) class passengers now see more utility in purchasing a cheaper unrestricted Y (resp. M) class fare on the new entrant; similarly, former B (resp. Q) class passengers now prefer a less restricted Y (resp. M) class ticket for the price of B (resp. Q) class on Airline 1. In addition, as Airline 3 is now differentiating between Y and M class passengers, it is able to revenue-manage its seats and ensure that Y class seats remain available for later-booking higher-fare passengers, hence further allowing former Y and B class passengers on Airline 1 to book on Airline 3. This increases the amount of revenue diversion from Airline 1. Stimulation of low-fare demand (through the new lowest market fare) allows the nonstop incumbent carrier to initially maintain (and even increase) its loads in Q class. In the case of Scenario 3_{LM}^{50}, the high capacity on the new entrant carrier leads higher availability of M class seats on the new entrant and thus to the diversion of Q class passengers from the nonstop incumbent carrier.

Scenario 3_{LM}	Absolute capacity	% of nonstop incumbent	Airline 1	Airline 2	Airline 3	*Total*
No Entrant	0	0%	$12,003	$3,910		*$15,914*
3x15	45	50%	$6,197	$3,628	$5,412	*$15,237*
3x25	75	83%	$4,794	$2,847	$7,606	*$15,247*
3x30	90	100%	$4,559	$2,466	$8,395	*$15,420*
3x50	150	167%	$3,370	$1,033	$11,372	*$15,775*

Table 5.33: Revenues by airline as a function of new entrant capacity - Scenario 3_{LM}

Figure 5.12 shows the impact of entry on revenues by fare class on Airline 1, and highlights the decrease in revenues from upper classes (Y, B and M). Figure 5.12 also shows the change in revenues in Q class, and in particular the initial increase in Q class revenues following entry. In this case, as Airline 3 diverts higher fare class traffic from Airline 1, the nonstop incumbent finds itself with more seats available in the lower fare classes. These seats fill-up with lower-fare passengers (because of demand stimulation), which explains the revenue increase in Q class. As we discuss later on, the increased availability in Q class is created by the revenue management system.

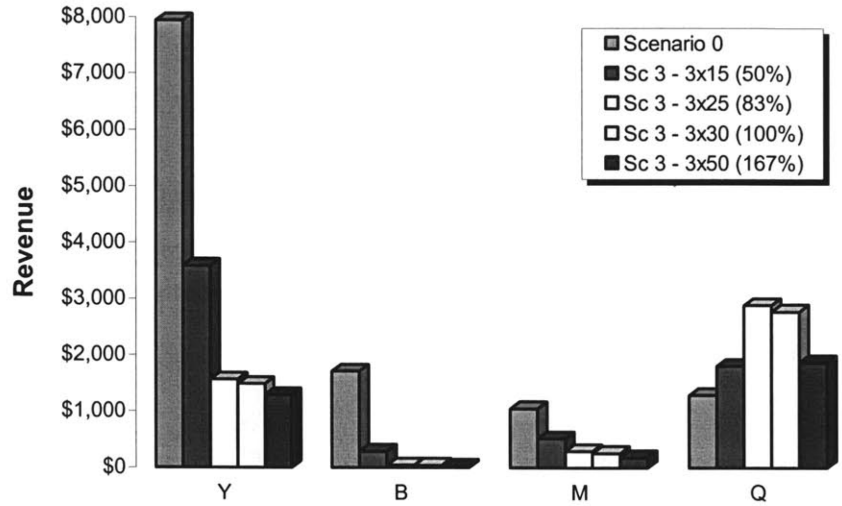


Figure 5.12: Airline 1 revenues by fare class pre- and post-entry - Scenario 3_{LM}

As shown in Figure 5.13, the average fare on Airline 1 decreases sharply upon entry, as a result of the traffic diversion described earlier, but it is also interesting to note that the average fare starts increasing in the case of Scenario 3_{LM}^{50} (compared to 3_{LM}^{30}). This is a consequence of the large capacity on the new entrant, and the fact that Airline 3 now begins to divert passengers from all classes, rather than only the higher fare classes. The result is that the mix on Airline 1 shifts back towards the higher fare classes, which is reflected in the average fare (c.f. Figure 5.13).

Finally, average load factors are also severely impacted by entry and decrease from 83% to as low as 47% on Airline 1 in Scenario 3_{LM}^{50}, as shown in Table 5.34.

We must here discuss the shift in passengers between incumbent carriers as well. Indeed, looking at Airline 1's revenues and passenger loads, we observed that Q class loads increase slowly post-entry. This relatively slow increase is somewhat striking in that one would have expected a much greater impact on Airline 1's Q class loads due to both the stimulation of low-fare traffic and the diversion of passengers from Airline 1 towards Airline 3. However, the initial impact of entry leads to an increase in Q class loads mostly on Airline 2 and not on Airline 1, as would have been expected (c.f. Table 5.34).

Entrant cap. (% of nonstop inc.)	Airline 1 Loads						Airline 2 Loads					
	Total	Y	B	M	Q	ALF	*Total*	Y	B	M	Q	ALF
No Entrant	*75*	30.4	12.7	11.4	20.5	83%	*47*	4.3	0.6	1.1	41.4	53%
3x15 (50%)	*56*	13.7	2.1	5.6	34.0	62%	*67*	0.4	0.0	0.1	66.1	74%
3x25 (83%)	*64*	6.0	0.3	3.2	54.5	71%	*48*	1.4	0.1	0.5	45.6	53%
3x30 (100%)	*61*	5.7	0.3	2.8	52.3	68%	*40*	1.5	0.0	0.4	38.1	45%
3x50 (167%)	*42*	4.9	0.2	2.0	35.2	47%	*15*	1.1	0.0	0.1	13.6	17%

Table 5.34: Airline 1 and 2 loads by fare class - Scenario 3_{LM}

Table 5.35 shows passenger preferences by passenger type for Scenario 3^{15}_{LM} – business or leisure, and more specifically the aggregated first choice of passengers, for example the total number of business passengers whose first choice is Y class on Airline 3 (59), and whether these passengers got their first choice or at least their first choice airline and class, but not flight. In our example of 59 business passengers whose first choice is Y class on Airline 3, only 33 of these passengers get Y class on Airline 3 and on the flight of interest, while an additional 5 passengers get Y class on another flight on Airline 3 but not Y class on the flight of interest.

As apparent when looking at passenger choice statistics, upon entry, passengers prefer Airline 3, and it is natural to infer that business passengers prefer Airline 3's Y class while leisure travelers prefer Airline 3's M class. We expect that passengers will always prefer Airline 3 to any other airline, since fares are lower on Airline 3 for the same restrictions and advance purchase requirements. However, because of capacity constraints on Airline 3, only 56% of passengers wanting to book Y class on Airline 3 (and 0.3% of those interested in M class) get their first choice. The remaining passengers get redistributed between airlines 1 and 2 and the "NoGo" alternative.

Meanwhile, as Airline 1 still observes traffic in its higher fare classes, the revenue management system continues to protect Airline 1's higher fare classes to make sure that seats remain available for later-booking passengers. On Airline 2, however, there is no such protection (because bookings are low), thus leading to more availability of low fare classes (Q in particular).

The added effect of very limited availability in M class on Airline 3, limited availability in Q class on Airline 1, both because of revenue management controls, and the greater availability of Q class on Airline 2 (also because of revenue management controls), leads to an increase in Q class loads on Airline 2, compared to Scenario 0, in Scenario 3^{15}_{LM}. As new entrant capacity increases, the loads in Q class (and on

Airline 2 in general) start decreasing and eventually drop below those of Scenario 0, as the new entrant is able to accommodate more of its first choice traffic, particularly in M class.

Pax Type	Airline	Class	First Choice Obs/Day	Get First Choice	Get First Choice Airline/Class but not Flight
Business	1	Y/B/M/Q	0	0	0
	2	Y/B/M/Q	0	0	0
	3	**Y**	**59**	**33**	**5**
		B			
		M	0	0	0
		Q			
Leisure	1	Y/B/M/Q	1	0	0
	2	Y/B/M/Q	0	0	0
	3	Y	2	2	0
		B	0	0	0
		M	**148**	**0**	**1**
		Q	0	0	0

Table 5.35: Scenario 3_{LM}^{15} passenger preference and choice, by passenger type

On Airline 3, at low capacity, passengers book mostly in Y class, given its fewer restrictions and lesser fare. As capacity increases, passenger mix shifts towards the lower fare class as more passengers get diverted from airlines 1 and 2, as shown in Table 5.36 (since Airline 3 is able to accommodate more traffic).

As a result of this change in passenger mix as the new entrant's capacity increases, Airline 3's average fare decreases, contrary to that of Airline 1 which increases with the entrant's capacity.

Entrant cap. (% of nonstop inc.)	Airline 3 Loads					
	Total	Y	B	M	Q	ALF
3x15 (50%)	*41*	39.6	0.0	1.2	0.0	91%
3x25 (83%)	*66*	49.9	0.0	16.1	0.0	88%
3x30 (100%)	*80*	50.3	0.0	30.1	0.0	89%
3x50 (167%)	*133*	52.4	0.0	80.8	0.0	89%

Table 5.36: New entrant loads by fare class as a function of new entrant capacity – Scenario 3_{LM}

Finally, looking at average fares by airline, we observe that in this case, Airline 3 has the highest average fare regardless of the capacity settings tested here. As new entrant capacity increases, however, the differential between the new entrant's average fare and that of the incumbent carrier decreases. Furthermore, as capacity on the new entrant increases, the fare differential initially increases between the two nonstop carriers, in favor of the new entrant, because it is able to divert mostly high-fare traffic from the incumbent carriers. As its capacity increases, the new entrant must also rely on low-fare passengers and thus experiences a decrease in average fare, thus closing the gap between the two nonstop carriers' average fares.

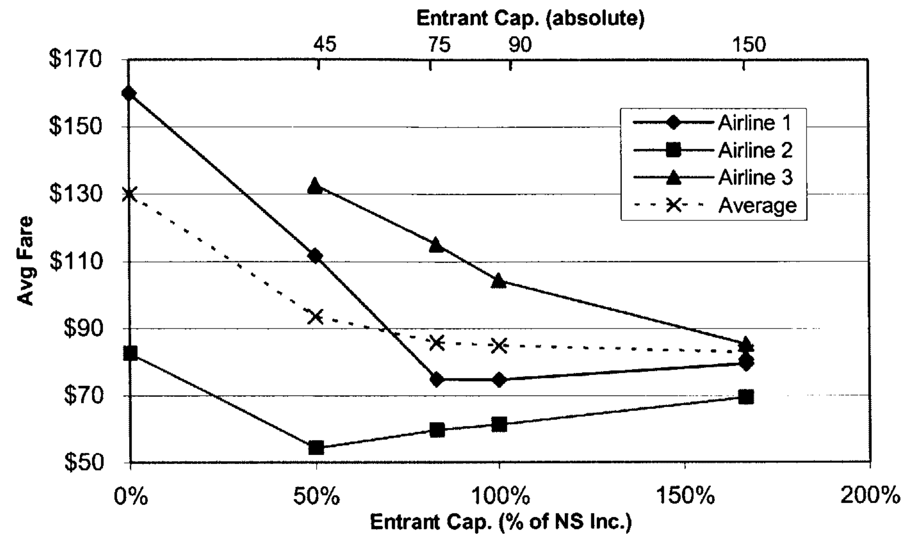


Figure 5.13: Average fares by airline - Scenario 3_{LM}

The impact of entry on Airline 1's market and revenue share is again negative, and leads to a decrease in market and revenue shares of Airline 1. The impact on revenues is once again greater than the impact on market shares, as shown in Table 5.37. At high new entrant capacity, the new entrant captures over 70% of market share and revenue share.

Entrant cap: absolute (% of nonstop incumbent)	Market Share (Traffic)			Revenue Share		
	Airline 1	Airline 2	Airline 3	Airline 1	Airline 2	Airline 3
No Entrant (0%)	61%	39%	0%	75%	25%	0%
3x15 (50%)	34%	41%	25%	41%	24%	36%
3x25 (83%)	36%	27%	37%	31%	19%	50%
3x30 (100%)	34%	22%	44%	30%	16%	54%
3x50 (167%)	22%	8%	70%	21%	7%	72%

Table 5.37: Market and revenue share by airline - Scenario 3_{LM}

In summary, entry with Scenario 3_{LM} parameters has substantially negative impacts on the nonstop incumbent carrier, in terms of revenues, average fares, and load factor. The new entrant carrier, who is now offering two lower fares with fewer restrictions, uses revenue management to ensure that its higher fares remain available late into the booking process. As a result, later-booking, higher fare passengers, who traditionally would book on Airline 1 (whose seats remained available and were more attractive than connecting seats on Airline 2), now have the option of booking on Airline 1 or Airline 3. Since fares are cheaper on Airline 3, these passengers will prefer to book on Airline 3. The excess demand still allows Airline 1 to extract some revenues from these passengers (at low entrant capacity), but much less than before entry. The result is a significant dilution of Airline 1's revenues, average fares and load factors, as shown in Table 5.38.

Airline 1	Entrant capacity: absolute (% of nonstop inc)			
% change	3x15 (50%)	3x25 (83%)	3x30 (100%)	3x50 (167%)
Revenues	-48%	-60%	-62%	-72%
Traffic	-26%	-15%	-19%	-19%
Avg. Fare	-30%	-53%	-53%	-50%

Table 5.38: Scenario 3_{LM} – effect of entry on traditional measures of performance for Airline 1 compared to Scenario 0

Scenario 3LM	Airline	Pax/Day	Avg Fare	Revenues	ALF	Market Share	Revenue Share
No Entrant (Sc. 0)	NS Incumbent	75	$160.07	$12,003	83%	61%	75%
3x15	NS Incumbent	56	$111.62	$6,197	62%	34%	41%
	New Entrant	41	$132.78	$5,412	91%	25%	36%
3x25	NS Incumbent	64	$74.94	$4,794	71%	36%	31%
	New Entrant	66	$115.12	$7,606	88%	37%	50%
3x30	NS Incumbent	61	$74.68	$4,559	68%	34%	30%
	New Entrant	80	$104.43	$8,395	89%	44%	54%
3x50	NS Incumbent	42	$79.54	$3,370	47%	22%	21%
	New Entrant	133	$85.39	$11,372	89%	70%	72%

Table 5.39: Scenario 3_{LM} summary table

Table 5.39 shows the impact of entry on traffic, average fares, revenues, load factors, market and revenue shares by airline as a function of new entrant capacity. In particular, Table 5.39 illustrates that in the case of Scenario 3_{LM}, the new entrant consistently achieves a higher average fare than the incumbent carrier (in the scenarios tested here), and that, as the new entrant's capacity increases, both carriers' average fares decrease. This is a consequence of the combination of capacity and revenue management effects, as, when the new entrant's capacity increases, the revenue management system opens up more seats in the lower fare classes which has a direct impact on the new entrant's average fare. In addition, the greater the new entrant's capacity, the greater the diversion from Airline 1 (the nonstop incumbent) towards the new entrant, which then affects the incumbent's average fare. Finally, the relatively more attractive fares on the new entrant carrier lead to the inability of the nonstop incumbent carrier to maintain high revenue traffic, which leads to the decrease in the nonstop incumbent's average fare to levels below those of the new entrant carrier.

This scenario illustrates another case of entry where the aggregate measures of airline performance do not provide any indication of the response of the incumbent carrier. Compared to previous cases of entry (scenarios 1 and 2_{LM}) Scenario 3_{LM} provides yet another set of effects of entry on aggregate measures of incumbent performance. Incumbent average fares respond differently to entry with a two-tier fare structure than they did in the previous cases, as do revenues and market shares.

Scenario 3_{FM}

In this case, the incumbent and new entrant carriers all offer the same two-tier fare structure. Table 5.40 summarizes the impact of entry on total market revenues, loads and average fare. As was the case in all other scenarios of entry, low-fare stimulation of demand, along with the new entrant's added capacity in the market, lead to significant increases in total market loads. In terms of passenger mix, the change to a two-tier fare structure from Scenario 0 leads to a shift in passengers from Y/B classes towards the new Y class in the two-tier structure and from M/Q classes towards the new M class in Scenario 3_{FM}.

Total market revenues, however, initially decrease upon entry at low entrant capacity (e.g. in the case of Scenario 3^{15}_{FM} as compared to Scenario 0). The explanation is directly linked to passenger mix and the fact that the average fare is now lower than in Scenario 0, in all cases of Scenario 3_{FM}. As a result, at low entrant capacity, traffic stimulation is not sufficient to balance the lower fares and generate equivalent revenues. As new entrant capacity increases, total market revenues increase as well and eventually reach Scenario 0 revenue levels.

Average fares decrease by about 35% upon entry and decrease slightly as new entrant capacity increases. Average load factors initially increase due to the stimulation of low-fare traffic and the relatively low increase in total market capacity (Scenario 3^{15}_{FM}), and steadily decrease as the new entrant's capacity increases.

Sc. 3_{FM}	Loads					Revenues					Avg. Fare	Avg. Load Factor
Entrant Cap.	*Total*	Y	B	M	Q	*Total*	Y	B	M	Q		
0 (0%)	*122*	35	13	12	62	*$15,914*	$9,061	$1,798	$1,150	$3,286	$130	68.0%
3x15 (50%)	*176*	57	0	119	0	*$14,062*	$7,761	$0	$6,300	$0	$80	78.3%
3x25 (83%)	*190*	58	0	132	0	*$14,827*	$7,842	$0	$6,985	$1	$78	74.4%
3x30 (100%)	*195*	58	0	136	0	*$15,116*	$7,880	$0	$7,235	$1	$78	72.1%
3x50 (167%)	*206*	60	0	146	0	*$15,805*	$8,049	$0	$7,754	$2	$77	62.3%

Table 5.40: Scenario 3_{FM} market loads and revenues by fare class, average market fare and load factor

At the airline level, we observe that Airline 1's revenues decrease substantially after entry, between 44% and 49% (c.f. Table 5.42), increasingly with entrant capacity, compared to Scenario 0. The decrease in revenues is a consequence of the change in passenger mix and the decrease in average fare. Indeed, loads remain relatively constant regardless of the entrant's capacity. In addition, the decrease in revenues is accompanied by a shift in revenues by fare class: Y class revenues decrease by about 50% while M class revenues more than double and B and Q class disappear (due to the new pricing structure), as shown in Figure 5.14.

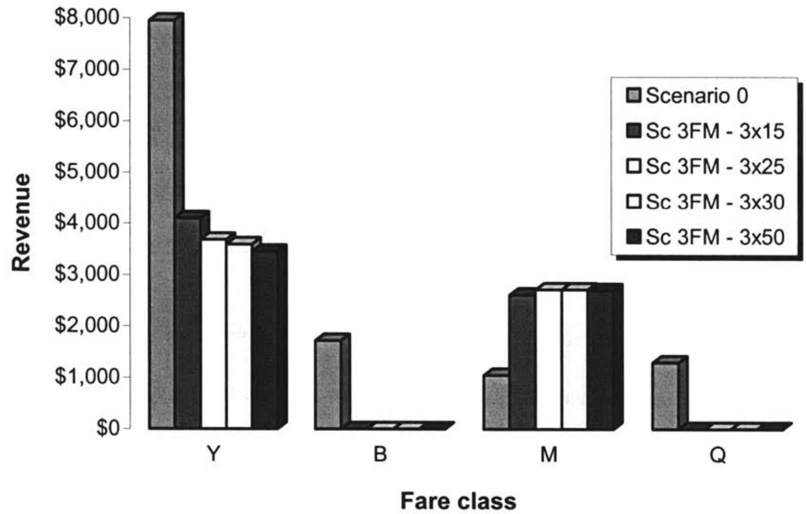


Figure 5.14: Airline 1 revenues by fare class - Scenario 3_{FM}

By comparison, new entrant revenues vary with new entrant capacity and do not make up for lost incumbent revenues (compared to total market revenues under Scenario 0, as shown in Table 5.43) until new entrant capacity increases to 150 seats per day, in which case the total revenues come back to Scenario 0 levels, but at much higher load levels, as discussed earlier. In addition, the increase in revenues is accompanied by a decrease in RASM on the new entrant carrier – from $0.307 at 15 seats per flight to $0.197 at 50 seats per flight – as was the case in all other scenarios.

Figure 5.15 shows the average fare by airline as a function of new entrant capacity, and highlights the fact that the nonstop carriers' average fares are generally higher than the average market fare. In addition, the nonstop carrier with the greater capacity has the lower average fare among nonstop carriers.

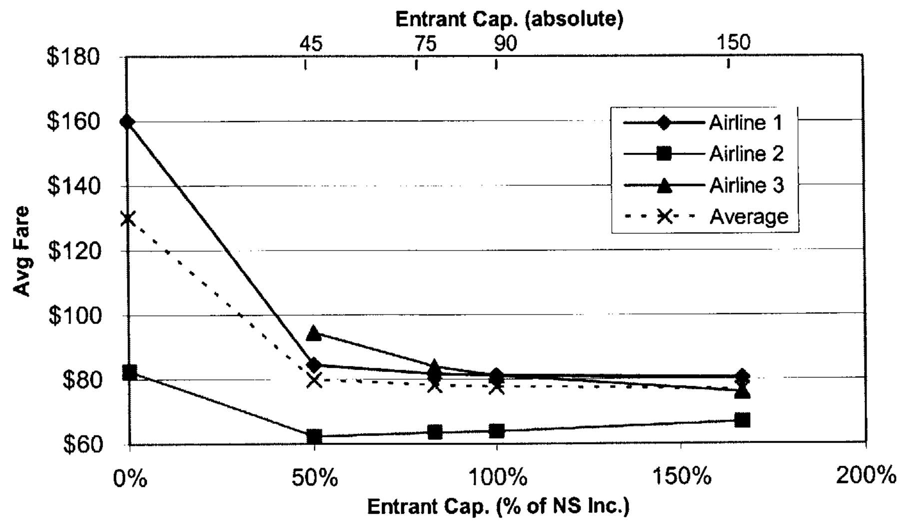


Figure 5.15: Scenario 3_{FM} average fare by airline as a function of new entrant capacity

Table 5.41 shows the market and revenue share by airline and the impact of entry on Airline 1's share of revenues and traffic. Once again, Airline 1's revenue share suffers disproportionately from entry compared to market shares.

Entrant cap: absolute (% of nonstop incumbent)	Market Share (Traffic)			Revenue Share		
	Airline 1	Airline 2	Airline 3	Airline 1	Airline 2	Airline 3
No Entrant (0%)	61%	39%	0%	75%	25%	0%
3x15 (50%)	45%	31%	24%	48%	24%	28%
3x25 (83%)	41%	24%	35%	43%	19%	38%
3x30 (100%)	40%	20%	40%	42%	17%	42%
3x50 (167%)	37%	9%	53%	39%	8%	53%

Table 5.41: Market and revenue share by airline - Scenario 3_{FM}

In summary, entry under Scenario 3_{FM} conditions has negative impacts on nonstop incumbent performance such as revenues and average fares. Average fares are affected by the change in the fare products offered by the incumbent carriers, and more specifically the fact that the nonstop incumbent carrier switches from a set of four fares to only two fares, priced lower on average than the original four fares. Revenues are then affected by the change in fares, and the fact that the new entrant carrier is offering the same fares as the incumbent carrier, thus forcing both carriers to split high fare demand. The effect is a change in passenger mix for the nonstop incumbent, and a decrease in revenues.

Traffic is not affected by entry as much because of the stimulation of low-fare traffic, combined with the incumbent's match of the new entrant's pricing strategy. As previously mentioned, passenger mix changes and leads to a decrease in average fare on the incumbent carrier. Table 5.42 summarizes the relative impact of entry on revenues, traffic and average fares on Airline 1. While revenues and average fare decrease by almost 50%, traffic increases slightly, because of traffic stimulation and the fact that the incumbent carriers match the new entrant's fare structure.

The more intuitive explanation is that, as the new entrant comes in and the incumbent carriers match its fares, three effects follow:

1. Demand is greatly stimulated by the lower fares
2. Passengers are able to purchase lower fares because of the change in all carriers' fare structure
3. Capacity and competition have increased, thus spreading the demand between more competitors

Airline 1	Entrant capacity: absolute (% of nonstop inc)			
% change	3x15 (50%)	3x25 (83%)	3x30 (100%)	3x50 (167%)
Revenues	-44%	-47%	-48%	-49%
Traffic	6%	4%	3%	3%
Avg. Fare	-47%	-49%	-49%	-50%

Table 5.42: Scenario 3_{FM} – effect of entry on traditional measures of performance for Airline 1 compared to Scenario 0

Table 5.43 summarizes the impact of entry on the nonstop incumbent and its new entrant competitor.

Scenario 3FM	Airline	Pax/Day	Avg Fare	Revenues	ALF	Market Share	Revenue Share
No Entrant (Sc. 0)	NS Incumbent	75	$160.07	$12,003	83%	61%	75%
3x15	NS Incumbent	79	$84.39	$6,707	88%	45%	48%
	New Entrant	41	$94.47	$3,914	92%	24%	28%
3x25	NS Incumbent	78	$81.63	$6,388	87%	41%	43%
	New Entrant	67	$84.04	$5,600	89%	35%	38%
3x30	NS Incumbent	78	$81.18	$6,300	86%	40%	42%
	New Entrant	78	$81.20	$6,304	86%	40%	42%
3x50	NS Incumbent	76	$80.51	$6,149	85%	37%	39%
	New Entrant	110	$76.08	$8,366	73%	53%	53%

Table 5.43: Scenario 3_{FM} summary table

Table 5.43 highlights the traffic, average fare, revenues, load factors and market and revenue share for the nonstop incumbent and the new entrant carrier as a function of new entrant capacity and highlights the fact that, as was the case in Scenario 1, when all carriers offer the same fare structure, the average fare on the new entrant carrier is higher than the nonstop incumbent's average fare, at lower new entrant capacity levels. This is a consequence of the joint effect of revenue management and capacity, and is discussed in more detail in Section 5.2.4.

This scenario illustrates the effect of a full fare match from the incumbent carriers. It highlights in particular that the nonstop incumbent carrier now benefits from matching the new entrant's fare structure with respect to revenues. In Scenario 2, matching the new entrant's single unrestricted low-fare led to revenue decreases on the incumbent carrier. In Scenario 3, matching now leads to an increase in revenues. These competitive interactions further illustrate the limits of aggregate measures of airline performance in assessing the response of incumbent carriers to low-fare entry.

5.2.4. Summary and Comparison of Scenarios 0 through 3 – Cross-Scenario Comparisons

In Sections 5.2.2 and 5.2.3 we discussed the characteristics and competitive settings of each individual scenario. In particular, we distinguished scenario 0 where there is no new entrant operating in the market from scenarios 1 through 3 where a new entrant offers nonstop service in the market, in direct competition with that of the incumbent carrier also offering nonstop service (Airline 1).

In scenarios 1 through 3, the new entrant carrier always offers three daily nonstop flights scheduled at the exact same times as the nonstop incumbent carrier's flights. The major competitive difference between scenarios 1, 2 and 3 lies in the pricing structure on the new entrant carrier and the incumbents' response. These three different pricing structures are summarized in Table 5.44.

	New Entrant Fares by Fare Class			
	Y	B	M	Q
Scenario 1	$261	$135	$92	$53
Scenario 2	$53	Not offered	Not offered	Not offered
Scenario 3	$135	Not offered	$53	Not offered

Table 5.44: New entrant fares by fare class and scenario

Market-Level Comparison of the Impact of Entry

In Sections 5.2.2 and 5.2.3, we discussed the impact of entry and more specifically focused on the impact on revenues, average fares and loads at the market level and on the nonstop incumbent carrier, within each scenario and as a function of new entrant capacity. We now compare the impact of entry across scenarios at the market level.

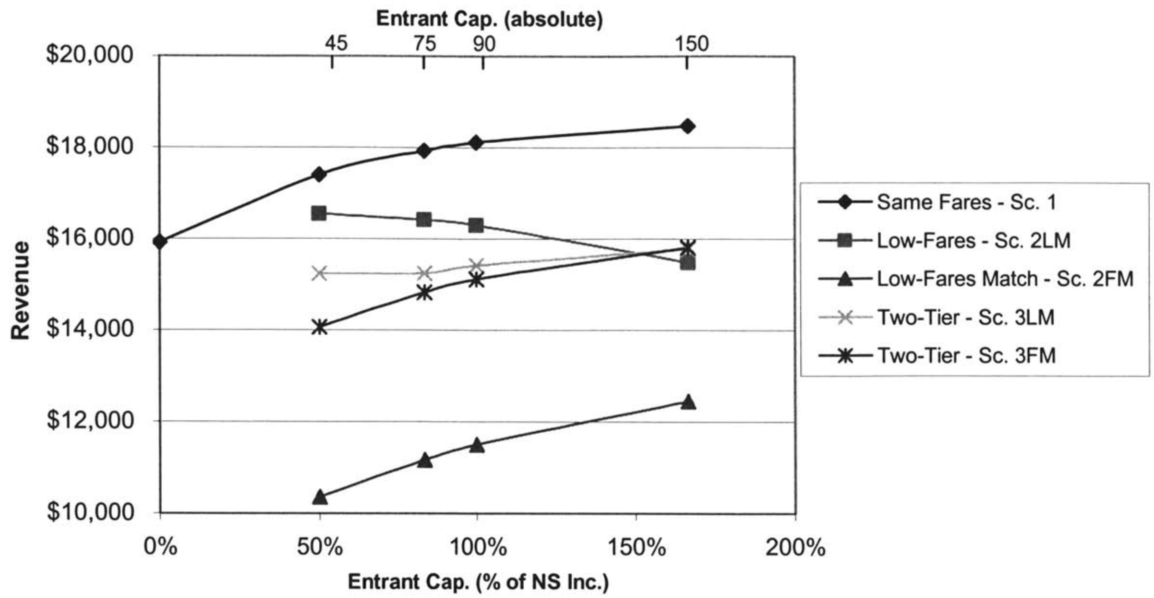


Figure 5.16: Total market revenues as a function of the scenario of entry

Figure 5.16 shows that revenues are impacted differently by entry, and that the relative ranking between scenarios (given a fixed new entrant capacity), at the total market level, is generally the same regardless of the capacity on the new entrant. Scenarios 1 and 2_{LM} generally lead to higher total market revenues than our benchmark case (Scenario 0). Scenarios 2_{FM} and Scenario 3 lead to a decrease in total market revenues, the worse case being that of Scenario 2_{FM}. Scenario 2_{LM}'s revenues become lower than those of scenarios 3_{LM} and 3_{FM} at high entrant capacity because the entrant's increasing capacity has an increasingly negative effect on total market revenues.

More specifically, Scenario 1 always leads to the greatest market revenues because all carriers offer differentiated fare products on which they perform revenue management to ensure revenue maximization. Scenario 2_{LM} often leads to increased total market revenues, but the increase decreases with increasing new entrant capacity because the new entrant diverts increasing numbers of Airline 1 passengers and lets these passengers purchase a lower fare. Initially, this effect is balanced by the increase in low-fare demand which leads Airline 3 to run out of availability early and thus does not substantially affect Airline 1's revenues, overall leading to an increase in total market revenues. As new entrant capacity increases, diversion becomes more important and eventually leads to total market revenue losses.

Scenario 2_{FM} leads to substantial revenue decreases because all carriers change their pricing structure and offer a single low-fare that is not balanced by sufficient increases in traffic (since it is limited by capacity). The end result is a major decrease in revenues, decrease which is reduced as new entrant capacity increases, but remains substantially greater than in any other scenario. Scenario 3 losses are smaller than those of Scenario 2_{FM} and decrease with increasing new entrant capacity, as the airlines are able to satisfy more of the total demand and also perform some product differentiation, albeit less than in scenarios 0 and 1. Scenario 3^{50} revenues surpass those of Scenario 2^{50}_{LM}.

In summary, at the total market level, each scenario behaves differently with respect to revenues and, if all carriers use the same fare structure, more product differentiation combined with revenue management is better than limited or no product differentiation. Indeed, Scenario 1 has higher revenues than Scenario 3_{FM} (with a two-tier fare structure) and even better than Scenario 2_{FM} (with a single low fare). Similarly, when only the new entrant uses a simplified fare structure, total market revenues are always higher when the new entrant differentiates its fare products rather than offers a single low-fare.

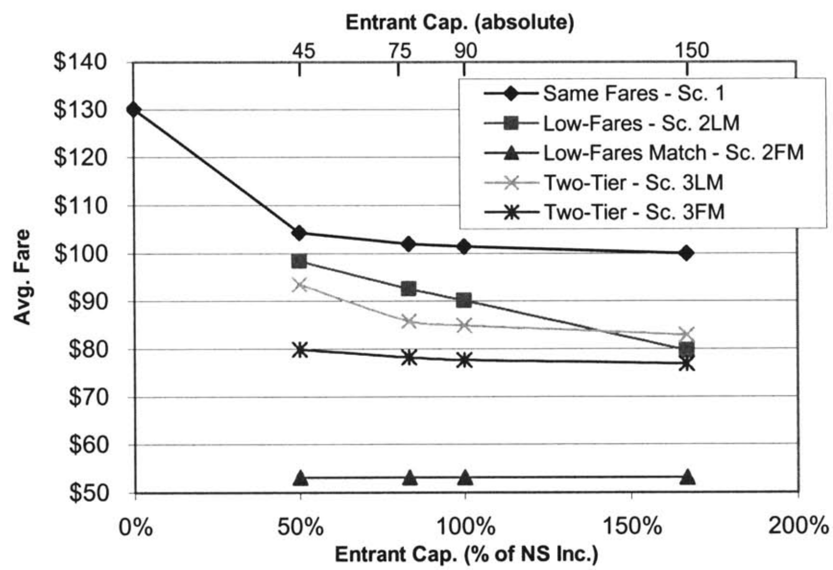


Figure 5.17: Average market fare as a function of new entrant capacity and scenario

Figure 5.17 shows the effect of entry in each scenario on average market fares, and the fact that the average fare is indeed greatly affected by entry. The major conclusion is that in all cases of entry, the average market fare decreases. This is due to the fact that upon entry, all carriers stimulate low-fare traffic (by offering a lower fare than the previously available Q fare). In addition, the increased capacity in the market leads to additional low-fare seat availability and thus to lower average fares. The extent of the decrease in average fare (in each scenario, relative to Scenario 0) is a consequence of the entrant and incumbents' pricing strategy and the entrant's relative capacity, as discussed in each individual scenario discussion. This leads to the same relative ranking of total market average fares by scenario as observed for revenues (except at very high new entrant capacity).

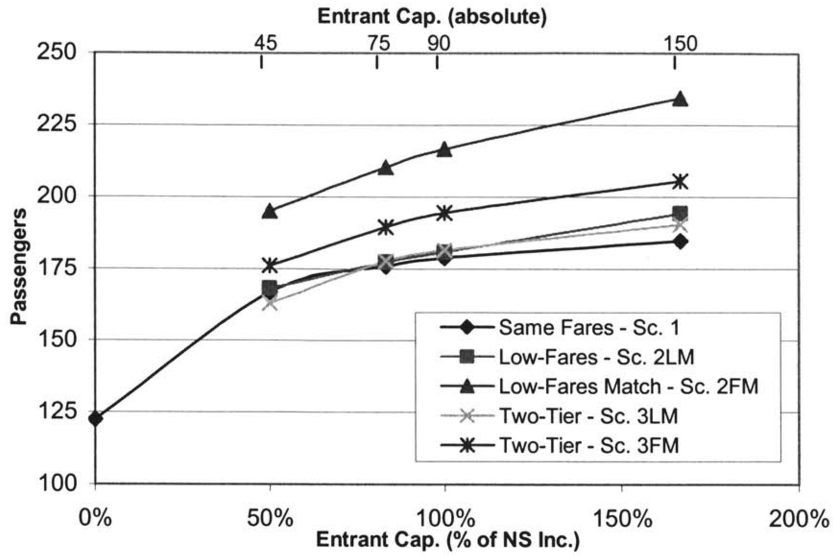


Figure 5.18: Total market loads as a function of entrant capacity and scenario

Finally, with respect to loads and average load factors, the rankings are reversed compared to revenues or average fares: The lower the average market fare, the greater the total traffic in the market. While a lower average market fare does lead to greater loads, the constraints with respect to total market capacity can lead to a decrease in total market revenues compared to Scenario 0 revenues.

Airline-Level Comparison of the Impact of Entry: Effects on the Nonstop Incumbent Carrier

Figure 5.19 shows Airline 1 revenues as a function of the new entrant's capacity and scenario settings. The first observation is that Airline 1's revenues are affected differently by entry and by each scenario. In addition, unlike total market revenues, Airline 1's revenues are generally not the highest when the new entrant comes in with Scenario 1 characteristics.

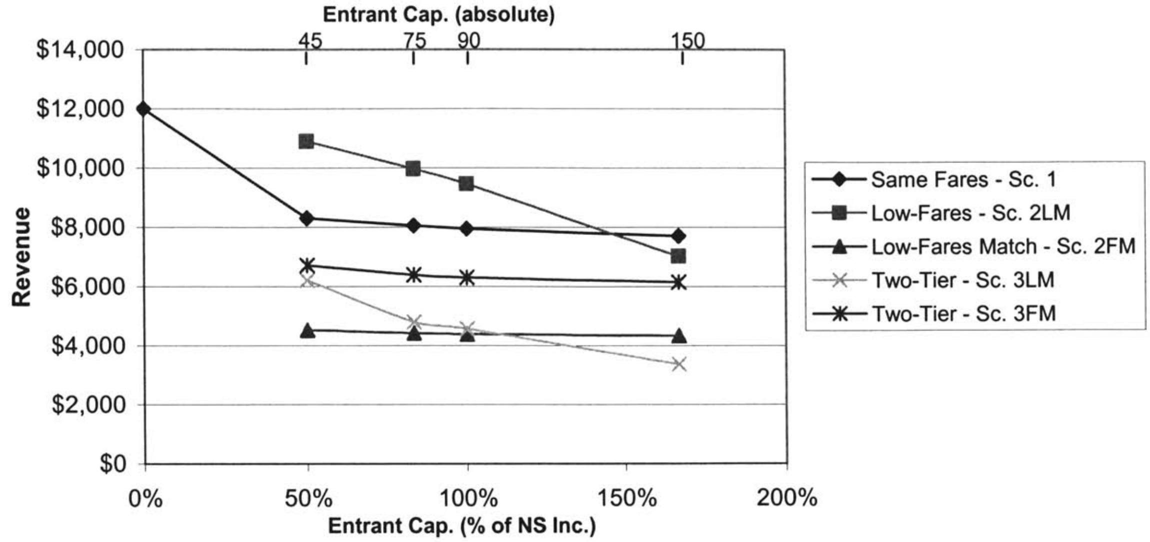


Figure 5.19: Airline 1 revenues as a function of entrant capacity and scenario settings

Scenario 2_{LM} brings the highest revenues to Airline 1, as long as the new entrant's capacity remains relatively low, since the new entrant carrier then fills up with low fare traffic and leaves higher fare passengers to Airline 1. Scenario 1 has the second highest revenues for Airline 1. In addition, Scenario 1 revenues remain relatively unaffected by the new entrant's capacity, as is the case for scenarios 3_{FM} and 2_{FM}.

Figure 5.19 thus allows us to conclude that entry always (in these simulations) has a negative impact on incumbent revenues (compared to no entrant competition as simulated in Scenario 0). In addition, incumbent revenues decrease with increasing new entrant capacity, with different rates of decrease depending on the scenario. Finally, we also observe that from Airline 1's perspective, matching the new entrant's pricing strategy can sometimes be a better alternative to maintaining its standard fare structure. For example, in the case of entry with a two-tier structure, the nonstop incumbent suffers a smaller revenue decrease (relative to Scenario 0 revenues) when matching the entrant's two-tier structure as compared to not matching the fare structure. Alternatively, in the case of entry with a single low-fare, the nonstop incumbent experiences a smaller decrease in revenues (relative to Scenario 0 revenues) by maintaining its structured fares rather than matching the new entrant's fare structure. These extreme examples illustrate the fact that the incumbent's best response, revenue-wise, is not the same in all situations.

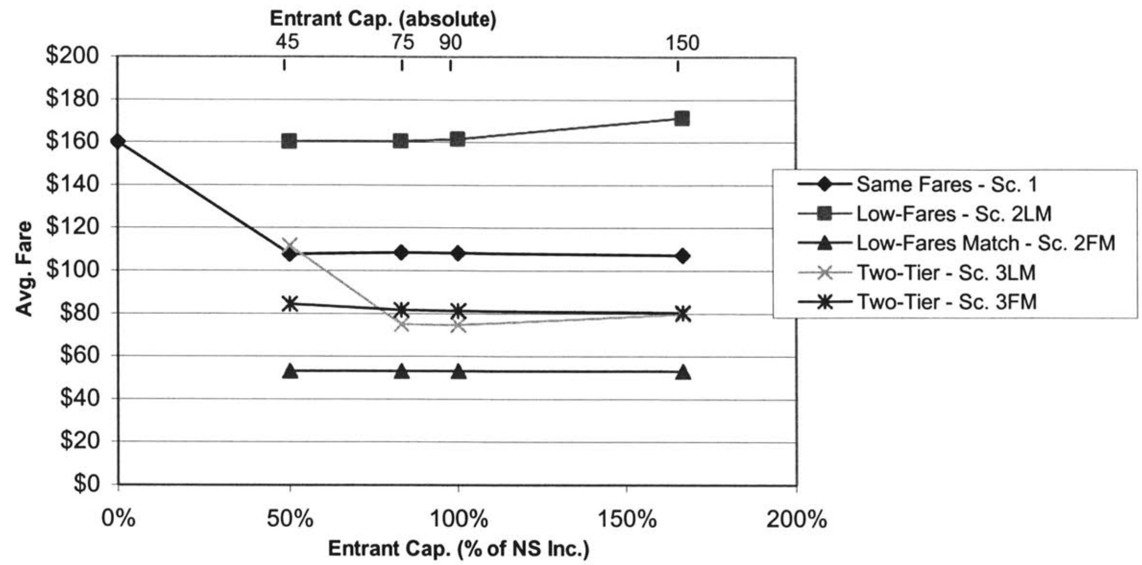


Figure 5.20: Airline 1 average fare as a function of entrant capacity and scenario

The average fare on Airline 1 also reacts very differently depending on the scenario of entry, as shown in Figure 5.20. Generally speaking, the average fare decreases upon entry, except in the case of Scenario 2_{LM} where the average fare actually increases slightly following entry, as the new entrant carrier diverts low-fare traffic away from the nonstop incumbent. Figure 5.20 also shows that even without matching the new entrant's fares or otherwise responding to entry by capacity, frequency or pricing changes, the average fare on the nonstop incumbent carrier will vary. The variation can be an increase or a decrease, and depends on the new entrant's capacity.

Figure 5.20 also shows that a limited response from the incumbent carriers to entry can lead to a lower average fare than a full-match response. For example, in the case of Scenario 3, the limited match response leads to a lower average fare on the incumbent carrier than the full match response, when the new entrant's capacity is greater than 15 seats per flight. These results emphasize the lack of information provided by average fares, relative to the response of incumbents to entry.

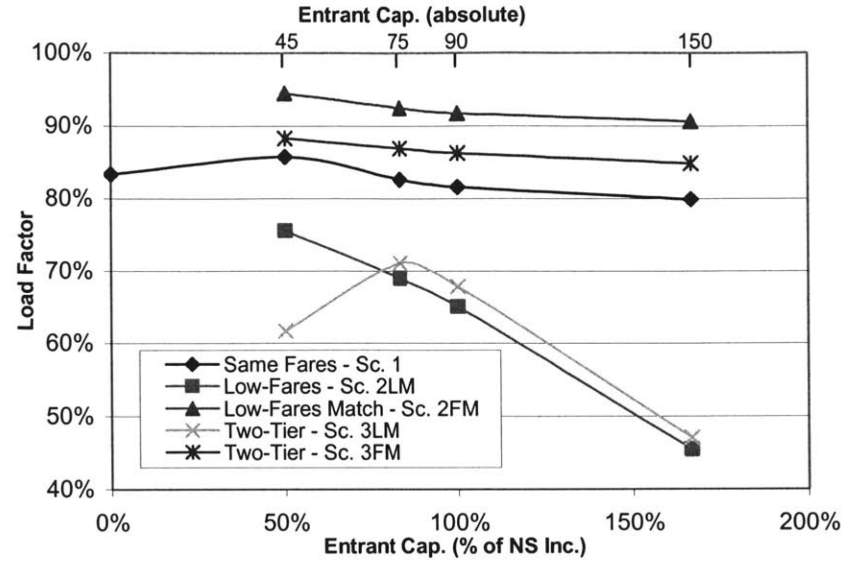


Figure 5.21: Airline 1 average load factor as a function of entrant capacity and scenario

Figure 5.21 shows the impact of entry on Airline 1's average load factors. We explained in Section 5.2.3 the reason for the initial increase in average load factor between scenarios 3^{15}_{LM} and 3^{25}_{LM}, and why it is accompanied by a decrease in average fare. Relatively speaking, average load factors are higher when the nonstop incumbent carrier matches the new entrant's pricing structure, as should be expected. When the nonstop incumbent carrier does not match the new entrant's fares, the average load factors on Airline 1 are much lower and decrease substantially as new entrant capacity increases.

Finally, Figure 5.22 shows the impact of entry on Airline 1's market and revenue shares. In particular, Scenario 2_{LM} exhibits a somewhat unusual pattern in that Airline 1's market share suffers most from entry, while Airline 1's revenue share suffers substantially less from entry. This can be explained by the fact that Scenario 2_{LM} presents the particularity of having Airline 3 come in with a single unrestricted low fare. As a consequence, Airline 3 diverts substantial amounts of traffic (mostly low fare traffic) but not revenues, as Airline 1 is still able to extract revenues from high fare passengers.

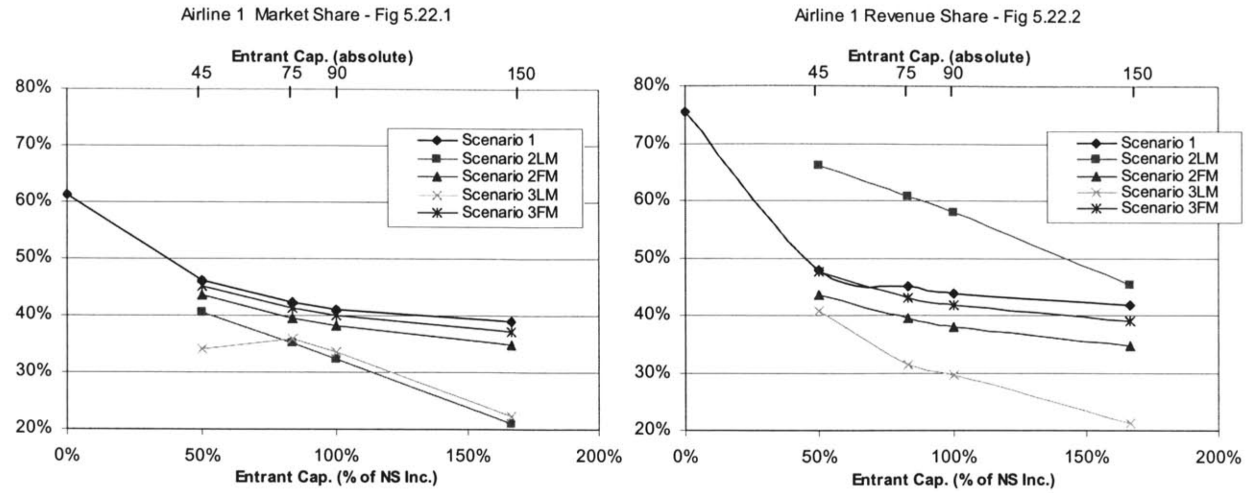


Figure 5.22: Market and revenue share for Airline 1

Comparison of Revenues, Average Fares and Loads across Carriers

We now focus on the relative performance of the nonstop incumbent and the new entrant carrier across scenarios and compared to one another. Results show that each scenario leads to very diverse situations, as described below.

Figure 5.23 shows revenues by airline in each scenario as a function of new entrant capacity. As apparent in Figure 5.23, the relative performance of one carrier compared to the other nonstop carrier is highly dependant on the scenario and entrant capacity. The first obvious trend is that incumbent revenues decrease as new entrant capacity increases, while new entrant revenues increase with new entrant capacity. The second trend is that in the full match cases, scenarios 1, 2_{FM} and 3_{FM}, airlines 1 and 3 share revenues as a function of their relative capacity: The carrier with the greater capacity has the higher revenues. In the case of limited match scenarios, the revenue shares vary more and Airline 1 performs better when Airline 3 has a single fare compared to the case where Airline 3 has two fares. This implies that more price differentiation is better for the new entrant carrier with respect to revenue maximization.

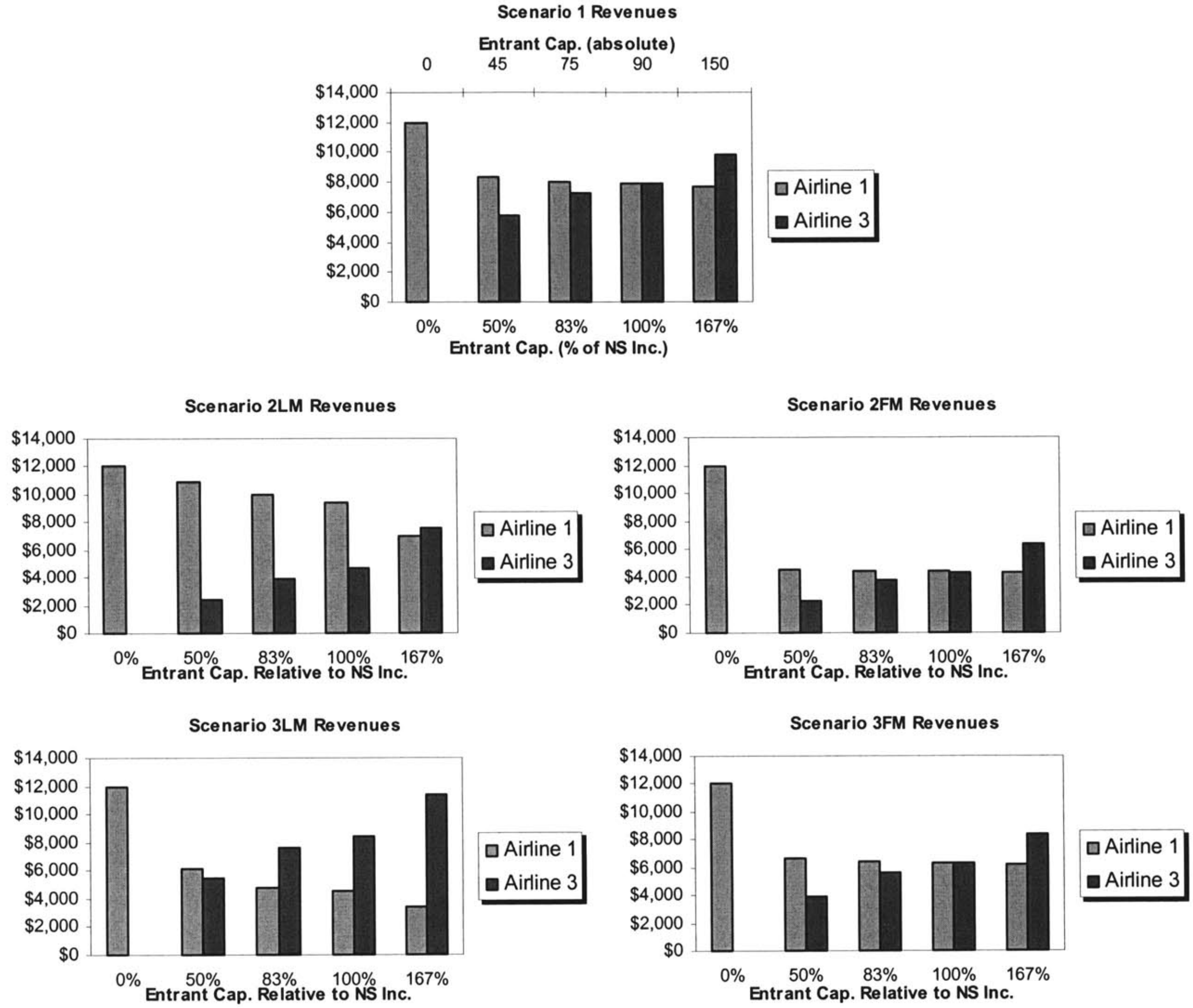


Figure 5.23: Airlines 1 and 3 revenues as a function of entrant capacity and scenario

Figure 5.24 shows average fares by airline in each scenario as a function of new entrant capacity. Once again, we note that the relative average fare between carriers depends on the scenario and the new entrant capacity. The most noteworthy trend is that the incumbent's average fare decreases with entry, in most cases. Only in Scenario 2_{LM} is this not the case, due to the fact that the new entrant diverts all of the low-fare traffic from the incumbent carrier, and that there is sufficient surplus of demand to ensure higher average fares on the incumbent.

In addition, it is also often the case that the carrier with the greater capacity has the lower average fare in the market. As previously explained, this is related to the fact that the carrier with greater capacity is more likely to have availability to carry more low fare traffic, which will negatively impact its average fare. One notable exception appears in Scenario 3_{LM} where the new entrant maintains a higher average fare even at high capacity. The fare differential between airlines 1 and 3 decreases, however, with increasing new entrant capacity. The explanation for this unusual case lies in the fact that the new entrant carrier has a simplified two-tier fare structure and is able to generate sufficient higher-fare stimulation and diversion from Airline 1 to maintain a higher average fare. The case of Scenario 2_{LM} is of course dismissed as the new entrant only offers one low-fare, which thus imposes that its average fare be the lowest available fare in the market, hence above that of the incumbent carrier.

Finally, Figure 5.24 shows that the relative positioning of the incumbent and the new entrant's average fare is highly dependant on the situation and is not indicative of a particular response: For example, in scenarios 1^{15}, 1^{25} and 3_{LM}, the incumbent carrier has a lower average fare than the new entrant, even though the incumbent carrier did not respond (other than by matching the lowest fare in the market) to Airline 3's entry in the market. This once again illustrates the great dependence of relative average fares (between carriers) on relative capacity and new entrant pricing strategy.

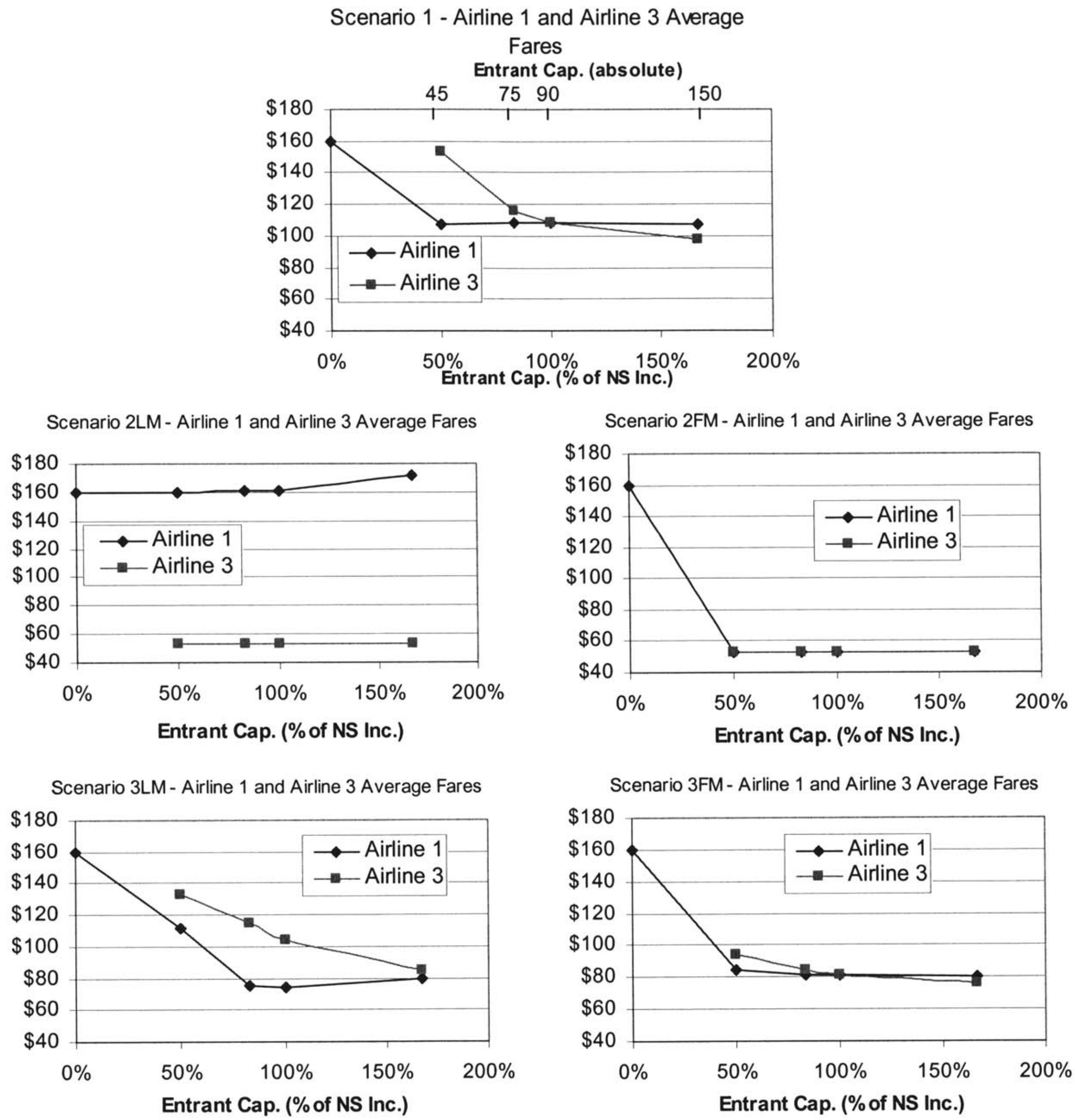


Figure 5.24: Airlines 1 and 3 average fares as a function of entrant capacity and scenario

Figure 5.25 shows revenue share between Airline 1 and Airline 3 as a function of entrant capacity and scenario (Airline 2 revenue share is implied but not shown). Figure 5.25 highlights the fact that in all scenarios, Airline 3's revenue share increases with increasing new entrant capacity, while Airline 1's share of revenues decreases. Furthermore, there is an inversion between Airline 1 and Airline 3's share of revenues as new entrant capacity increases. The point where this inversion occurs is a function of the scenario.

In the case of "full-match" scenarios (1, 2_{FM} and 3_{FM}), the inversion occurs when both carriers have the same capacity: That is, the carrier with the greater capacity has the greater share of revenues. This intuitively makes sense as the two nonstop carriers both offer the same service at the same times and at the same fares. We therefore expect the carrier with greater capacity to garner a greater share of revenues and traffic (which is also the case).

In the case of "limited match" scenarios (2_{LM} and 3_{LM}), the inversion occurs either before or after the new entrant's capacity increases beyond that of the nonstop incumbent carrier. In the case of Scenario 2_{LM}, the new entrant carrier offers a single low-fare, while the nonstop incumbents still offer a standard fare structure. In this case, the new entrant quickly takes over in terms of market share (between 3x15 and 3x25 seats on the new entrant) while its share of revenues remains very low. The reason for the lower revenues is that the new entrant essentially dilutes much of its potential revenues by offering a single low fare, and is unable to differentiate between passengers and to use revenue management controls. As a result, while its market share is higher, its share of revenues is quite low.

In contrast, in Scenario 3_{LM}, the opposite picture can be observed. This is because the new entrant carrier is able to differentiate between passengers effectively (and practice revenue management), and thus divert not only low-fare traffic from the incumbent carrier, but also high-fare traffic. The result is a diversion of a substantial amount of high-fare passengers from airlines 1 and 2, and fewer low-fare passengers, overall leading to a much quicker increase in market and revenue share for the new entrant carrier. In this case, the new entrant carrier acquires market share and revenue share dominance simultaneously, even before it reaches equal capacity with the nonstop incumbent carrier.

We thus observe very different effects on market and revenue shares for airlines 1 and 3, as a function of the scenario and the response of the incumbent carriers. When they match the new entrant's fare structure, market and revenue shares are dominated by the nonstop carrier with the greater capacity. When the incumbent carriers do not fully match the entrant's fare structure, the impact on market and revenue share depends on the new entrant's ability to differentiate between passengers and offer a more attractive product than the incumbent carriers.

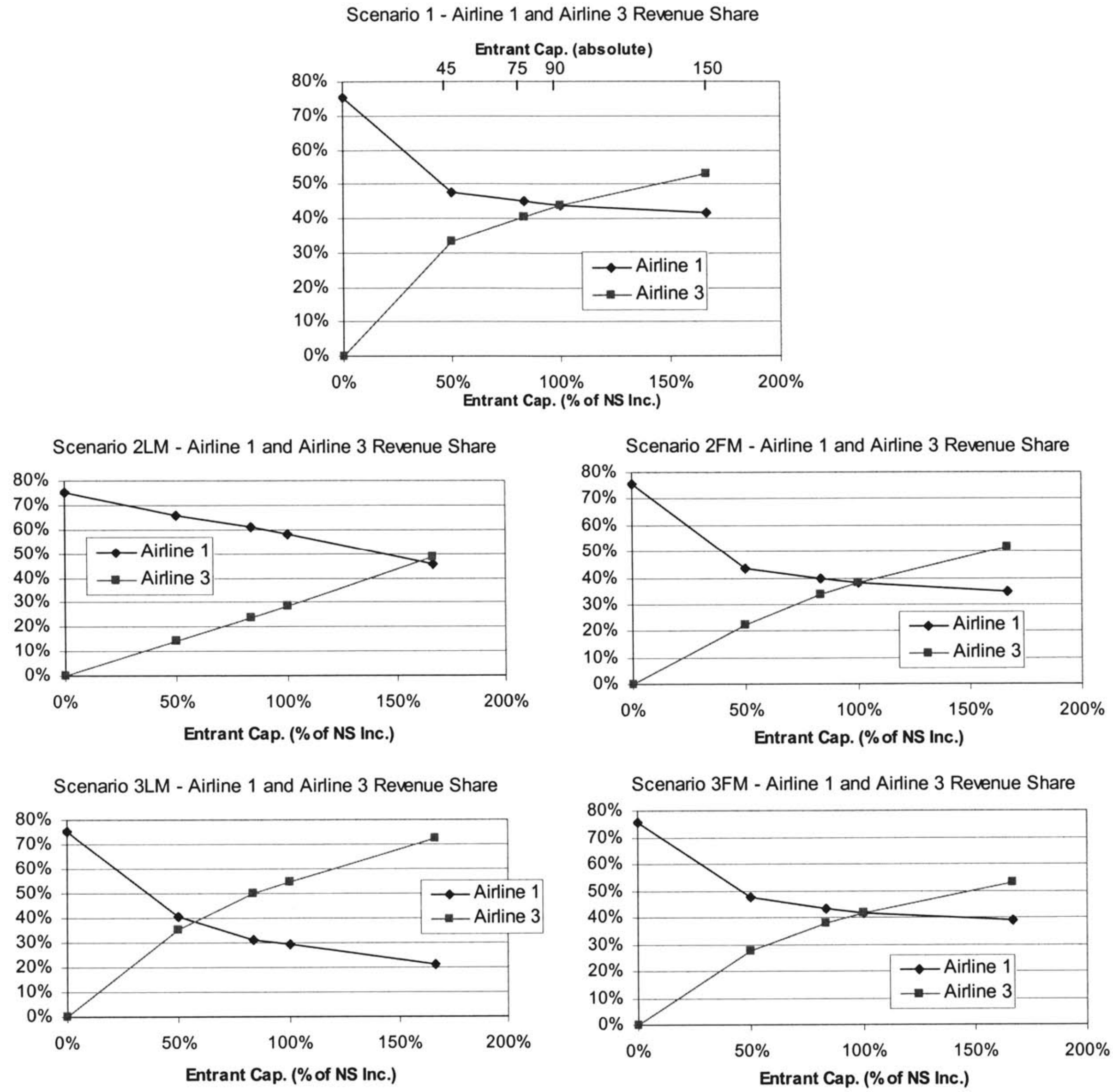


Figure 5.25: Airlines 1 and 3 revenue share as a function of new entrant capacity and scenario

Conclusions

Through simulation of entry in a single market case under various pricing and response strategies, we have identified a number of major factors explaining incumbent and new entrant performance. In particular, the simulation results illustrate the importance of the new entrant's capacity relative to that of the incumbent carriers' and total market demand. For example, incumbent revenues, loads and average fares are increasingly affected by increasing new entrant capacity. Under the assumption of full match of the entrant's fare structure by the incumbent carriers, incumbent revenues and average fares generally decrease following entry, while loads increase. Under the assumption of a match of the entrant's fare structure limited to the lowest fare available (limited match), incumbent revenues and loads decrease, while average fares can either increase or decrease depending on the entrant's pricing strategy (single unrestricted or differentiated two-tier fare structure).

Furthermore, the simulation results also show that the impact of entry on incumbent and new entrant average fares is highly dependent on the new entrant's relative capacity. Under full match cases, the carrier with the greater capacity has the lower average fare, while under asymmetric pricing conditions, the impacts on relative average fares varies as a function of the relative pricing and capacities of the nonstop competitors.

The results also show that, from a strategic perspective, matching the new entrant's pricing structure is not always the revenue and market share maximizing strategy for the incumbent carrier. Depending on the incumbent carriers' goals, one strategy might be better than the other. For example, in the case of entry with a single unrestricted low fare, between the two alternatives simulated, the limited match response leads to greater revenues on the incumbent carrier than the full match response. The latter response, however, maximizes the incumbent carrier's market share.

The simulations also highlight the inadequacy of aggregate measures of airline performance in assessing the response of an incumbent carrier to entry. The Detroit-Boston and Atlanta-Orlando case studies had allowed us to conclude that two markets that appeared to have had identical responses to entry (according to aggregate measures of airline performance), could in fact have been experiencing quite different competitive conditions with respect to low-fare entry. The results of this single market case simulation showed that identical responses to entry (in the limited match case) under different entry strategies (but identical demand and market parameter conditions) could lead to considerably different outcomes in terms of measures of average fare, revenues and traffic on the nonstop incumbent carrier, thus reinforcing the inadequacy of aggregate measures of performance.

Finally, in explaining the impact of entry on individual airline performance, we relied heavily on the effects of revenue management in clarifying the causes of passenger shifts between airlines. This implicitly stresses the importance of revenue management and its influence on individual carrier performance, as we discuss in the next chapter. In addition, this single market case does not include the effect of network flows of passengers, which are modeled in Chapter 7.

CHAPTER 6

EFFECT OF REVENUE MANAGEMENT ON TRADITIONAL MEASURES OF AIRLINE PERFORMANCE IN THE SINGLE MARKET CASE

6.1. Effects of Revenue Management on Incumbent Performance

In Chapter 5, we discussed the impact of entry on total market and airline revenues, average fares and traffic under specific default revenue management assumptions for all carriers. We assumed that all airlines in the market used Fare Class Revenue Management (FCRM). The results from Chapter 5 showed that airline performance depends greatly on capacity, fare structures and response of the incumbents to entry, and that relative average fares or traffic cannot be used alone to determine whether an incumbent's response to entry (or lack thereof) was revenue maximizing.

We are now interested in the additional impact of revenue management on the effect of entry. In this chapter, we show that more advanced revenue management allows the airlines to increase their revenues and be less affected by entry. Our simulation results also illustrate the impacts of revenue management on aggregate measures of airline performance. These results reinforce our previous conclusions that such measures provide very few insights on the response of incumbents to low-fare entry. To illustrate the importance of revenue management, we now allow all carriers to either use Fare Class Revenue Management or rely solely on advance purchase requirements as a segmentation of their passengers, and thus accept passenger requests on a First-Come, First-Served (FCFS) basis.

6.1.1. Competitive Revenue Management Settings

Using the scenarios defined in Chapter 5, we now allow the incumbent and new entrant carriers to modify their revenue management systems to evaluate the impact of revenue management on incumbent and new entrant performances (with respect to revenues, fares and traffic).

To reflect revenue management choices by airline, we define the following three competitive situations, applicable in scenarios 0, 1, 2 and 3:

a) None of the carriers perform revenue management and therefore all accept requests for seats on first-come first-served (FCFS) basis

b) Both incumbent carriers use FCRM but the entrant uses FCFS

c) All three carriers use FCRM

Table 6.1 summarizes the various competitive revenue management alternatives tested in the upcoming discussion of the effects of revenue management on traditional measures of airline performance.

	Revenue Management		
Scenario	**Airline 1**	**Airline 2**	**Airline 3**
Scenario 0	FCFS	FCFS	N/A
	FCRM	***FCRM***	N/A
Scenario 1	FCFS	FCFS	FCFS
	FCRM	***FCRM***	FCFS
	FCRM	***FCRM***	***FCRM***
Scenario 2	FCFS	FCFS	FCFS
	FCRM	***FCRM***	FCFS
Scenario 3	FCFS	FCFS	FCFS
	FCRM	***FCRM***	FCFS
	FCRM	***FCRM***	***FCRM***

Table 6.1: Revenue management settings by scenario

The scenarios tested in Chapter 5 are scenarios 0, 1, 2 and 3 when all competing carriers use FCRM. Note the absence of Scenario 2 with all three carriers using FCRM because of the fact that in Scenario 2, the new entrant offers a single fare structure. As a result, revenue management is not used by the new entrant carrier.

In the remainder of this discussion, we study the impact of changing revenue management settings within each scenario. The first case, in which all carriers accept passenger bookings on a first-come first-served basis, is somewhat unrealistic but will provide an estimate of the gains (revenues and traffic) that can be attributed to revenue management, and illustrates the effect of revenue management on traditional measures of airlines performance, even in the absence of low-fare competition. It also provides a baseline to further study the impact of the incumbents and new entrant using FCRM instead of FCFS.

The second case (where only the incumbent carriers use FCRM while the new entrant uses FCFS), although it assumes that the new entrant carrier does not perform revenue management, enables us to replicate the situation where the incumbent carriers use more advanced revenue management than the new entrant. This case will also allow us to assess the impact of revenue management on the incumbent carriers alone, and how it affects measures of performance on all three carriers.

Finally, the third case further illustrates the effects of revenue management on aggregate measures of performance when all competitors use FCRM in a single market environment. Comparison of all three cases will show how traditional measures of performance respond to changes in the competitive revenue management situation.

In a first step, we discuss the effects of revenue management when there is no new entrant competition. We then study the impact of revenue management on average fares, revenues and traffic in each case of entry (scenarios 1 through 3). In a third step, we compare the impacts across scenarios when the incumbent carriers and the new entrant carrier use FCRM instead of FCFS, and conclude to the impact of revenue management on traditional measures of airline performance as a function of the competitive scenario settings. Lastly, we discuss the sensitivity of the results presented in Chapters 5 and 6 to changes in some of the fundamental simulation assumptions, and show that the general trends presented in these results remain unchanged.

6.1.2. Scenario 0: No New Entrant Competition

In this section, we focus on the revenue impact of using fare class revenue management for the incumbent carriers, in the absence of a new entrant competitor. We thus compare previously discussed results for Scenario 0 when both incumbents use FCRM (in Chapter 5) to those for Scenario 0 when none of the competitors use revenue management, as simulated here.

We first examine incumbent carrier revenues. Figure 6.1 shows each of the two airlines' revenues, and highlights an apparent asymmetry, even in the case where both carriers accept bookings on a first-come first-served basis. This is essentially due to the fact that Airline 2 does not offer nonstop service in the market. As a result, the path utility on Airline 2, all else being equal, will necessarily be worse and passengers will book on Airline 1, if it is available. Furthermore, path preference might even induce passengers into booking a higher fare on Airline 1 rather than the lower fare on Airline 2, if the added restrictions on Airline 2's lower fare ticket further decrease its utility beyond that of the more expensive ticket on Airline 1.

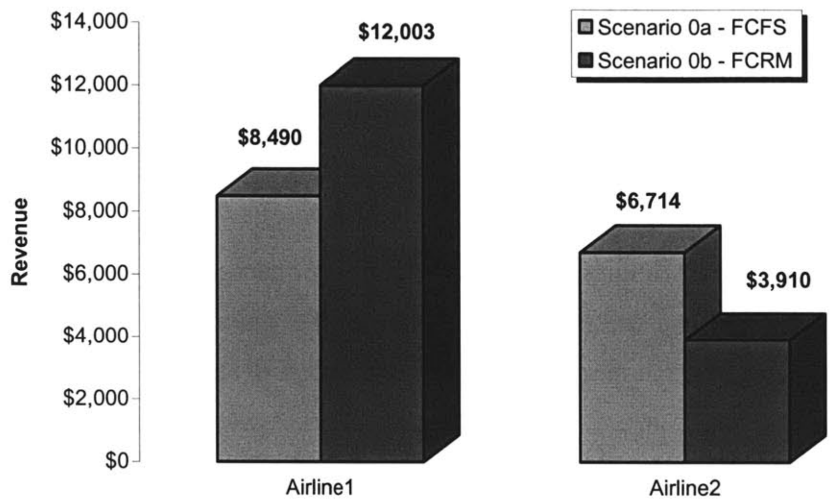


Figure 6.1: Incumbent carrier revenues in the case of no new entrant competition

The next step is to observe that when both carriers use FCRM, the asymmetry is even greater, in favor of Airline 1, the carrier which offers nonstop service. In addition, total market revenues increase from $15,205 to $15,914, or by 4.7%.

The increase in market revenues can be explained by the fact that fare class revenue management now allows both carriers to protect seats for later-booking passengers, under the assumption that the expected additional revenue from these passengers is greater than the expected revenue from earlier-booking, low-fare passengers. Table 6.2 shows traffic and revenues by fare class in each of the two scenario settings and confirms that with fare class revenue management, loads are higher in Y, B and M classes and lower in Q class, as are revenues, overall leading to higher market revenues.

	Revenue Management	*Total*	Y	B	M	Q
Traffic	(FCFS; FCFS)	*125.51*	31.12	12.73	7.00	74.66
	(FCRM; FCRM)	*122.38*	34.68	13.30	12.49	61.90
Revenues	(FCFS; FCFS)	*$15,205*	$8,130	$1,721	$644	$4,710
	(FCRM; FCRM)	*$15,914*	$9,061	$1,798	$1,150	$3,905

Table 6.2: Total traffic and revenues by fare class as a function of the revenue management environment

At the airline level, however, the impact is positive on Airline 1, whose revenues increase by 41.4% from \$8,490 to \$12,003, and negative on Airline 2, whose revenues decrease by 41.8% from \$6,714 to \$3,910. The explanation for this shift is now the combination of the effect of revenue management along with the fact that passengers will generally prefer Airline 1 to Airline 2 because of its better path quality (nonstop vs. connecting). As a result of these combined effects, passenger traffic in the higher fare classes decreases on Airline 2, which now carries exclusively low-fare passengers, while Airline 1 is able to protect seats for later-booking high-fare passengers and thus increase its own revenues. Figure 6.2 shows the change in fare class revenues on Airline 1 and further highlights the increase in higher fare class revenues and decrease in low fare class revenues. Airline 1's average fare consequently increases by 58% from \$101 to \$160.

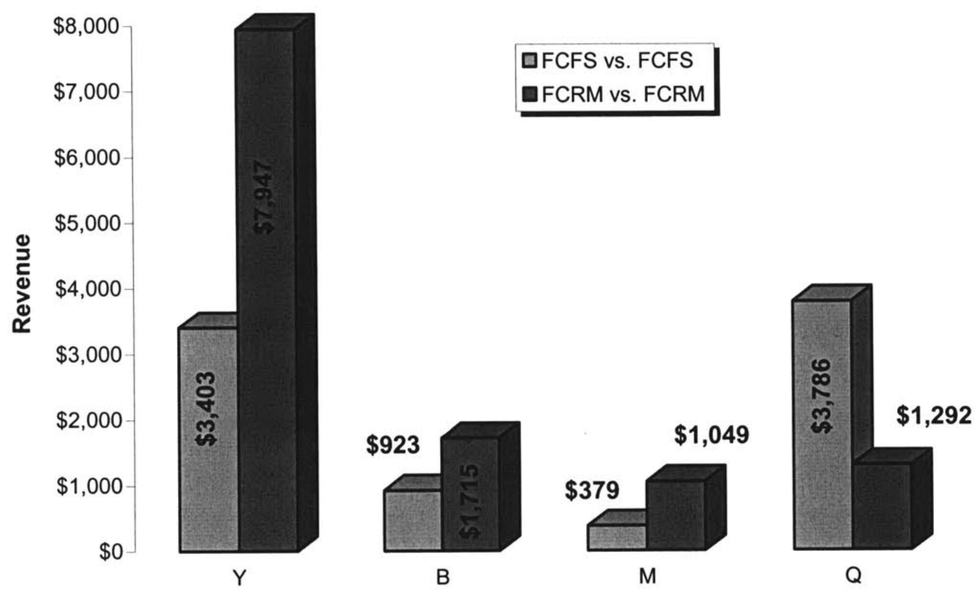


Figure 6.2: Airline 1 revenues by fare class under each revenue management environment

Finally, Figure 6.3 shows the traffic on Airline 1, by fare class and as a function of the competitive revenue management environment. Figure 6.2 and Figure 6.3 show that with FCRM, loads and revenues are greater in Y, B and M classes on Airline 1 and substantially lower in Q class. The overall impact on Airline 1's revenues, as mentioned earlier, is an increase in market revenues, accompanied by a decrease in average load factor from 93% under FCFS on both carriers to 83% when both incumbents use FCRM. On Airline 2, the opposite change occurs at the fare class level: Traffic in Y, B and M classes decreases, while Q class loads increase substantially. This results in a reduction in revenues and an increase in average load factor (from 46% to 53%).

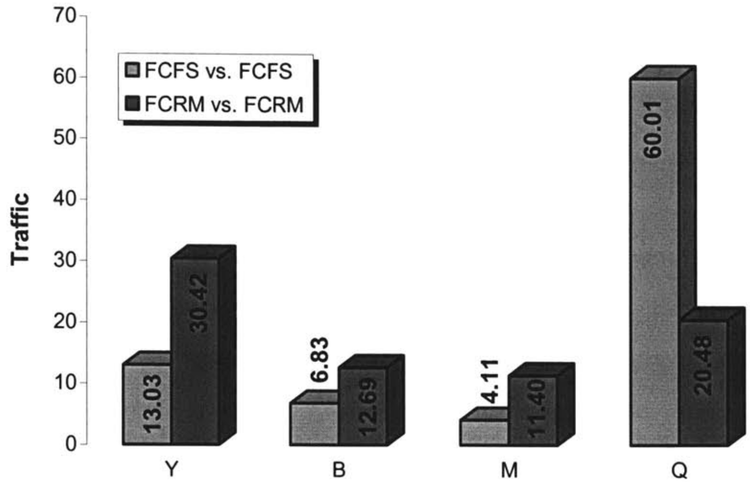


Figure 6.3: Airline 1 traffic by fare class and scenario

In summary, in the case of two airlines, there is asymmetry in the revenues earned by each airline due to the fact that Airline 1 offers nonstop service while Airline 2 only offers connecting service in the market. In addition, use of fare class revenue management by both carriers further increases the asymmetry in favor of Airline 1 whose revenues increase by 41% while Airline 2's revenues decrease by 42% (relative to FCFS revenues). The result is a dramatic change in market share and revenue share, whereby Airline 1's revenue share increases to 75% (from 56%) while its market share drops from 67% to 61%, as shown in Table 6.3.

	Market Share		Revenue Share	
Revenue Management	Airline 1	Airline 2	Airline 1	Airline 2
(FCFS; FCFS)	67%	33%	56%	44%
(FCRM; FCRM)	61%	39%	75%	25%

Table 6.3: Market and revenue share - Scenario 0

Use of FCRM on both incumbents leads to a substantial increase in revenues (+41%) and average fare (+58%) on Airline 1, mostly due to an increase in full fare Y class passenger revenues and a change in passenger mix, accompanied by a decrease in average load factor. This illustrates the impacts of revenue management on aggregate measures of airline performance, even without low-fare new entrant competition.

6.1.3. Scenarios 1 – 3: Competitive Simulation of Entry

Scenario 1: Entry with the Standard Fare Structure and Stimulation of Low-Fare Traffic

We now study the impact of revenue management on revenues, traffic and average fares in the case of Scenario 1. We show that the use of revenue management on the incumbents only and then on all three competitors generally leads to an increase in total market revenues, a decrease in total market traffic and thus an overall increase in average market fare (regardless of the new entrant's capacity in the market). On Airline 1, however, we show that FCRM leads to an increase in revenues compared to FCFS, with a decrease in traffic, and that the magnitude of the increase is directly related to the revenue management setting for Airline 3: When Airline 3 uses FCFS, Airline 1's revenues are higher than when Airline 3 uses FCRM. Airline 1's traffic and average fares are also affected quite differently by changing new entrant capacity as a function of the competitive revenue management situation, as we discuss below.

Market-Level Impacts

Figure 6.4 shows revenues at the total market level, as a function of new entrant capacity and revenue management settings for Scenario 1. Revenues increase when first the incumbents, then all three competitors, use FCRM, relative to FCFS on all three carriers. The increase in total revenues, relative to FCFS on all three carriers, is comparable when only the incumbents use FCRM and when all three competitors use FCRM. This relative increase in revenues (within each new entrant capacity case) varies between 0.6% at high new entrant capacity and 9% at low new entrant capacity. The reason for the greater relative increase in revenues at low new entrant capacity is related to the fact that there are greater capacity constraints at low capacity. The "industry as a whole" therefore benefits more from practicing revenue management at low capacity than when capacity is less constraining, in which case the airlines can accept all passengers without the risk of displacing a high-fare passenger by accepting a low-fare passenger, if in addition price segmentation is properly achieved.

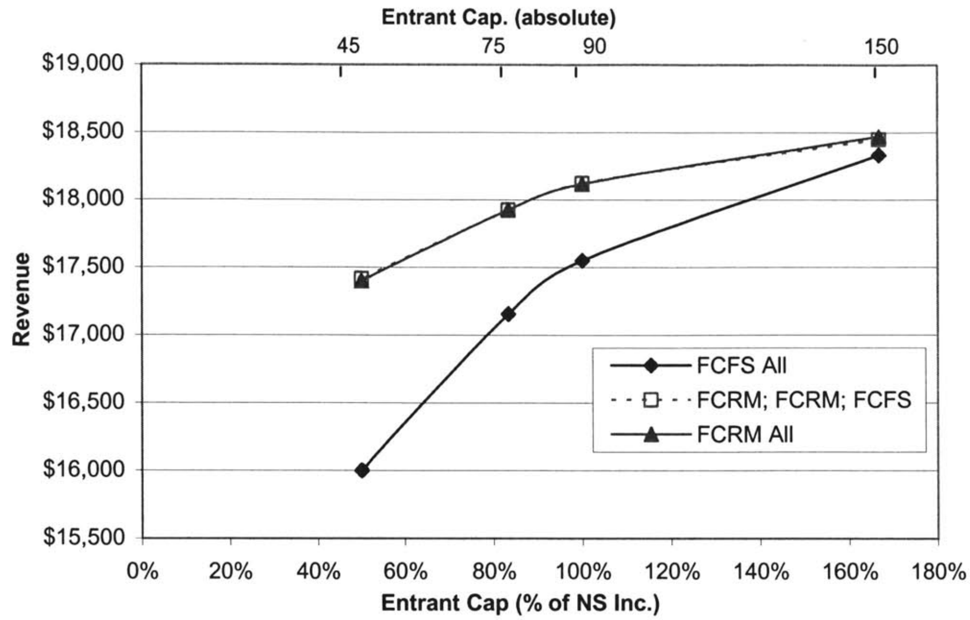


Figure 6.4: Total market revenues as a function of the revenue management settings and new entrant capacity – Scenario 1 (Scenarios with FCRM on the incumbents only and FCRM on all carriers overlap)

Figure 6.5 corroborates the "improvement" in passenger mix (shift towards higher fare classes) and shows the increase in average market fare when the airlines use FCRM, as more seats are protected for high fare passengers. Furthermore, the average fare varies with capacity within each scenario: When all carriers use FCFS, the average fare increases with new entrant capacity, as more high fare passengers can travel when capacity is high. In contrast, the average fare decreases with capacity in either case with FCRM, as more low-fare passengers can travel at high new entrant capacity, as compared to lower capacity levels, where FCRM protects seats for high-fare passengers rather than giving them away to earlier-booking low-fare passengers. This difference in the response of average market fares to low-fare entry as a function of the competitive revenue management situation is of critical importance.

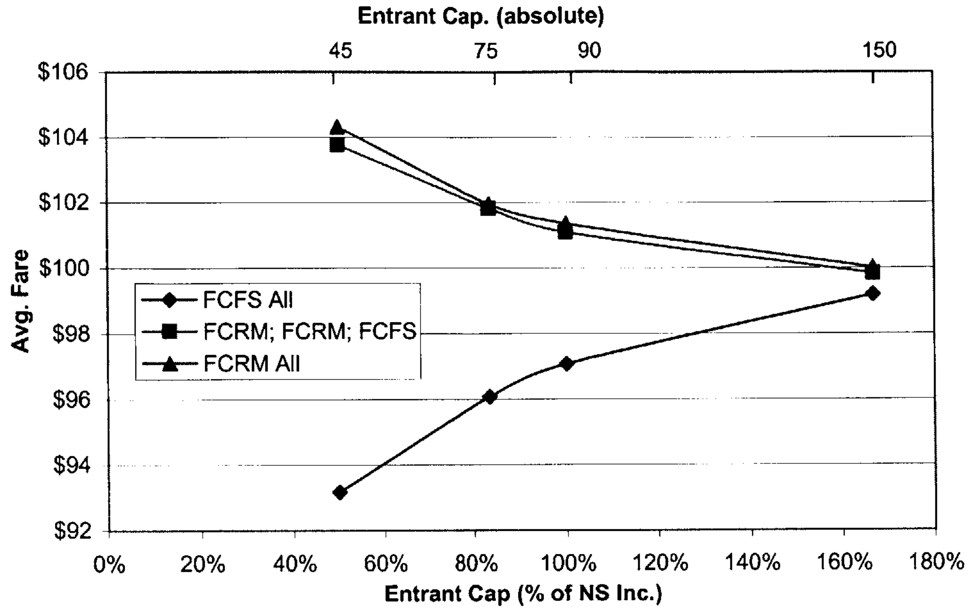


Figure 6.5: Average market fare as a function of the revenue management settings and new entrant capacity – Scenario 1

Finally, with respect to average load factors, we observe in Table 6.4 that use of revenue management leads to a decrease in average load factors at the market level. As more carriers use revenue management, they trade low fare passengers (with a higher probability of booking) for high fare passengers with a lower probability of booking, but a higher revenue contribution. This leads to lower load factors. In addition, the decrease is more apparent at low new entrant capacity, as relatively more low fare passengers are turned down for high fare passengers.

Entrant capacity		Traffic			ALF		
Absolute	% of nonstop incumbent	FCFS All	(FCRM; FCRM; FCFS)	FCRM All	FCFS All	(FCRM; FCRM; FCFS)	FCRM All
3x15	50%	172	168	167	76%	75%	74%
3x25	83%	179	176	176	70%	69%	69%
3x30	100%	181	179	179	67%	66%	66%
3x50	167%	185	185	185	56%	56%	56%

Table 6.4: Total market traffic and average load factors - Scenario 1

Airline-Level Impacts

The impact of competitive revenue management situation on Airline 1 follows the pattern shown in Figure 6.6, regardless of the new entrant's capacity. When only the incumbents use FCRM, Airline 1 gains substantial revenues (between 23% and 62% increases, decreasingly so with increasing new entrant capacity). When the new entrant then also uses FCRM, the increase is smaller, that is, relative to the case where only the incumbents use FCRM, Airline 1 incurs a loss in revenues. This loss ranges between 5% and 25%, but remains a significant increase over the case where none of the carriers use revenue management (between 17% and 22%). The loss in Airline 1 revenues when the new entrant uses revenue management (relative to when only the incumbents use FCRM) can be explained by the fact that Airline 3 is now able to better allocate its available seats between low-fare early-booking and higher-fare later-booking passengers.

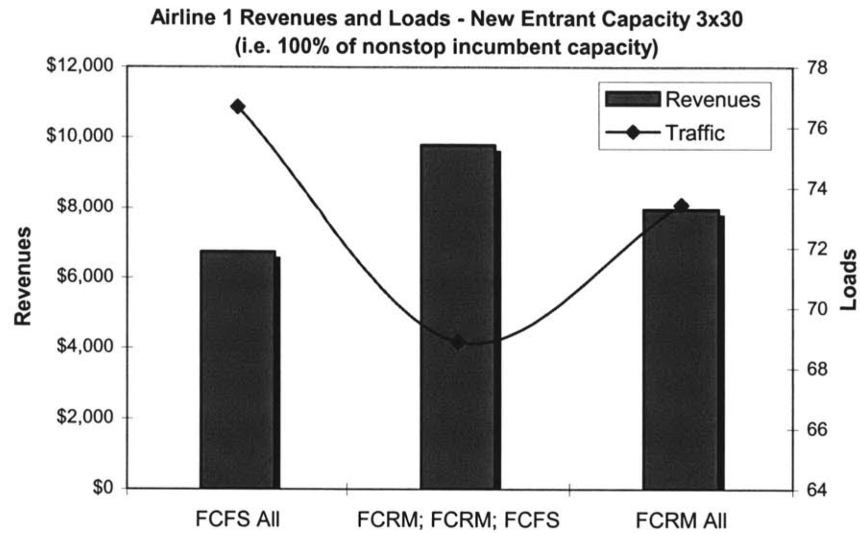


Figure 6.6: Airline 1 revenues and traffic as a function of incumbent and new entrant revenue management - Scenario 1[30]

While revenues increase when the incumbents use FCRM relative to FCFS, traffic decreases by 6% to 14%, and by 4% to 5% when all three carriers use FCRM, as shown in Table 6.5. In addition, as the new entrant's capacity increases, the relative traffic losses and revenue gains on Airline 1 decrease, when either the incumbents only, or all three carriers, use FCRM (relative to no revenue management). The decrease in traffic as the airlines shift to revenue management is explained by the fact that the premise of revenue management is to protect seats for later-booking, higher-fare passengers, with a lesser probability of filling the seats, but higher expected revenues. Thus, as the airlines shift to FCRM from FCFS, we expect traffic to decrease, but revenues to increase. When airlines move from only the incumbents using FCRM to all carriers using FCRM, increasing competition for high-fare late-booking passengers leads to a decreasing probability of filling seats with high-fare late-booking passengers. As a result, airlines trade less likely high-fare passengers for more likely low-fare passengers to mitigate the revenue loss. This leads to higher loads. Finally, the smaller revenue gains (greater traffic losses) at higher new entrant capacity are again a consequence of the lesser efficacy of revenue management at lower load factors.

Percent change relative to FCFS on all carriers		Revenues		Traffic	
Entrant capacity	% of nonstop incumbent	FCRM on incs only	FCRM all	FCRM on incs only	FCRM all
No Entrant	0%	41%	n/a	-11%	n/a
45	50%	62%	21%	-14%	-5%
75	83%	51%	19%	-12%	-5%
90	100%	45%	18%	-10%	-4%
150	167%	23%	17%	-6%	-4%

Table 6.5: Airline 1 relative revenue and traffic variation

As illustrated in Figure 6.7, the average fare on Airline 1 increases when the airlines use FCRM rather than FCFS (at all capacity levels). The increase is greater on Airline 1 when only the incumbent carriers uses FCRM and the new entrant continues accepting seat requests on a first-come, first-served basis, as a result of the changes in traffic and revenues described previously. Overall, when comparing no revenue management to FCRM on the incumbents or on all carriers, the average fare on Airline 1 increases.

Figure 6.7 also shows that the effect of increasing new entrant capacity on average fares differs depending on the competitive revenue management situation. When only the incumbents use FCRM, the average fare decreases with increasing new entrant capacity because the new entrant diverts increasing numbers of high fare passengers. By comparison, in the other two cases, the incumbent's average fare remains much more stable because of the symmetry in the competitive revenue management situation.

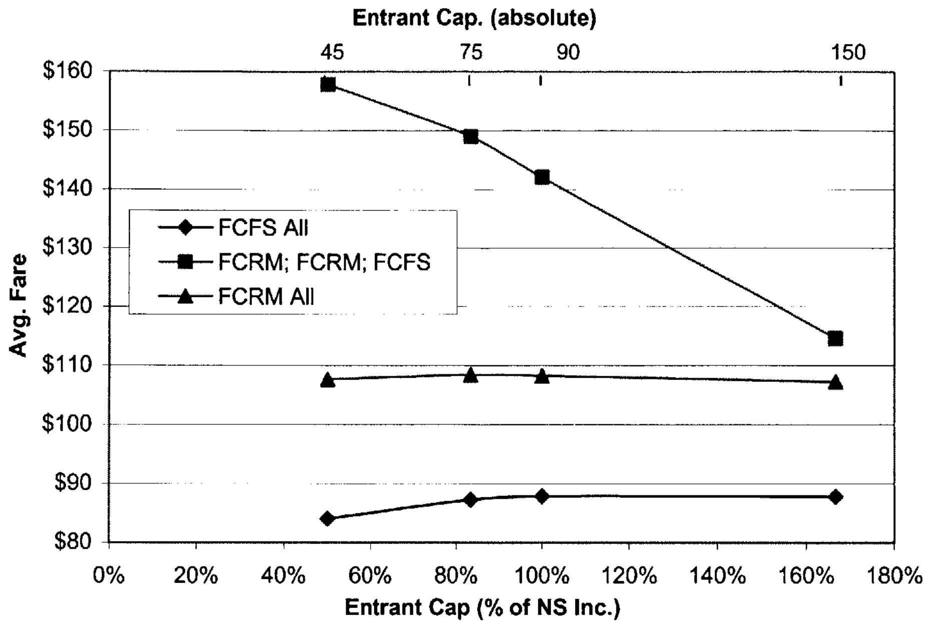


Figure 6.7: Average fare on Airline 1 as a function of scenario settings and new entrant capacity – Sc. 1

Finally, Airline 1's average load factors are also impacted by the change in revenue management: As shown in Table 6.6, when comparing no revenue management to FCRM on the incumbent carriers, Airline 1's average load factor decreases significantly (by as much as 13 percentage points at low entrant capacity). When all three carriers use FCRM, Airline 1's average load factors reach a middle ground between the other two scenarios. As mentioned earlier, when the incumbents use FCRM, Airline 1's revenue management system is trading loads for revenues, and, when this cannot be done anymore (either under FCFS on all carriers or FCRM on all carriers), Airline 1 lets more passengers on, thus increasing its traffic and revenues.

Entrant Daily Capacity		Average Load Factor		
Absolute	% of nonstop incumbent	FCFS all	FCRM on incumbents only	FCRM all
3x15	50%	91%	78%	86%
3x25	83%	87%	76%	83%
3x30	100%	85%	77%	82%
3x50	167%	83%	79%	80%

Table 6.6: Airline 1 average load factor as a function of scenario settings and new entrant capacity - Scenario 1

On Airline 3, contrary to Airline 1, comparing no revenue management to FCRM on the incumbents only, or on all three competitors, does not always lead to an increase in revenues. In particular, when only the incumbent carriers use FCRM, the new entrant loses revenues relative to FCFS on all carriers (c.f. Figure 6.8). This is an expected decrease in revenues, as the incumbent carriers now protect more seats for higher-fare passengers. The relative revenue loss does not depend on the new entrant's capacity, in our simulations.

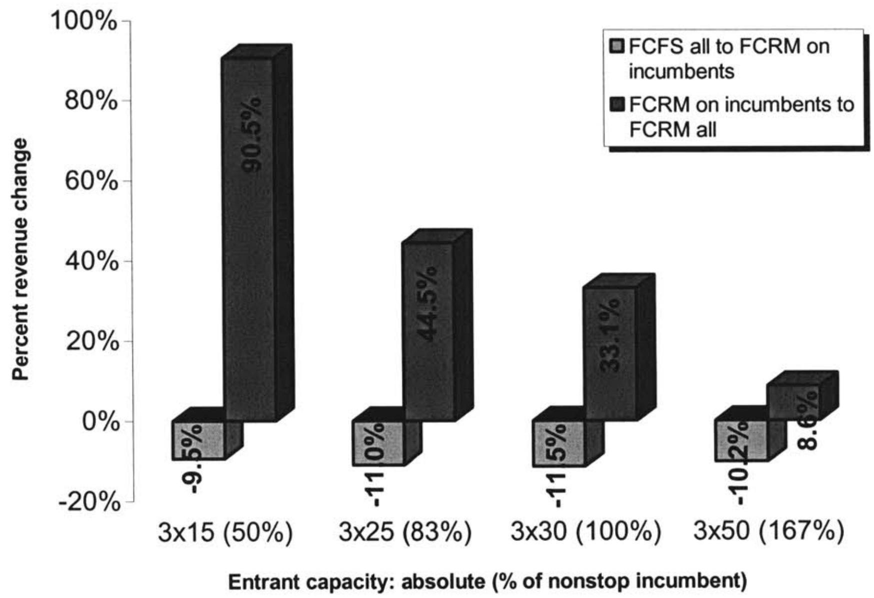


Figure 6.8: Relative revenue changes on Airline 3 as a function of capacity and ccenario settings - Sc. 1

The decrease in revenues when only the incumbents use FCRM is accompanied by an increase in traffic on Airline 3, and by a change in passenger mix, compared to no revenue management (as shown in Table 6.7). The new entrant, which is now the only airline accepting passenger bookings on a first-come, first-served basis, fills up early with low-fare passengers, as the incumbents now reject these passengers. The result is that Airline 3 carries more passengers, but at a lower average fare, hence the lower revenues. Table 6.7 shows the decrease in average fare on the new entrant carrier when only the incumbents use revenue management relative to when all carriers accept booking requests using FCFS.

Entrant Daily Cap.		Traffic			Average Load Factor			Average Fare		
Absolute	% of nonstop incumbent	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCRM; FCRM; FCRM)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCRM; FCRM; FCRM)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCRM; FCRM; FCRM)
3x15	50%	43	44	38	96%	97%	84%	$77	$70	$153
3x25	83%	67	69	63	90%	92%	84%	$84	$73	$116
3x30	100%	77	80	74	85%	89%	82%	$88	$75	$108
3x50	167%	100	104	101	67%	69%	67%	$101	$87	$97

Table 6.7: New entrant traffic, load factors and average fares

When the new entrant also accepts seat requests using FCRM, we observe that it generally benefits from this change in revenue management system. At low entrant capacity, revenues increase by as much as 72.5% over FCFS on all carriers, and by as much as 91% when the new entrant uses FCRM relative to when only the incumbents do, as shown in Figure 6.8. This relative increase in revenues decreases when the entrant's capacity increases. The reason for this decrease in relative revenue increase comes from the fact that as the new entrant's capacity increases, even if requests for seats are accommodated on a first-come, first-served basis, given the larger capacity, there always remain seats available for later-booking passengers. It therefore becomes less critical to perform revenue management, as the revenue management system itself would recognize the available capacity and thus allow all passengers to book, as does FCFS. In short, this once again highlights the relatively lesser importance of revenue management at lower load factors.

Compared to when only the incumbents use FCRM, when Airline 3 also uses FCRM, the new entrant's traffic decreases, but the mix of passengers shifts towards higher fare classes, thus leading to an increase in average fares and revenues, as shown in Figure 6.8 and Table 6.7. In addition, as was the case for Airline 1 when using FCRM, the relative decrease in traffic is smaller as capacity increases on the new entrant.

Finally, Figure 6.8 also shows that at high new entrant capacity, i.e. 150 seats on the new entrant carrier, compared to no revenue management, FCRM on all carriers has a negative cumulative impact on Airline 3's revenues. We had shown earlier than Airline 1 benefited from its use of FCRM in general, but more from the asymmetric revenue management scenario. For Airline 3, it is less attractive to have all airlines using revenue management at high capacity, as opposed to all airlines accepting seat requests on a first-come, first-served basis. The problem, at high new entrant capacity, is that both nonstop carriers are now expecting later-booking high-fare passengers, but, given the high capacity on the new entrant, most of demand can be satisfied. The challenge remains to capture high-fare passengers, which both Airline 1 and Airline 3 manage through FCRM, but at a loss to Airline 3 compared to when none of the airlines practiced revenue management, because Airline 1 does not fill up as quickly. In Scenario 1^{50} without revenue management, Airline 1 had less capacity than Airline 3, and therefore filled up sooner than Airline 3. This left Airline 3 with available seats for later-booking high-fare passengers, which generated disproportionate amounts of revenues. By comparison, in Scenario 1^{50} with revenue management on all carriers, Airline 1 also expects these passengers and thus diverts some revenues from Airline 3. This explains the decrease in revenues on Airline 3 from between no revenue management and revenue management on all carriers at high new entrant capacity shown in Table 6.8. In addition, Airline 3

RASMs are also affected by the change in revenue management methods, in comparable ways as the revenues, but they decrease with increasing new entrant capacity, as discussed in Chapter 5.

Entrant Daily Capacity		Airline 1 Revenues			Airline 3 Revenues		
Absolute	% of nonstop incumbent	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCRM; FCRM; FCRM)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCRM; FCRM; FCRM)
3x15	50%	$6,852	$11,095	$8,307	$3,348	$3,031	$3,874
3x25	83%	$6,796	$10,255	$8,063	$5,663	$5,038	$4,091
3x30	100%	$6,738	$9,785	$7,951	$6,752	$5,977	$4,232
3x50	167%	$6,586	$8,113	$7,709	$10,059	$9,031	$4,708

Table 6.8: Nonstop incumbent and new entrant revenues – Scenario 1

The impact of the change in revenue management systems on Airline 3's average load factors is the opposite as the impact on Airline 1, as apparent in Table 6.7. The asymmetric revenue management scenario (FCRM on the incumbents vs. FCFS on the new entrant) consistently leads to the highest traffic on Airline 3, as the nonstop incumbent manages its revenues and forces low-fare traffic to book on Airline 3, which thus tends to fill up more often. When all carriers use FCRM, the new entrant also practices revenue management and trades revenue for loads, thus leading to the smallest average load factors.

Summary

In summary, we have highlighted the tremendous impact of revenue management on traditional measures of airline performance and discussed the competitive effects which explain these behaviors. In particular, the simulation results show that average fares (at the total market or individual airline level) are affected quite differently by entry under different competitive revenue management situations. Total market average fare, for example, increases with increasing new entrant capacity under FCFS on all competitors. In contrast, it decreases in the other two competitive cases. On the nonstop incumbent carrier however, the average fare decreases when only the incumbents use FCRM (and not the low-fare new entrant), and remains relatively stable otherwise. We have explained that this effect is a direct consequence of the asymmetry in revenue management methods between the incumbents and the new entrant, combined with the capacity constraints on the low-fare carrier (at low capacity).

We have also illustrated how a symmetric revenue management situation leads to the even distribution of traffic and revenues among competitors as a function of relative capacity levels, under the assumption of identical fare structures on all competitors. The results also show that revenue management generally leads to higher revenues than FCFS (in symmetric cases) by protecting more seats for late booking high fare passengers. By comparison, under FCFS, revenues and average fares are lower due to the lack of protection for later booking, higher fare passengers.

In asymmetric revenue management conditions, the airline(s) using revenue management force the low-fare traffic onto the carrier accepting requests on a first-come first-served basis, which negatively affects average fares and revenues on that carrier and leads to a feedback loop whereby the airline(s) using FCRM forecast more high fare traffic and protects more seats for these passengers.

These competitive revenue management lessons remain true in the remainder of the discussion in the chapter, and play a very important role in explaining the effects of revenue management on the traditional measures airline performance. In subsequent sections, we also discuss the effect of fare structures combined with revenue management settings on airline performance.

Scenario 2: Entry with a Single Unrestricted Low-Fare Priced $10 Lower than the Q Fare in Scenario 0

We now look at the impact of revenue management in the case of entry under the assumptions of Scenario 2 where the new entrant offers a single unrestricted low-fare. In this case, we focus on only one of the two sub-scenarios, Scenario 2_{LM} (limited match) where the incumbent carriers only match the lower fare level in Q class. Scenario 2_{FM} (full match) does not provide any interesting insights in that all carriers are offering a single fare, and therefore do not use revenue management since there is no product differentiation. This also implies that the only scenarios we discuss here are those where either all carriers use FCFS, or only the incumbent carriers use FCRM. Airline 3 does not offer a differentiated fare structure and therefore does not use FCRM.

We show in this section that revenue management helps the nonstop incumbent carrier recover some revenues lost after entry, and again affects aggregate measures of airline performance.

Market-Level Impact

At the market level, we observe that total revenues increase when the incumbent carriers use FCRM. The relative increase in revenues ranges between 1% and 10%, decreasingly so with increasing new entrant capacity. As previously explained, the increase in relative revenue gains as new entrant capacity decreases (c.f. Figure 6.9) is linked to capacity constraints on the new entrant, which limit its ability to divert passengers, and thus lets the nonstop incumbent carry more high-fare passengers, when it uses FCRM (and thus protects seats for these passengers). In addition, while revenues initially increase as new entrant capacity increases when the incumbents use FCRM (as discussed in Chapter 5), they continuously decrease under the assumption of no revenue management, thereby emphasizing the impact of revenue management on total market revenues.

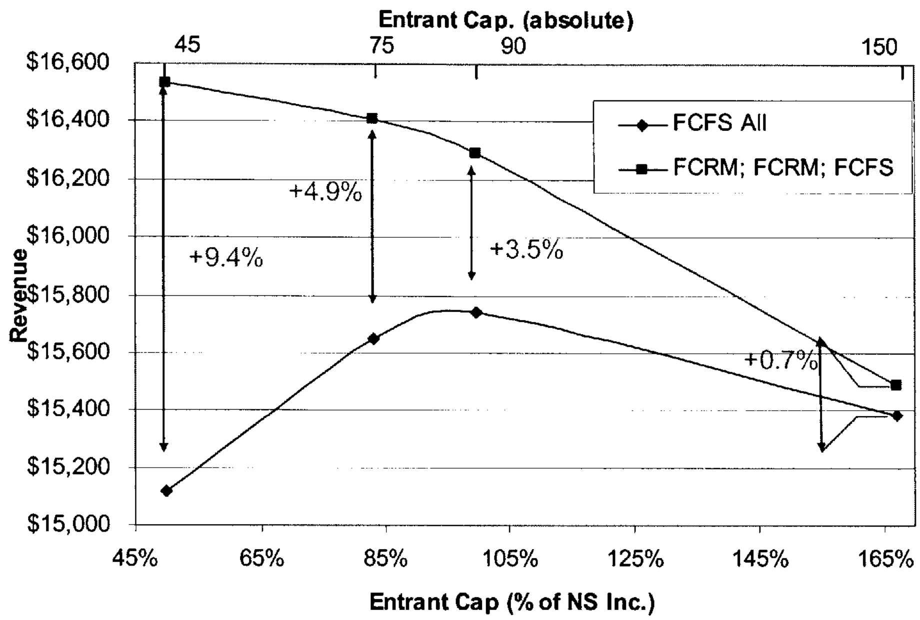


Figure 6.9: Total market revenues as a function of revenue management settings - Scenario 2_{LM}

With respect to total market traffic and load factors, use of FCRM (on the incumbents) leads to a decrease in total market traffic, as the incumbent carriers now protect seats for later-booking passengers (c.f. Table 6.9). Accordingly, average load factors decrease. At the same time, average fares also increase relative to when the incumbents use FCFS, at a given new entrant capacity setting, as shown in Table 6.9. The relative increase (respectively decrease) in average fare (respectively traffic) is greater at low entrant capacity because revenue management has a greater effect in a capacity constrained environment, as discussed earlier. At the total market level, the effect of capacity on average fares and traffic is the same in both competitive revenue management cases, even though the fares are greater in when the incumbents use FCRM while loads are higher when they don't.

Entrant Daily Capacity		Traffic		Average Load Factor		Average Fare	
Absolute	% of nonstop incumbent	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)
3x15	50%	172	168	76.4%	74.7%	$87.96	$98.39
3x25	83%	179	177	70.3%	69.5%	$87.24	$92.57
3x30	100%	182	181	67.6%	67.0%	$86.28	$90.11
3x50	167%	195	194	59.0%	58.9%	$79.05	$79.67

Table 6.9: Total market traffic and average market load factor - Scenario 2_{LM}

Airline-Level Impacts

Airline 1 benefits from the use of revenue management by 14% to 60%, once again increasingly with decreasing new entrant capacity. Figure 6.10 shows Airline 1 revenues in each sub-scenario case, and more generally the lesser increase in revenues (as a function of revenue management) at high new entrant capacity. This, as discussed previously, is the consequence of the fact that at high new entrant capacity, a large portion of traffic is diverted by the new entrant's more attractive fares, and that, given the lesser capacity constraint, the negative revenue impact on the incumbent is greater.

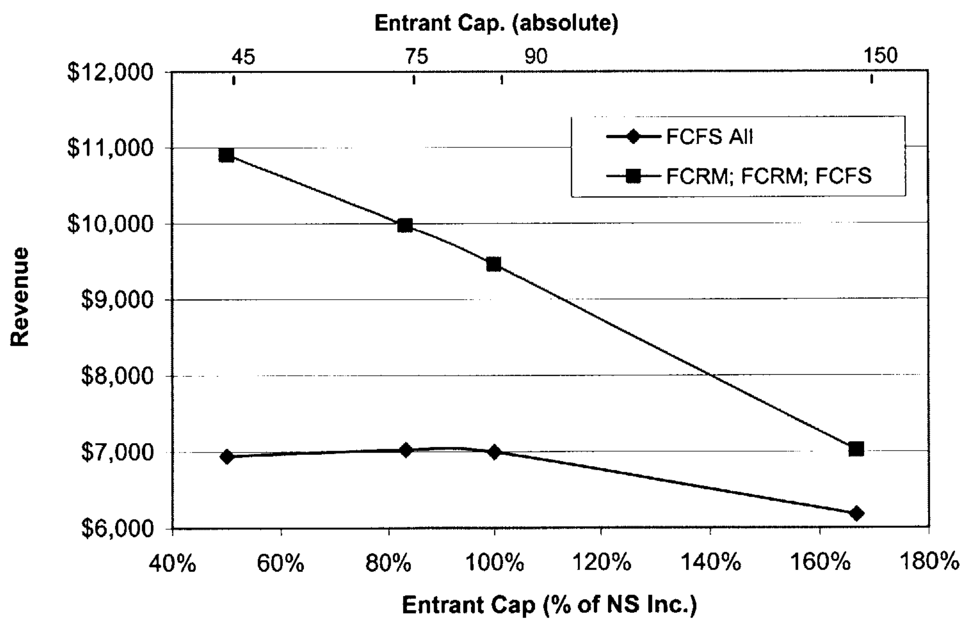


Figure 6.10: Airline 1 revenues as a function of scenario settings and new entrant capacity – Scenario 2_{LM}

These results show that, while Airline 1 revenues decrease with increasing new entrant capacity (regardless of the revenue management situation), incumbents are relatively more affected by increasing new entrant capacity when they use FCRM. The reason for this is that the mix of passengers carried under

FCRM has more high fare passengers. When the new entrant's capacity increases, it diverts relatively more high fare passengers, resulting in a greater relative impact on the incumbent carrier.

Figure 6.11 shows the change in loads by fare class on Airline 1 depending on the competitive revenue management situation. The mix in passengers is clearly skewed towards higher fare classes when the incumbents use FCRM, predominantly at low new entrant capacity. In addition, all fare classes are affected by increasing new entrant capacity under FCRM while it is mostly Q class that suffers under FCFS on the incumbent carriers. As a result, under FCRM, Airline 1 revenues and loads are more severely affected by increasing new entrant capacity.

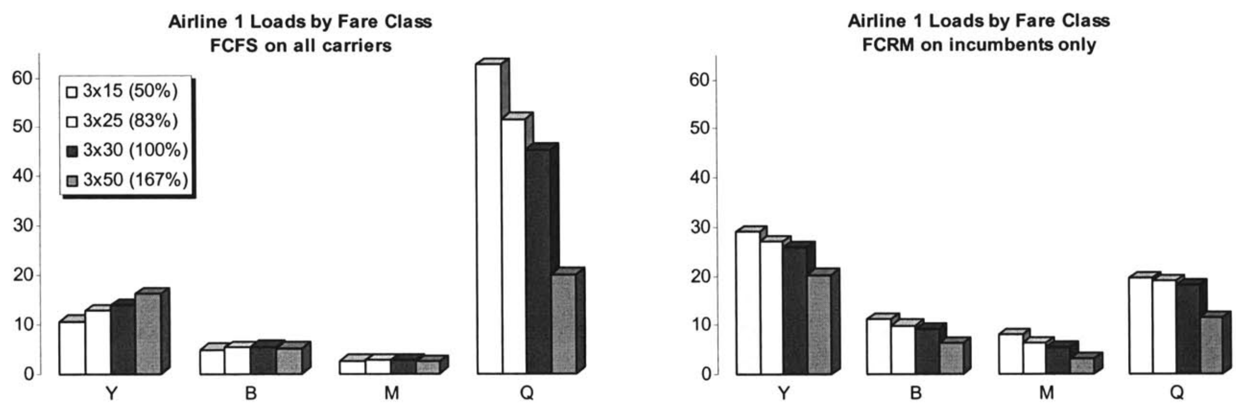


Figure 6.11: Airline 1 Loads by Fare Class and Scenario - Scenario 2_{LM}

As a consequence of the competitive revenue management situation, average fares are substantially higher on Airline 1 when the incumbents use FCRM rather than FCFS. In addition, average fares increase with new entrant capacity in both cases, as shown in Table 6.10. The increase in average fares as new entrant capacity increases is again a consequence of the revenue management situation, as explained in Section 6.1.3 (Scenario 1). With FCRM however, the increase in average fare is smaller on the incumbent carrier since the new entrant diverts traffic more evenly from all fare classes on the incumbent. The use of revenue management by the incumbent carriers allows Airline 1 to forecast high fare passengers, which explains the higher fare, and highlights the difference in the effect of entry on average fares under FCRM as compared to FCFS.

Entrant Daily Capacity		Revenues		Average Fare		Traffic		ALF	
Absolute	% of nonstop incumbent	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)
3x15	50%	$6,941	$10,905	$86.41	$160.37	80.33	68.00	89%	76%
3x25	83%	$7,025	$9,970	$97.24	$160.66	72.24	62.06	80%	69%
3x30	100%	$6,996	$9,458	$104.16	$161.52	67.17	58.55	75%	65%
3x50	167%	$6,178	$7,026	$141.61	$171.52	43.63	40.96	48%	46%

Table 6.10: Airline 1 revenues, average fare, traffic and average load factor - Scenario 2_{LM}

On Airline 3, the impact of the use of FCRM on airlines 1 and 2 is negligible. Indeed, as Airline 3 only offers one unrestricted low-fare priced at the same level as the lowest fare on Airline 1, its revenues only depend on traffic in that single fare class. This traffic is unaffected by the change in the incumbents' revenue management system: As explained previously, when the incumbent carriers use FCRM, total traffic decreases at the market level and on Airline 1. This indicates that there must be excess demand, as compared to the case where all carriers accept seat requests using FCFS. This excess demand can thus feed into Airline 3's flights. As a result of the use of FCRM on the incumbents, we would have expected an increase in Airline 3's traffic. However, given the excess demand and the capacity constraints on Airline 3, there is no increase in traffic following the incumbent carriers' use of FCRM, and therefore very little change in Airline 3's revenues.

Summary

We have shown that once again, FCRM leads to increased revenues on the nonstop incumbent carrier over FCFS. In particular, for the nonstop incumbent, revenue gains can be as high as 60% over FCFS. While revenues increase, traffic and average load factors decrease on the nonstop incumbent, and average fares increase. As a result, the nonstop incumbent carrier's share of traffic decreases when it moves to FCRM, while its revenue share increases by as much as 20 percentage points (at 3x15).

More importantly, our results show once again that revenues, traffic and average fares are affected quite differently by entry under FCFS or FCRM conditions on the incumbent carriers. Under FCRM, Airline 1 revenues are more affected by increasing new entrant capacity than under FCFS, while average fare and loads are more affected under FCFS. The general trends of the effect of entry are the same when the incumbents use FCFS or FCRM, except revenues which are affected quite differently as a function of the revenue management situation (as discussed earlier). Airline 3 does not suffer or benefit from the change in revenue management on the incumbent carriers, as the demand is very high and Airline 3 offers a single unrestricted low fare.

Scenario 3: Entry with a Two-Tier Fare Structure

The focus of this section is on the impact of revenue management on the performance of the three competitors in the case of Scenario 3 settings. In this scenario, the incumbent airlines have the option of offering a standard fare structure and matching the lowest market fare in Q class (limited match) or fully matching the new entrant's simplified two-tier fare structure (full match). The new entrant carrier offers only the simplified two-tier fare structure.

As in Chapter 5, we divide the analysis into two sub-scenarios, the first one where the incumbent carriers maintain their standard fare structure (referred to as Limited Match, with subscript LM), and the second one where the incumbent carriers fully match the new entrant's two-tier fare structure (referred to as Full Match, with subscript FM).

The analysis will show that there are once again benefits in using revenue management for the incumbent carriers, and thus in mitigating the effect of entry on revenue losses. In addition, the simulation results illustrate the impact of revenue management on traditional measures of airline performance and highlight the changes in behavior of these indicators under different revenue management situations. For example, average fares respond very differently to increasing new entrant capacity depending on the competitive revenue management situation.

Scenario 3_{LM}: Limited Match

In this scenario, the new entrant carrier comes in with a two-tier fare structure. Its two fares are respectively unrestricted and with restrictions equivalent to those of M class on the incumbent carriers, but priced at the B and Q class level on the incumbent carrier (c.f. Chapter 5, Section 5.2.3, Scenario 3). In addition, the new entrant prices its lower fare at $53, that is, $10 cheaper than the cheapest fare class in Scenario 0. In Scenario 3_{LM}, the incumbent carriers adjust their lowest fare (Q) to match the lower fare value on the new entrant, but do not match the two-tier structure on the new entrant nor the fewer restrictions of the new entrant carrier.

<u>Market-Level Impact</u>

As shown in Figure 6.12, upon entry with first-come, first-served accommodation of seat requests, total market revenues increase with new entrant capacity. The more seats are available in the market, the greater the total revenues, as more passengers are able to book when total market capacity increases. Furthermore, given passenger behavior (early booking passengers are price-sensitive passengers), we also anticipate a large increase in revenues as new entrant capacity increases. Indeed, as capacity constraints are relaxed, more high-fare, late-booking passengers are able to book. Since these passengers' revenue contribution is greater than that of early-booking low-fare passengers, the overall impact on revenues is greater, as apparent in Figure 6.12.

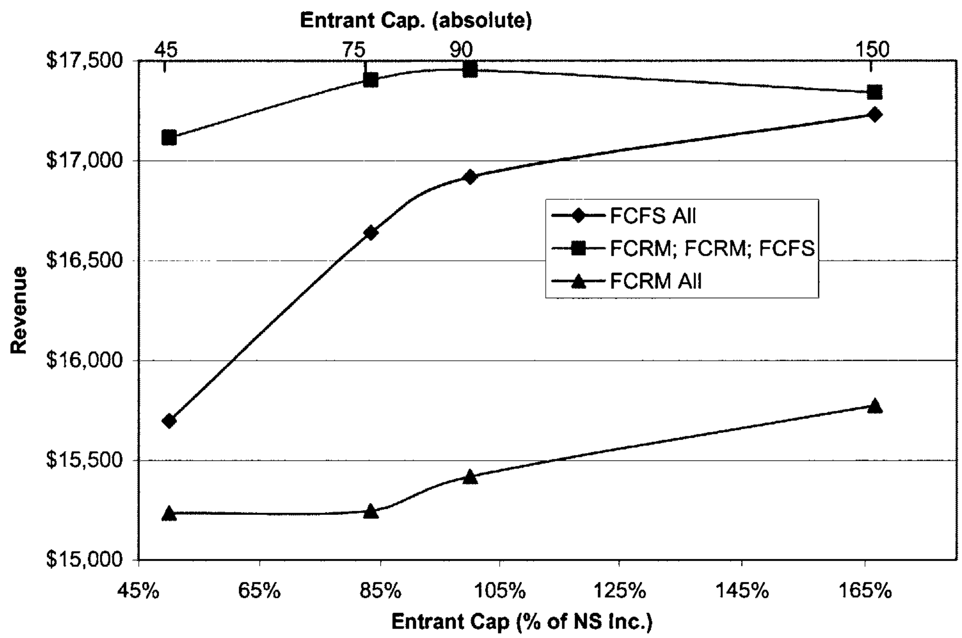


Figure 6.12: Total market revenues as a function of the revenue management setting and new entrant capacity - Scenario 3_{LM}

In the case where either only the incumbents or all carriers use FCRM, total market revenues also increase with new entrant capacity, simply because of the fact that there is greater capacity in the market, which allows more passengers to travel. Figure 6.12 shows that when only the incumbents use FCRM, revenues generally increase with new entrant capacity, except at high capacity (3x50) where revenues are lower than with 3x25 seats. The explanation for this result comes from the fact that both incumbent carriers use FCRM, while the new entrant accommodates requests for seats on a first-come, first-served basis. As a result, even at low capacity, the incumbent carriers allocate seats to higher fare classes and ensure that late-booking passengers will find availability. Given a fixed entrant capacity, this leads to increased market revenues, compared to FCFS on all carriers, by as much as 9% (at low entrant capacity). As new entrant capacity increases, more seats become available for passengers to travel. Since the new entrant is accepting passenger bookings on a first-come, first-served basis, this increase in capacity has the effect of letting more passengers travel, but also of diverting some of the incumbents' late-booking traffic towards the new entrant (since it remains available longer in the booking process). Furthermore, since the new entrant offers cheaper fares than the incumbents, this diversion also leads to revenue dilution, hence the decrease in total market revenues at high new entrant capacity when only the incumbents use FCRM.

Figure 6.12 also shows the effects of the competitive revenue management situation on total market revenues and highlights the lower revenues when all carriers use FCRM compared to the other two cases. This observation might initially appear to be counter-intuitive, in that one would have expected that when all carriers use some form of revenue management, revenues would increase overall. It is not the case here, for the following reasons. When all carriers use FCRM, they all protect for later-booking high-fare passengers. As a result, since the new entrant carrier offers a cheaper unrestricted fare, and ensures that the fare remains available, most late-booking passengers will travel on the new entrant, thus leading to revenue dilution for the market overall. Consequently, the incumbent carriers will be forced to carry more low-fare traffic. The combination of revenue management and revenue dilution by the new entrant leads to this situation whereby having all carriers use FCRM leads to lower market revenues, as compared to having all carriers accommodating seat requests on a first-come, first-served basis. It is the combination of different fare structures on incumbents and new entrant, and the use of revenue management by the new entrant (as well as by the incumbent carriers), which leads to this decrease in total market revenues.

Airline-Level Impact

Figure 6.13 shows that Airline 1 revenues follow the same pattern as total market revenues in terms of which competitive revenue management setting leads to the highest revenues (as shown in Figure 6.12). Two important observations emerge:

- First, revenues on Airline 1 decrease with increasing new entrant capacity, unlike total market revenues, which generally increased with new entrant capacity
- Second, the ranking of revenues remains unchanged as the revenue management environment changes: The greater the new entrant's capacity, the smaller Airline 1's revenues. Relative changes however, vary as a function of the competitive revenue management situation.

We therefore focus on the relationship between new entrant capacity and revenue management, and explain how revenue management affects the relative change in revenues, average fares and traffic on the incumbent and new entrant carriers.

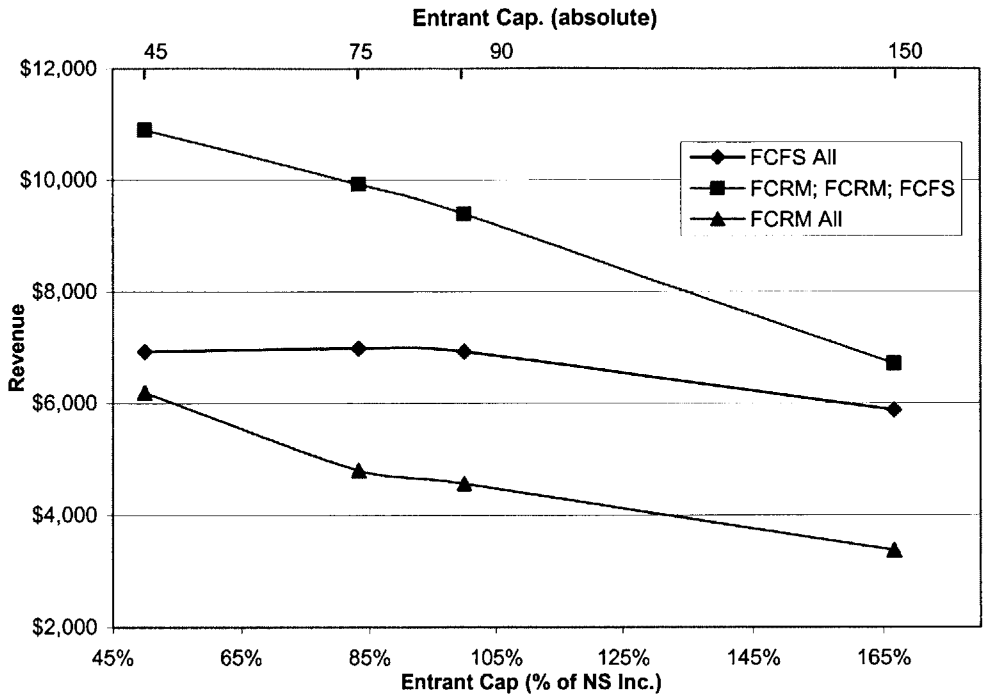


Figure 6.13: Airline 1 revenues as a function of new entrant capacity and revenue management settings - Scenario 3_{LM}

To understand the impact of entrant capacity and revenue management on Airline 1's revenues, we look at loads by fare class on Airline 1, as shown in Figure 6.14, and on the new entrant (Airline 3), as shown in Figure 6.15. Clearly, the patterns are quite different depending on the competitive revenue management situation.

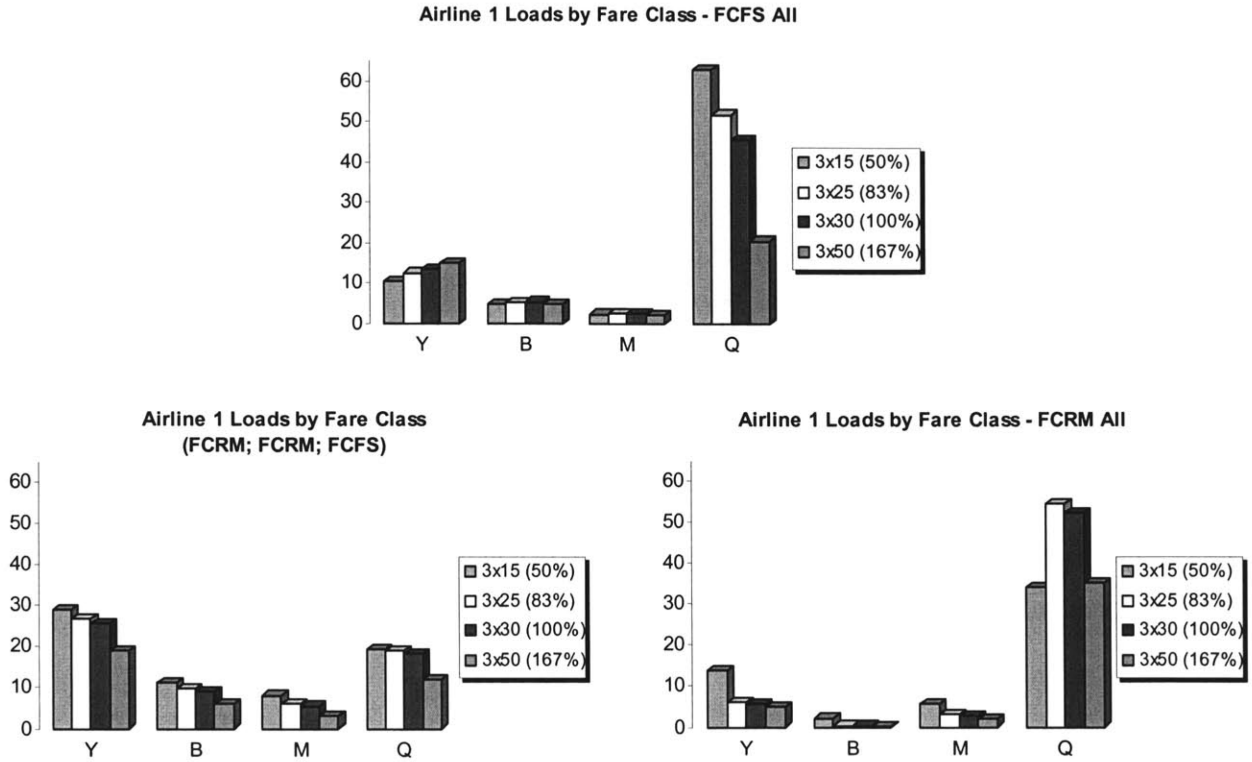


Figure 6.14: Airline 1 loads by fare class - Scenario 3_{LM}

With none of the carriers using revenue management, traffic decreases substantially in the lowest fare class (Q) on Airline 1, as new entrant capacity increases. Since the new entrant is accommodating passenger bookings on a first-come, first-served basis, the greater its capacity, the longer its low fare seats are likely to be available (until the advance purchase requirement closes the class down), and the greater Airline 3's traffic in M/Q class (hence the decreasing the traffic in Q class on Airline 1). This is apparent in Figure 6.15, which shows new entrant loads by fare class, and the fact that M/Q loads increase substantially with new entrant capacity, relative to the slower increase in Y/B loads. This decrease in Airline 1's Q class traffic allows for more high fare passengers to travel in the higher fare classes, and compensates some of the losses incurred by the loss of low-fare traffic. This is again reflected in Figure 6.18.1, which shows Airline 1's average fare as a function of new entrant capacity, and the fact that it increases on Airline 1 with new entrant capacity. Overall, Airline 1's revenues suffer from increasing new entrant capacity, but its average fare increases.

When only the incumbents use FCRM, the same pattern appears for the new entrant's traffic as when none of the carriers used revenue management, as should be expected since the new entrant does not change its seat allocation mechanism and maintains an FCFS approach to accepting seat requests. On the nonstop incumbent (Airline 1) however, the impact of increasing new entrant capacity is far greater. The reason once again lies in the fact that the incumbent carriers are using FCRM, as opposed to FCFS. As a result, the nonstop incumbent carrier anticipates late-booking full-fare passengers and protects seats for them. The result is a shift in passenger mix towards higher fare classes (higher loads in Y, B and M classes) relative to equivalent cases without revenue management. The increase in average fare (shown in Figure 6.18.1) when only the incumbents use FCRM relative to when they used FCFS further supports this observation. The outcome of this "better" passenger mix is that diversion from the nonstop incumbent towards the new entrant, as new entrant capacity increases, takes away passengers in all fare classes and hurts incumbent revenues substantially more than in when all carriers use FCFS, as shown in Figure 6.13. Figure 6.18.1 corroborates the fact that passengers are diverted from all fare classes almost equivalently, as the average fare remains almost stable with increasing new entrant capacity. This shows that the passenger mix does not change substantially despite a decrease in Airline 1's total traffic. As new entrant capacity gets large (3x50), more low-fare passengers are diverted, as evidenced by the slight increase in the nonstop incumbent's average fare.

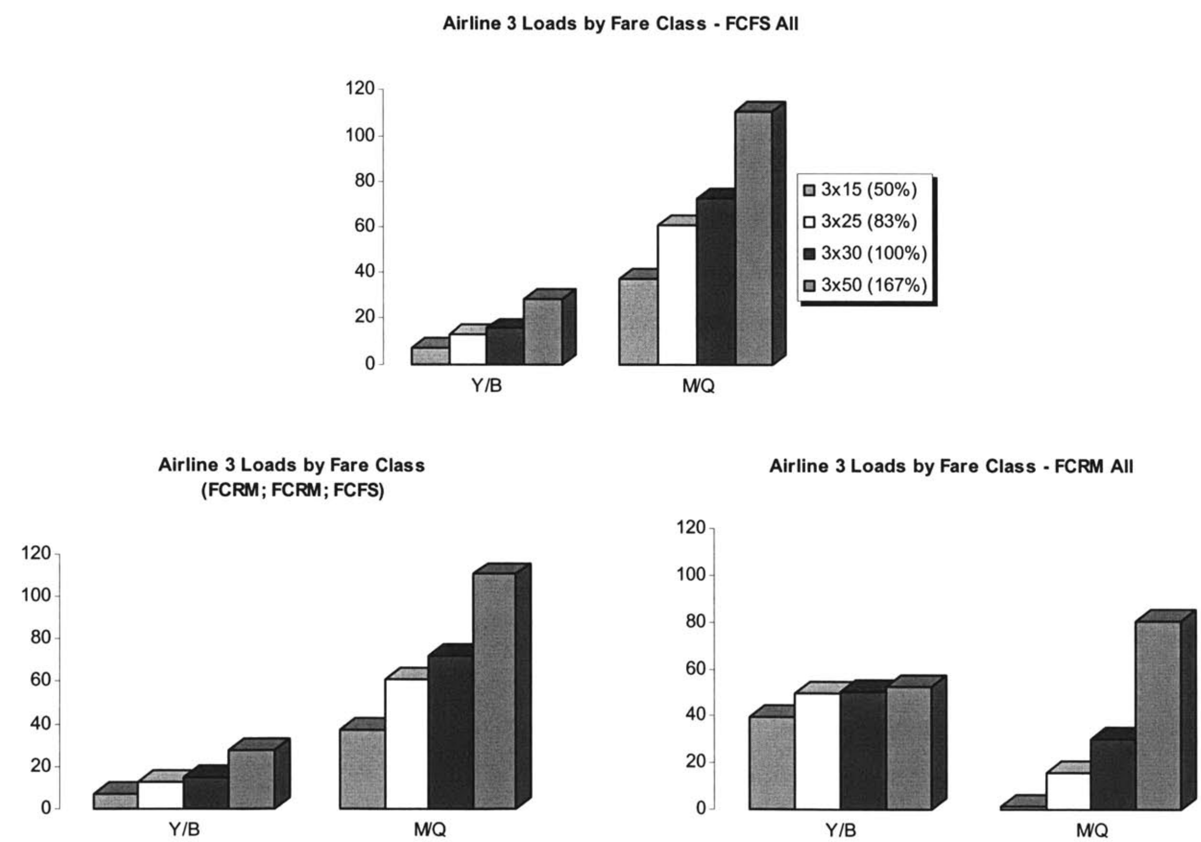


Figure 6.15: New entrant (Airline 3) loads by fare class - Scenario 3_{LM}

Finally, when all carriers use FCRM, traffic on the new entrant carrier behaves quite differently as new entrant capacity increases. Since all carriers are now using FCRM, the new entrant expects late-booking high-fare passengers, and thus protects for them. As a result, its loads in Y/B class are high from the start, i.e. even at low entrant capacity (relative to the other two cases). As new entrant capacity increases, traffic in Y/B class also increases, but far less than in M/Q class, where traffic is initially very low (at low entrant capacity). The lesser increase in Y/B class traffic as new entrant capacity increases is due to the fact that the new entrant is using FCRM and thus already carrying a significant amount of high fare passengers even at low capacity.

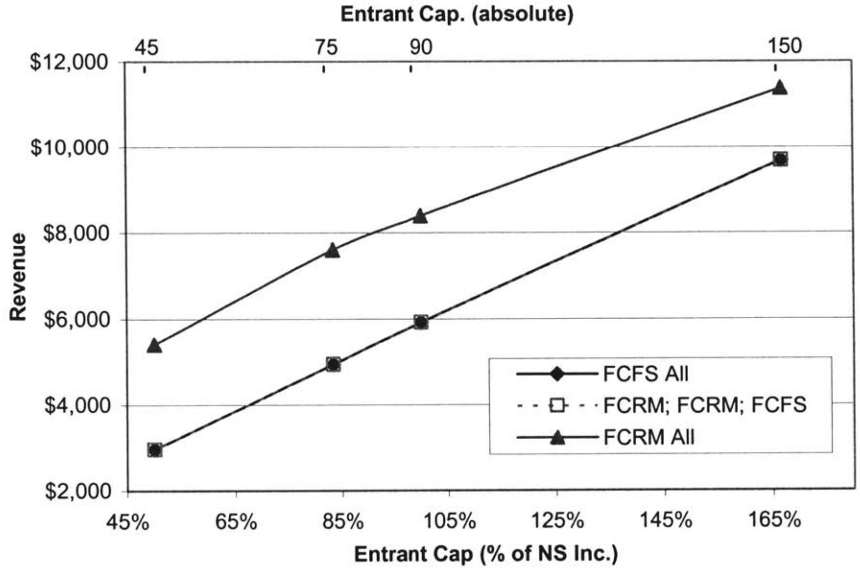
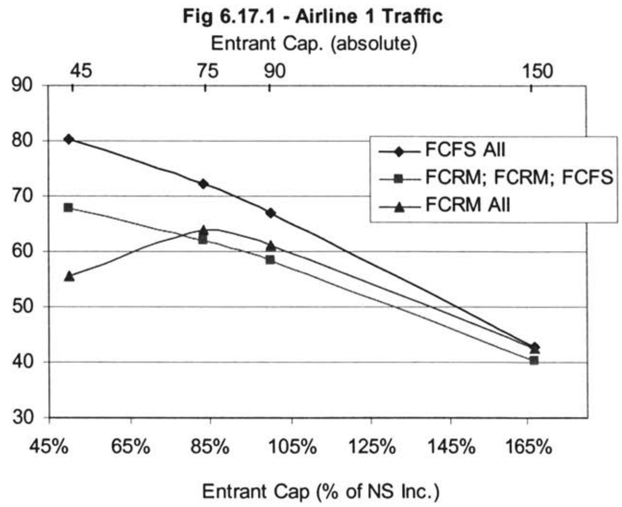


Figure 6.16: New entrant revenues as a function of revenue management and capacity settings - Scenario 3_{LM} (FCFS All and (FCRM; FCRM; FCFS) overlap)

On the nonstop incumbent carrier, traffic reacts differently to increasing new entrant capacity. Y class traffic decreases as the new entrant's capacity increases and diversion increases. Similarly, B and M traffic decreases with increasing new entrant capacity. In Q class, however, loads initially increase – because the nonstop incumbent compensates for lost Y, B and M traffic with Q class traffic – and eventually decrease at high new entrant capacity as it starts diverting low-fare traffic, as explained in Chapter 5. This observation is supported by the average fare on the nonstop incumbent: It initially decreases sharply as the passenger mix shift towards lower fare classes, and increases slightly afterwards, as Q class traffic decreases.



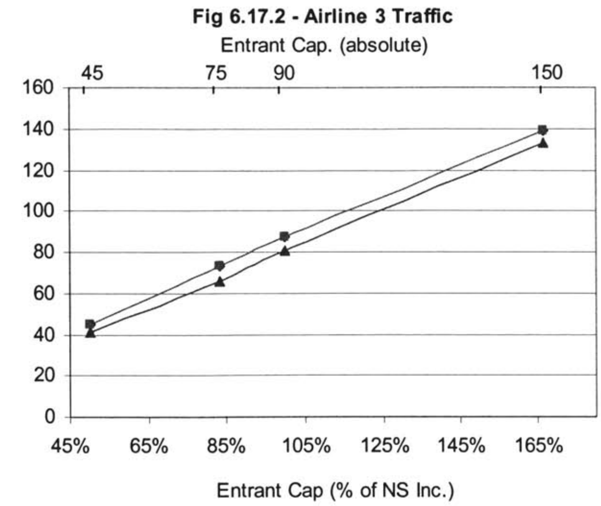


Figure 6.17: Traffic on airlines 1 and 3 as a function of new entrant capacity and revenue management settings - Scenario 3_{LM} (FCFS All and (FCRM; FCRM; FCFS) overlap on the new entrant carrier)

As shown in Figure 6.17, traffic decreases both on the nonstop incumbent carrier and on the new entrant carrier (at low entrant capacity) when either only the incumbents use FCRM or when all carriers use FCRM, showing that both carriers are more selective in allowing passengers to book. At higher new entrant capacity, traffic increases slightly on the nonstop incumbent when all carriers use FCRM (as compared to when only the incumbents use FCRM), as it tries to make up for some of its lost high-fare traffic by carrying a few more lower-fare passengers and takes advantage of demand stimulation. On the new entrant carrier, traffic keeps decreasing, as the new entrant becomes more selective of its passengers. The average fare on the new entrant carrier also decreases with increasing new entrant capacity, as shown in Figure 6.18, but remains greater than when the new entrant uses FCFS (in the other two cases).

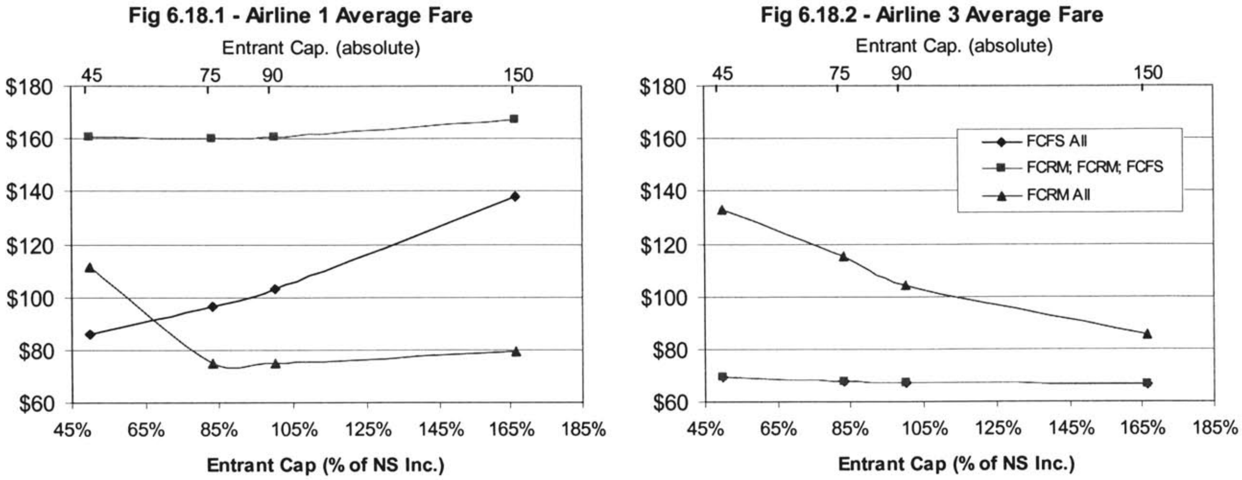


Figure 6.18: Average fare on airlines 1 and 3 as a function of new entrant capacity and revenue management settings - Scenario 3_{LM} (FCFS All and (FCRM; FCRM; FCFS) almost overlap on the new entrant carrier)

The overall impact of having all three carriers use FCRM is negative at the total revenue level, as mentioned earlier. This result is primarily due to the fact that the new entrant carrier offers a two-tier fare structure which dilutes total market revenues. It is this effect that is felt when all carriers use FCRM. FCRM still maximizes each individual airline's revenues, given the competitive situation. This case shows that from a market standpoint, FCRM on all carriers leads to lower revenues than if the new entrant carrier were accepting requests for seats on a first-come, first-served basis, once again because of the lower fares on the new entrant and the ensuing diversion of traffic. In conclusion, in an asymmetric fare structure environment, we observe that revenue management still leads to revenue gains for individual carriers, but that overall market revenues may suffer from the asymmetry and use of revenue management. Other results (not shown here) support the fact that the incumbent carriers have lower revenues without revenue management than with revenue management when competing with a new entrant using FCRM.

In addition, these results also highlight the effects of revenue management on average fares, revenues and traffic on the incumbent and new entrant carrier. Average fares are much more affected by entry under symmetric revenue management conditions (FCFS or FCRM on all competitors) and react in opposite way to increasing new entrant capacity: They increase under FCFS on all carriers, but decrease with increasing new entrant capacity under FCRM on all carriers.

Summary

Scenario 3_{LM} results show that at the total market level, revenue management has a diverse effect. When only the incumbent carriers use FCRM, total market revenues increase (relative to FCFS on all carriers) because the new entrant fills its seats from the bottom up, i.e. from the lower fares up. The incumbent carriers are consequently able to use revenue management to leverage the passenger mix and increase the average fare paid by its average passenger. Conversely, when all carriers use FCRM, total market revenues decrease compared to the case where none of the carriers use FCRM, or when only the incumbents use FCRM. In this case, we explained that the new entrant now also maximizes its revenues, which creates severe dilution on the incumbent carriers because of the lower fare structure offered by the new entrant. The asymmetry of the fare structures between the incumbents and the new entrant carrier is responsible for the decrease in market revenues observed when the new entrant uses revenue management. By maximizing its revenues, the new entrant hurts total market revenues.

The nonstop incumbent carrier's revenues follow the same pattern as total market revenues: They increase when only the incumbents use FCRM, but decrease when the new entrant matches the revenue management.

These results show the importance of the relative fare structure (in combination with the competitive revenue management situation) in explaining the impacts of entry on traditional measures of airline performance. The asymmetry in fare structures between the incumbent carriers and the new entrant, combined with the various revenue management situations tested here, explains the various effects on fares, revenues and traffic observed in this section.

Scenario 3_{FM}: Full Match

In Scenario 3_{FM}, all three carriers offer the same fare structure. The new entrant still offers a two-tier fare structure, with a lower fare than originally offered on the incumbent carriers, by $10 (before entry). In this case, the incumbent carriers fully match the new entrant's fare structure.

Market-Level Impact

Figure 6.19 shows total market revenues as a function of new entrant capacity and revenue management settings, and highlights the fact that revenues are affected jointly by new entrant capacity and revenue management settings. In particular, given a revenue management setting, revenues increase with capacity, regardless of the revenue management setting. The greater the capacity on the new entrant, the higher the revenues in the market. In addition, given a capacity setting, we also note that total market revenues increase as the airlines move to FCRM compared to FCFS acceptance of booking requests.

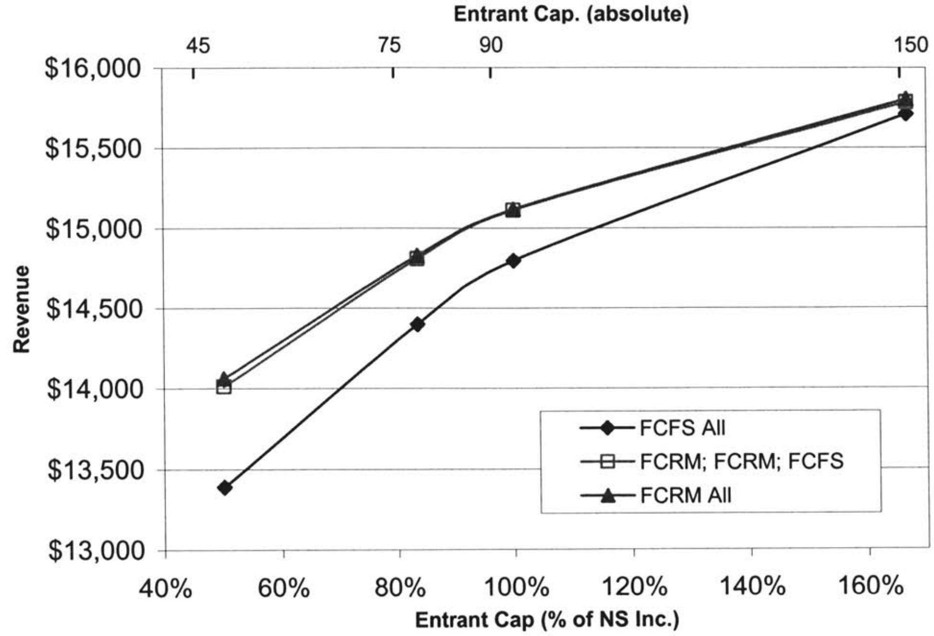


Figure 6.19: Total market revenues as a function of revenue management settings and new entrant capacity - Scenario 3_{FM}

Relatively speaking, the increase in total market revenues can be as high as 4.7% when the incumbents use FCRM relative to FCFS, and up to 5% from when all three carriers use FCRM relative to FCFS. Table 6.11 shows the details of absolute and relative increases in revenues as a function of new entrant capacity. It also shows that the relative increase in revenues decreases with increasing new entrant capacity, which is again a consequence of the lesser capacity constraints.

The increase in revenues is much larger when only the incumbents use FCRM compared to FCFS on all carriers than when all carriers use FCRM compared to only the incumbents. The intuition is that both incumbent carriers already use FCRM, which severely decreases the potential for revenue increases when the new entrant also uses FCRM. In addition, at low entrant capacity, the relative capacity on the new entrant is far smaller than that of the incumbents combined. As a result, the effect of using FCRM is much smaller than when only the incumbents move to FCRM, as apparent in Table 6.11. As new entrant capacity increases, the new entrant's relative capacity also increases. However, as mentioned earlier, the potential for revenue increases is now smaller, since total market capacity is rather large, hence the smaller relative gains.

Entrant Daily Capacity		Airline 1 Revenues			Relative Revenue Change		
Absolute	% of nonstop incumbent	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCRM; FCRM; FCRM)	(FCFS; FCFS; FCFS)	(FCRM; FCRM; FCFS)	(FCRM; FCRM; FCRM)
3x15	50%	$13,389	$14,013	$14,062	4.7%	5.0%	0.3%
3x25	83%	$14,398	$14,807	$14,827	2.8%	3.0%	0.1%
3x30	100%	$14,797	$15,111	$15,116	2.1%	2.2%	0.0%
3x50	167%	$15,709	$15,784	$15,805	0.5%	0.6%	0.1%

Table 6.11: Total market revenues by case, and relative revenue increase as a function of revenue management - Scenario 3_{FM}

Figure 6.20 shows that total market traffic increases with capacity, regardless of the revenue management setting. This observation is expected and very intuitive: The greater the available capacity, the more passengers are able to travel.

Given a new entrant capacity, traffic decreases when airlines use FCRM, and more precisely, in all cases other than 3x50, traffic initially decreases when only the incumbent carriers use FCRM, but increases slightly when the new entrant matches the incumbents' revenue management. As mentioned before, the decrease in traffic when the incumbents use FCRM is explained by the fact that the incumbents become more selective of the passengers they carry, while the new entrant continues to fill up with early-booking traffic (c.f. Scenario 1). At high entrant capacity, loads continue to decrease when the new entrant also uses FCRM, as it also becomes more selective of its traffic. At lower entrant capacity, traffic increases slightly because the new entrant also becomes more selective, but diverts some of the high-fare traffic from the incumbents to itself. As a consequence, the incumbents compensate with more low-fare traffic, and relatively more than they lost high-fare traffic, in an attempt to balance the fare differential. This leads to a slight increase in total loads, as shown in Figure 6.20.

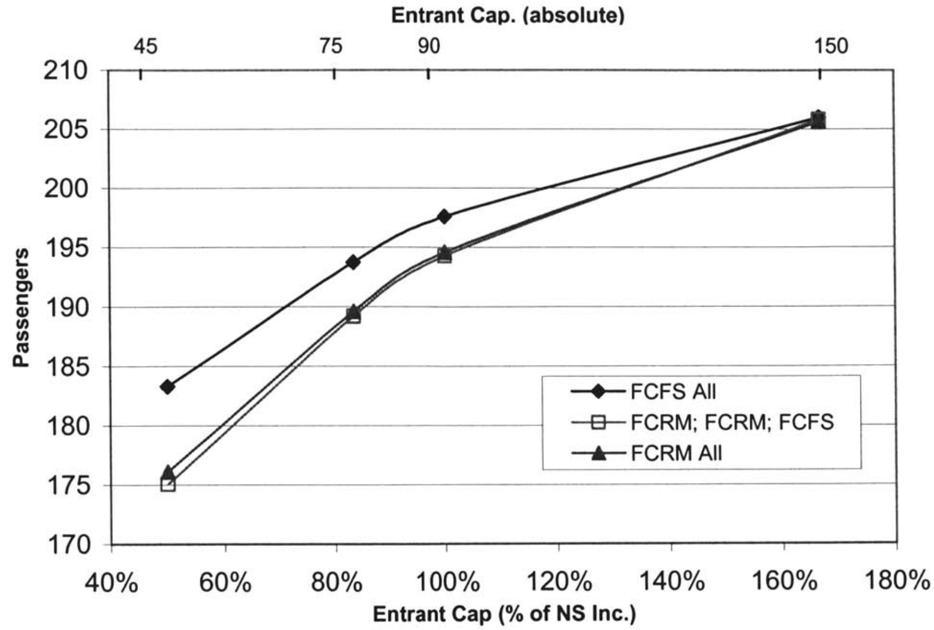


Figure 6.20: Total market traffic as a function of new entrant capacity and revenue management settings - Scenario 3_{FM}

Figure 6.21 shows the average market fare as a function of new entrant capacity and competitive revenue management settings. The case where carriers use FCFS clearly differs from the cases where either the incumbents only, or all carriers, use FCRM. Indeed, when all carriers use FCFS, the average market fare increases with new entrant capacity, while in both other cases, the average market fare decreases with increasing new entrant capacity. In addition, when carriers use FCRM, the average fare is higher than when all carriers accept seat requests on a first-come, first-served basis. The curves converge to the same limit, as new entrant capacity increases. These effects are comparable to those observed in Scenario 1 since all carriers now offer the same fare structure, and the reader is thus referred to the discussion relative to Scenario 1 for more details on the effects of revenue management on average fares.

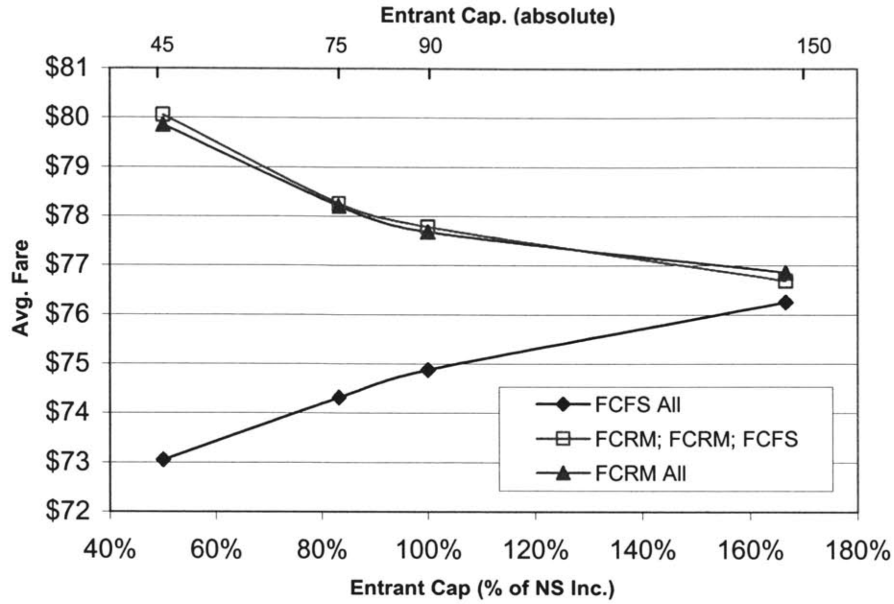


Figure 6.21: Average market fare as a function of new entrant capacity and revenue management settings - Scenario 3_{FM}

Airline-Level Impact

Figure 6.22 shows Airline 1 revenues as a function of both new entrant capacity and competitive revenue management settings. Airline 1 revenues generally decrease as new entrant capacity increases. In addition, the incumbent's revenues increase when it uses FCRM, relative to FCFS revenues. The increase in revenues is greater if the new entrant does not also implement revenue management. When the incumbent carrier protects for later-booking, high fare passengers, it increases its revenues. When the new entrant carrier also matches this strategy, all carriers have to share revenues, and the incumbent carrier does not benefit as much, but still benefits from revenue management. Once again, these results are similar to those observed in Scenario 1 and can be explained in the same way.

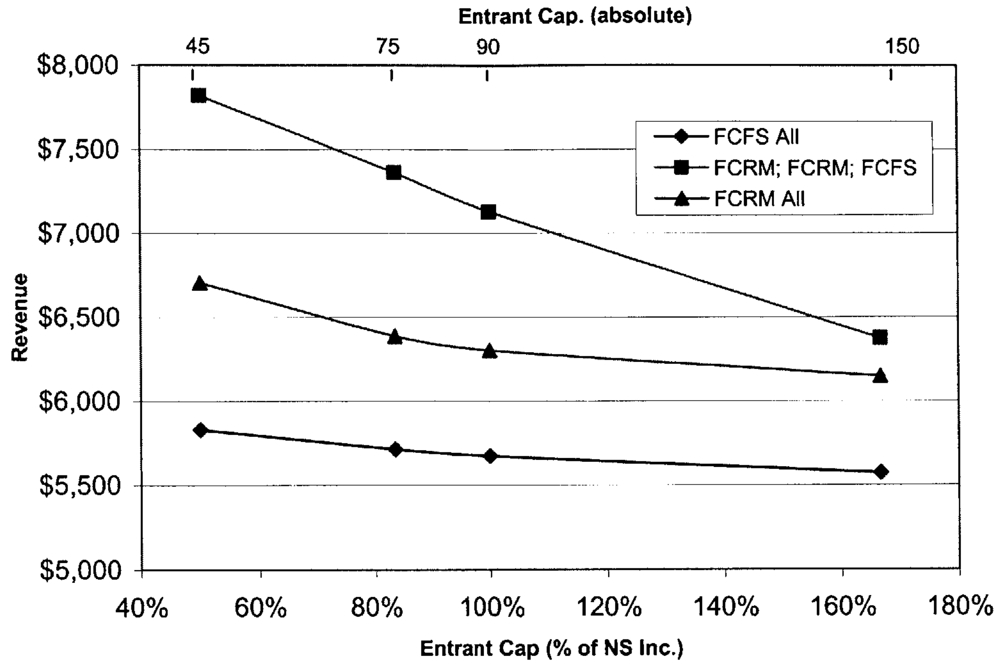


Figure 6.22: Airline 1 revenues as a function of new entrant capacity and competitive revenue management settings - Scenario 3_{FM}

Figure 6.23 shows the impact of revenue management and new entrant capacity on the nonstop incumbent's traffic and average fare, and explains the behavior of revenues described previously. As the incumbent carriers start using FCRM (but the new entrant does not), traffic on Airline 1 decreases: The nonstop incumbent trades some of its "high probability of purchasing a ticket" low fare passengers for full fare passengers with a lower probability of actually booking, hence the overall increase in revenues but decrease in total traffic. Figure 6.23 shows that while under asymmetric revenue management conditions, the nonstop incumbent's loads are lower than in the other two cases, its average fare is higher. As new entrant capacity increases, the difference in traffic and average fare between cases decreases, as revenue management becomes less of an advantage when capacity constraints (and consequently load factors) decrease.

When all carriers use FCRM, the nonstop incumbent's traffic and average fare reach a middle ground between the case where none of the carriers use revenue management and the case where only the incumbents do. The reason is that when the new entrant also uses FCRM, the probability of increasing revenues by trading a low-fare passengers for a less likely high-fare passenger becomes lower since airlines 1 and 3 share these passengers. It consequently becomes better (revenue-wise) for the nonstop incumbent carrier to let a few more low-fare passengers book, which has the dual effect of increasing traffic and the decreasing average fare (compared to the asymmetric revenue management case).

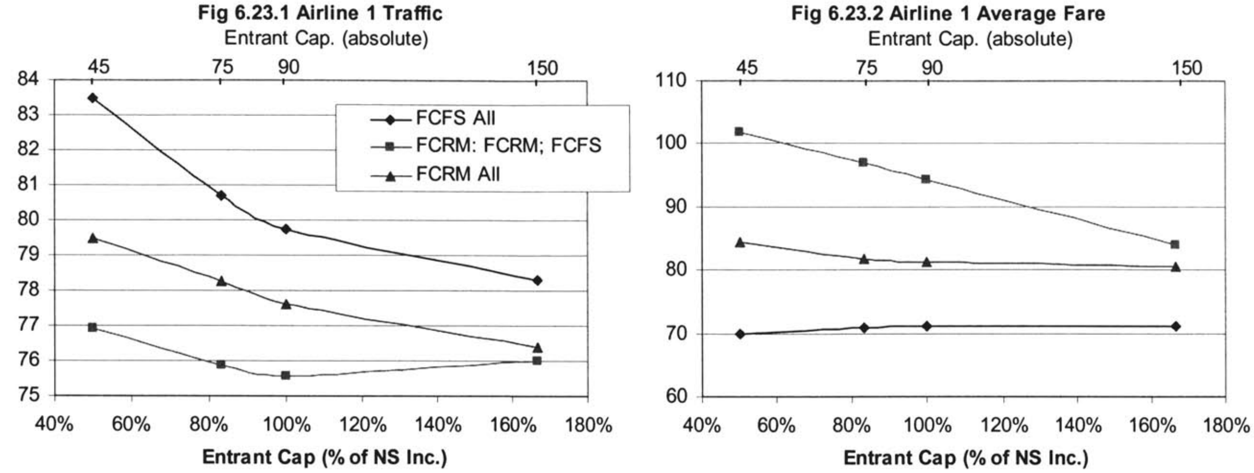


Figure 6.23: Airline 1 traffic and average fare as a function of revenue management and new entrant capacity

Figure 6.24 shows new entrant revenues as a function of its capacity and competitive revenue management settings. New entrant revenues increase with capacity, but also with revenue management (as was the case in Scenario 1).

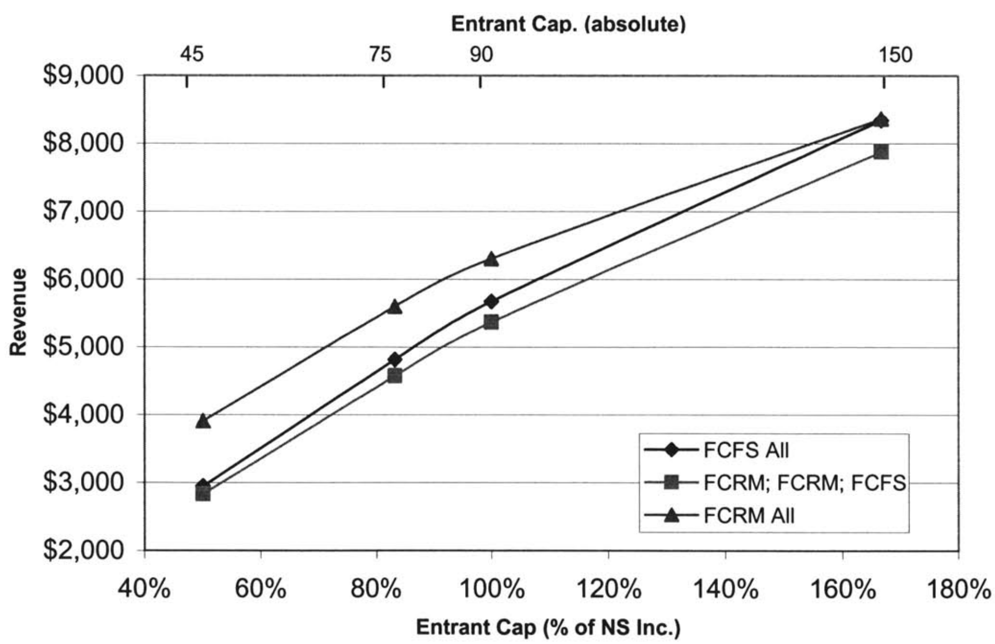
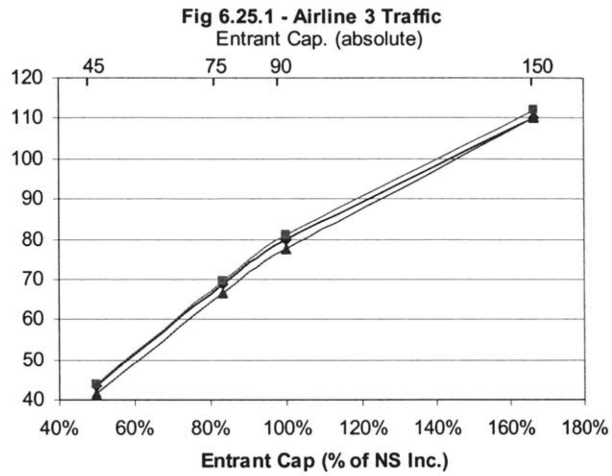


Figure 6.24: New entrant revenues as a function of new entrant capacity and competitive revenue management settings

Figure 6.25 shows traffic and average fare on the new entrant carrier as a function of its capacity and of the competitive revenue management situation. Traffic increases with new entrant capacity, and is highest when the incumbent carriers are the only competitors to use FCRM. Figure 6.25.2 shows the average fare on the new entrant carrier, and particularly that it is considerably higher when the new entrant carrier uses FCRM. This effect of revenue management plays a critical role in illustrating the inadequacy of traditional aggregate measures of airline performance in understanding the nature of the incumbents' competitive response to entry.



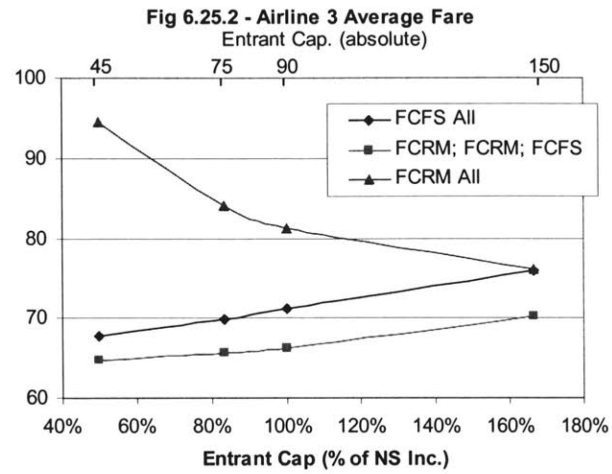


Figure 6.25: New entrant traffic and average fare as a function of new entrant capacity and competitive revenue management settings

Comparing incumbent and new entrant average fares, we observe that in Scenario 3_{FM}, new entrant average fares behave very differently from incumbent average fares, both as a function of new entrant capacity, and as a function of the competitive revenue management situation. When all carriers use FCFS, the carrier with the greater capacity has the higher average fare. We explained that this is due to the fact that the carrier with greater capacity is able to accommodate more high fare demand, since it books late. When only the incumbents use FCRM, regardless of the new entrant capacity settings tested here, the incumbent carrier maintains a higher average fare. In this case, the incumbents use FCRM, which allows them to keep seats available for later-booking passengers, and thus increase their revenues. Finally, when all carriers use FCRM, the opposite of FCFS on all carriers is observed: The carrier with the smaller capacity has the higher average fare. In this case, the carrier with smaller capacity carries mostly high fare passengers and therefore has a higher average fare.

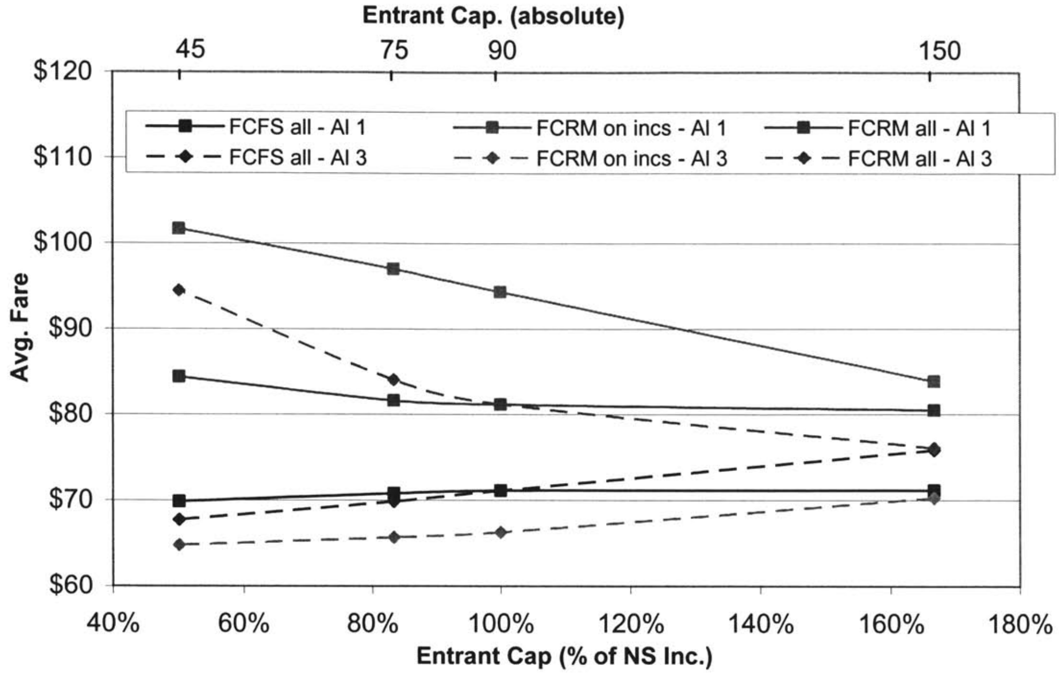


Figure 6.26: Incumbent and new entrant average fares as a function of new entrant capacity and competitive revenue management situation – Scenario 3_{FM}

Summary

In Scenario 3_{FM}, we therefore observed similar effects of revenue management on traditional measures of airline performance to those of Scenario 1. We explained that these similar results are the consequence of the symmetric fare structures offered by the competitors: All carriers use an identical two-tier fare structure. These results thus further illustrate the importance of the combined effects of the competitive revenue management situation, the relative fare structure between competitors and the new entrant's relative capacity on average fares, revenues and traffic.

6.2. Summary and Comparison of Scenarios 0 through 3: Impacts of Revenues Management and Cross-Scenario Comparisons

Having looked at the impact of revenue management on revenues, traffic, and average fares in each of the previous four scenarios, we now focus on the effect of revenue management across scenarios and highlight the great importance of revenue management with respect to the change in aggregate measures of airline performance as a function of new entrant capacity.

6.2.1. Market-Level Comparisons

Figure 6.27 shows total market revenues in the various scenarios tested and as a function of both the revenue management situation and the new entrant's relative capacity. It highlights in particular the usual revenue-increasing effect of entry (as discussed in Chapter 5) on total market revenues. Only in Scenario 2_{FM} is there a decrease in total market revenues following entry because of the revenue dilution caused by the incumbent carriers' matching the new entrant's single low fare. In addition, this figure also illustrates the changing effect of revenue management as a function of the competitive situation. In the case of entry with symmetric fares, revenues increase with new entrant capacity and are lowest under FCFS acceptance of seat request (in scenarios 1 and 3_{FM}, except Scenario 2_{FM}, as mentioned).

Under asymmetric fare structures (scenarios 2_{LM} and 3_{LM}), revenue management has varying effects on total market revenues. In the case of entry under Scenario 2_{LM} conditions, revenue management on the incumbent carriers leads to a decrease in total market revenues as the new entrant's capacity increases – as explained in Section 6.1.3 – because the new entrant diverts increasing numbers of passenger from the incumbent carriers. Under Scenario 3_{LM}, total market revenues are lower when all carriers use FCRM than when all carriers accept seat requests on a first-come, first-served basis.

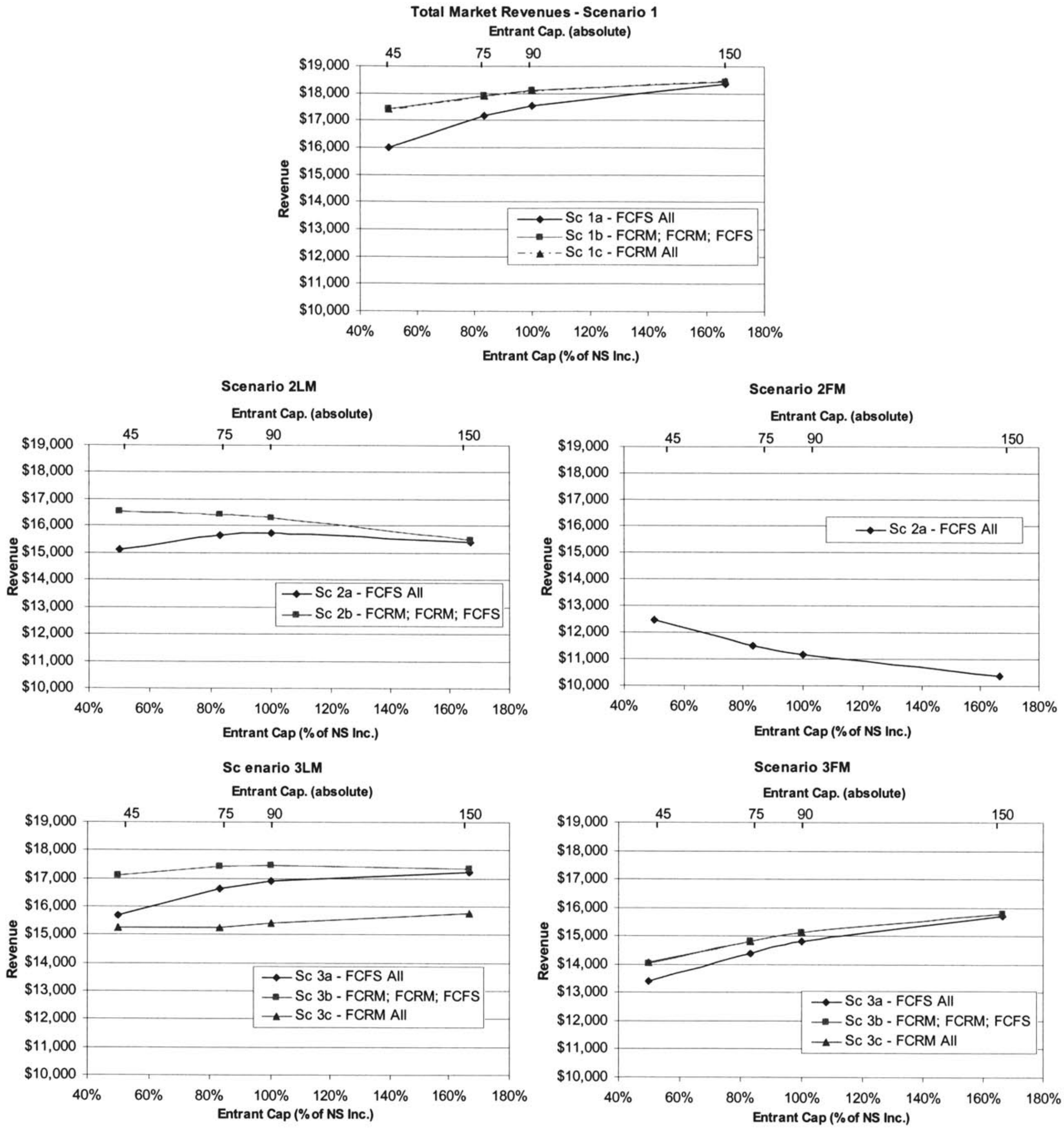


Figure 6.27: Total market revenues by scenario as a function of the competitive revenue management situation and new entrant capacity (a: FCFS on all carriers; b: FCRM on incumbents, FCFS on entrant; c: FCRM on all carriers)

Figure 6.28 further highlights the changing effects of revenue management on average market fares depending on the carriers' use of FCRM or FCFS and on the relative fare structure on the competitors. In this case, under symmetric fare structures, our results show that the average market fare is impacted quite differently depending on whether the airlines use revenue management or not. For example, in scenarios 1 and 3_{FM} – where all carriers use the same fare structure – when none of the carriers use revenue management, the average market fare increases with increasing new entrant capacity (as more high fare passengers are able to travel). Conversely, as soon as the incumbents use FCRM, the average market fare decreases with increasing new entrant capacity, as the new entrant carrier now diverts some of the high fare traffic to its increasingly available lower fare classes. This example clearly highlights the effect of revenue management, independently of any particular response from the incumbent carriers (beyond matching the new entrant's fare structure).

Under asymmetric fare structures, revenue management also has a noticeable impact on average market fares, even though it does not affect the trend of decrease in average fare (with increasing new entrant capacity). Scenarios 2_{LM} and 3_{LM} both exhibit a decrease in average market fare as new entrant capacity increases, but the average fare is higher when only the incumbent carriers use FCRM. In the case where all carriers use FCRM (in Scenario 3_{FM} only), the average market fare is actually lower than in either of the other two cases simulated.

Aggregate measures of performance (revenues, fares and traffic) are therefore highly susceptible, even at the total market level, to changes in the revenue management environment, in the competitive fare structures and in the relative new entrant capacity (as discussed in Chapter 5). In the next section, we focus on the impacts at the airline level.

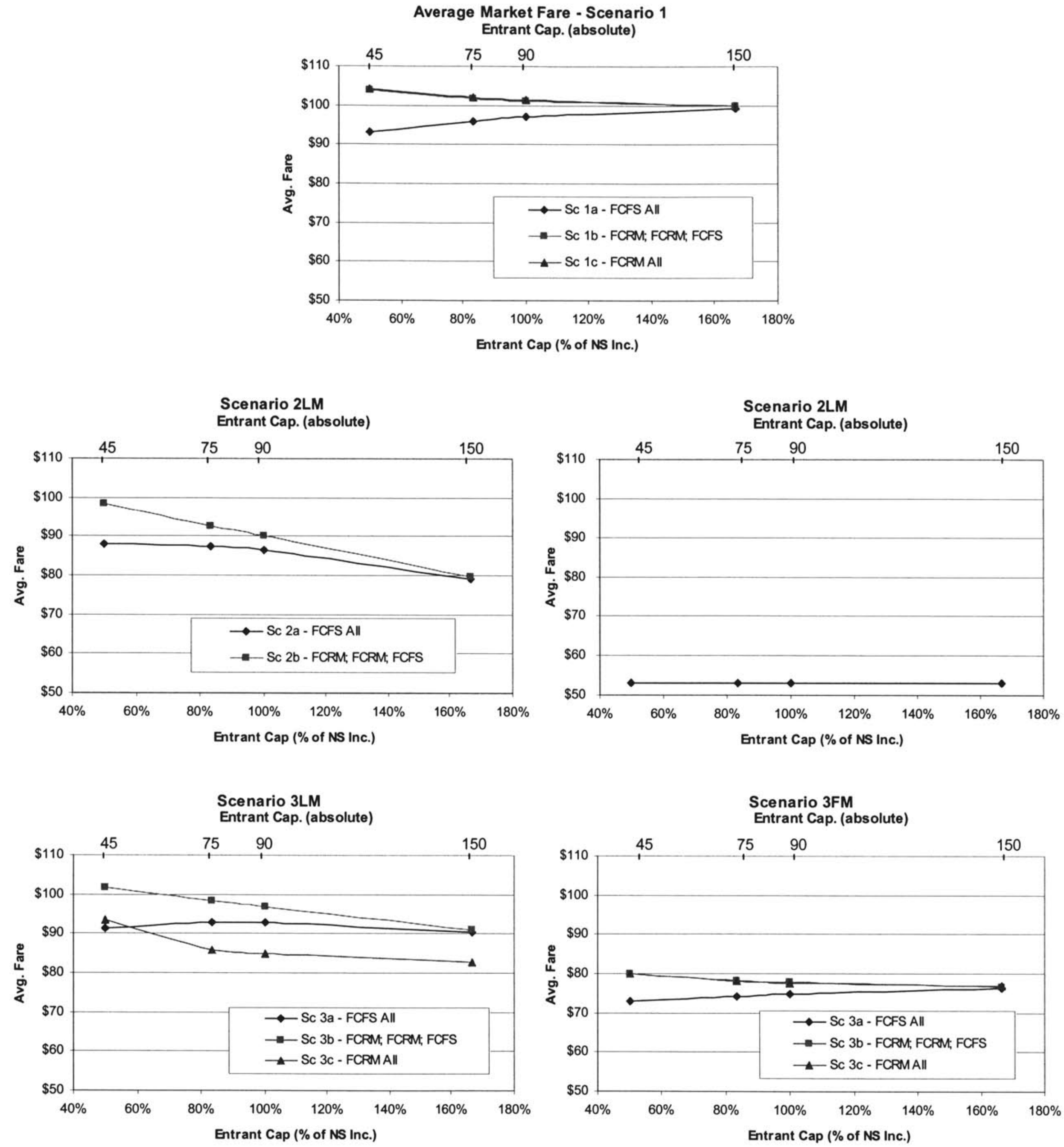


Figure 6.28: Average market fare by scenario as a function of the competitive revenue management situation and new entrant capacity

6.2.2. Airline-Level Comparisons

Nonstop Incumbent Carrier (Airline 1)

Figure 6.29 illustrates how incumbent revenues respond to a change in the competitive revenue management situation, as a function of new entrant capacity. It shows in particular that, although incumbent revenues decrease with increasing new entrant capacity (regardless of the competitive revenue management situation), incumbent revenues are usually lowest when all carriers use FCFS, and higher under the assumption of revenue management by either the incumbents alone or by all three competitors.

As previously discussed, under symmetric fares, the nonstop incumbent carrier achieves its highest revenues when it uses FCRM while the new entrant carrier accepts requests for booking on a first-come, first-served basis, and incurs a decrease in revenues when all competitors use revenue management (relative to this asymmetric competitive revenue management situation). We already explained that the increased competition for high fare passengers is responsible for this decrease in incumbent revenues in this particular case. Conversely, under asymmetric fare structures (scenarios 2_{LM} and 3_{LM}), when only the incumbent carriers use FCRM, Airline 1 revenues are higher than when all carriers use FCFS. In Scenario 3_{LM} however, under symmetric revenue management conditions, Airline 1's revenues are lower than even FCFS revenues. We discussed this particular case and explained that the loss in revenues on Airline 1 is the result of increased competition for high fare traffic, which, combined with a lower fare structure on the new entrant carrier, leads to high revenue dilution from Airline 1 to Airline 3.

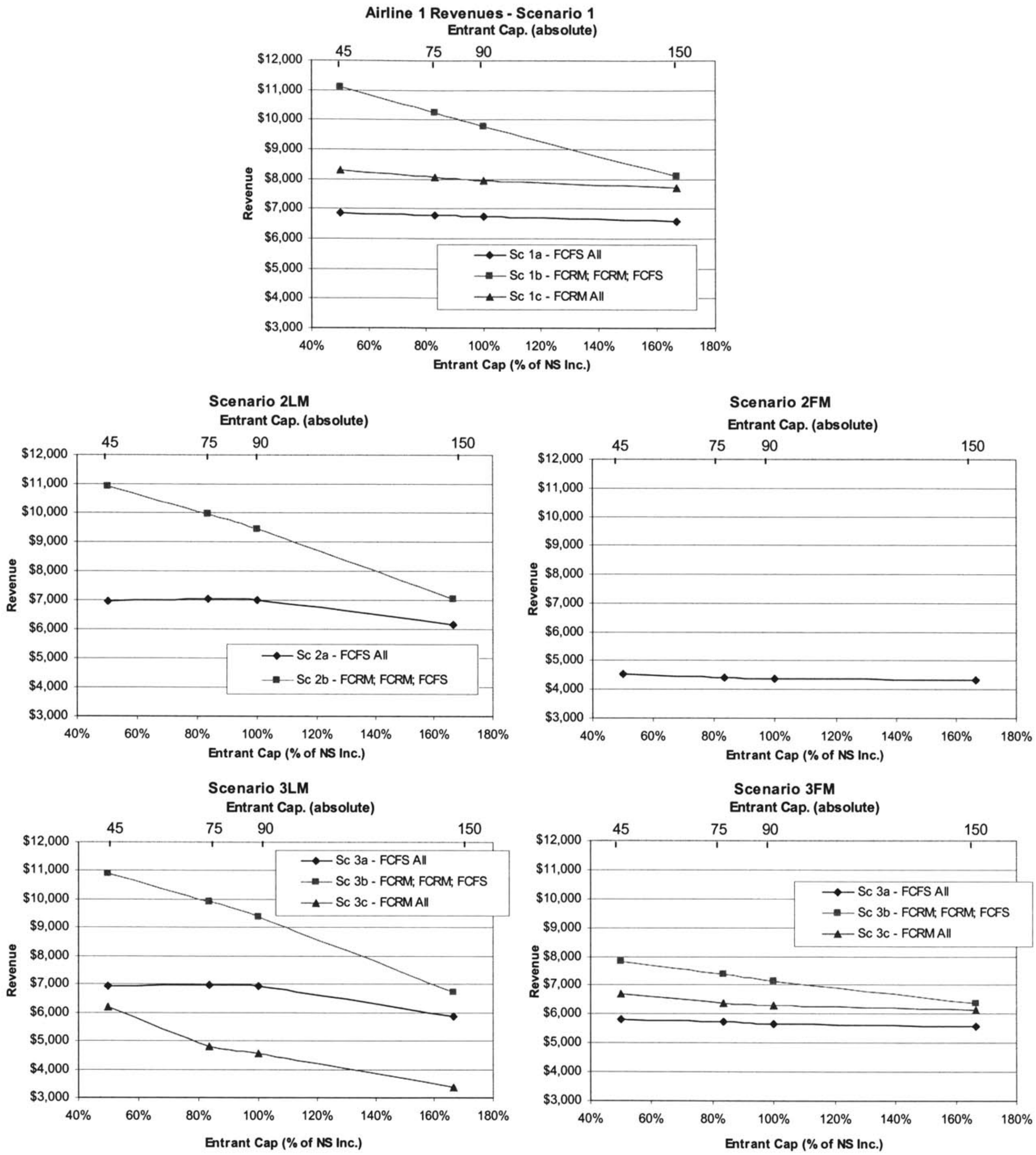


Figure 6.29: Airline 1 revenues by scenario as a function of the competitive revenue management situation and new entrant capacity

Unlike its revenues, Airline 1's average fares follow a more variable pattern as a function of the competitive revenue management situation. Its average fare in the market can increase, decrease or remain somewhat stable following as new entrant capacity increases, as shown in Figure 6.30. Once again, the effect of revenue management is closely linked to the relative new entrant capacity and fare structure. In the case of symmetric fares, the incumbent's average fare decreases with increasing new entrant capacity, is highest when only the incumbent carriers use FCRM and lowest when all carriers use FCFS. As previously mentioned, it is once again the increased competition for high revenue traffic – when all carriers use FCRM – which leads to the lower average fare on the incumbent (relative to FCRM on the incumbents only).

In asymmetric fare cases (scenarios 2_{LM} and 3_{LM}), the incumbent's average fare behaves very differently as the competitive revenue management situation changes. When all carriers use FCFS, the incumbent's average fare increases with increasing new entrant capacity, since the new entrant carrier diverts mostly lower fare traffic and leaves the incumbent with less traffic but higher revenue passengers. When only the incumbent carriers use FCRM, the incumbent's average fare tends to remain relatively stable as new entrant capacity increases, with a tendency to increase at very high new entrant capacity. Under Scenario 3_{LM} when all carriers use FCRM, the incumbent carrier's average fare suffers a sharp decrease with increasing new entrant capacity, unlike the other two cases under Scenario 3_{LM}. Once again, the increase in competition for high revenue, late booking traffic leads to the decrease in incumbent average fare under this scenario. Furthermore, the asymmetric fare structure provides the new entrant with an additional competitive advantage which lures passengers to its flights.

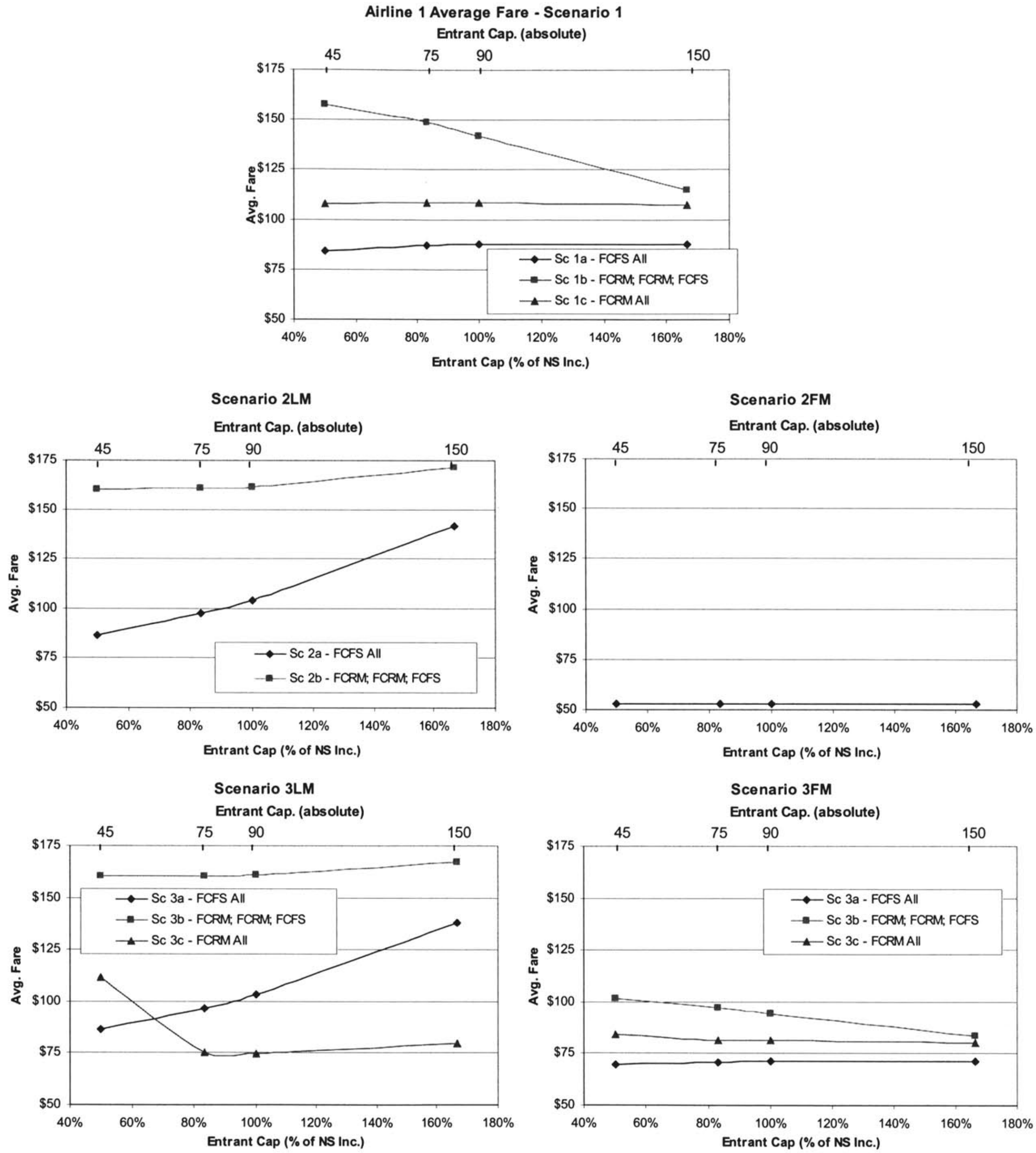


Figure 6.30: Airline 1 average fares by scenario as a function of the competitive revenue management situation and new entrant capacity

In summary, under symmetric fares, the incumbent's average fare decreases with increasing new entrant capacity, relatively more when only the incumbent carriers use FCRM. This effect on average fares is a direct consequence of the relative capacities and competitive revenue management situation, and assumes a full match from the incumbent carriers.

Under asymmetric fares, revenue management allows the incumbent carriers to maintain high fare traffic when they are not competing with a new entrant also using revenue management. Under FCFS, the carriers fill-up on a first-come, first-served basis, which allows the carrier with the higher capacity to carry the high fare traffic. When all carriers use FCRM, the incumbent then suffers extensively from the competitive fare advantage of the new entrant, and its average fare drops quickly with increasing new entrant capacity. This decrease in average fare is not indicative of a match response from the incumbent carriers (other than in the lowest fare class), but rather of the greater competition in the market.

New Entrant Carrier (Airline 3)

The new entrant carrier, unlike the nonstop incumbent, benefits from increasing capacity with respect to revenues, regardless of the revenue management situation. The relative effect of revenue management can be felt only in the case of differentiated fare structures on the new entrant carrier. In addition, Figure 6.31 shows that new entrant revenues increase when it moves to FCRM, while they can also decrease when the incumbent carriers move to FCRM, given that the new entrant accepts seat requests on a first-come, first-served basis. Generally speaking, as long as the new entrant offers some form of product differentiation, there are revenue gains associated with it moving to FCRM, and these revenue gains are greater when the incumbent carriers do not match the new entrant's lower fare structure.

Finally, Figure 6.31 also shows that at very high capacity under symmetric fares, new entrant revenues with FCFS can surpass those with FCRM. This result is the consequence of increased competition for high fare traffic, as explained previously.

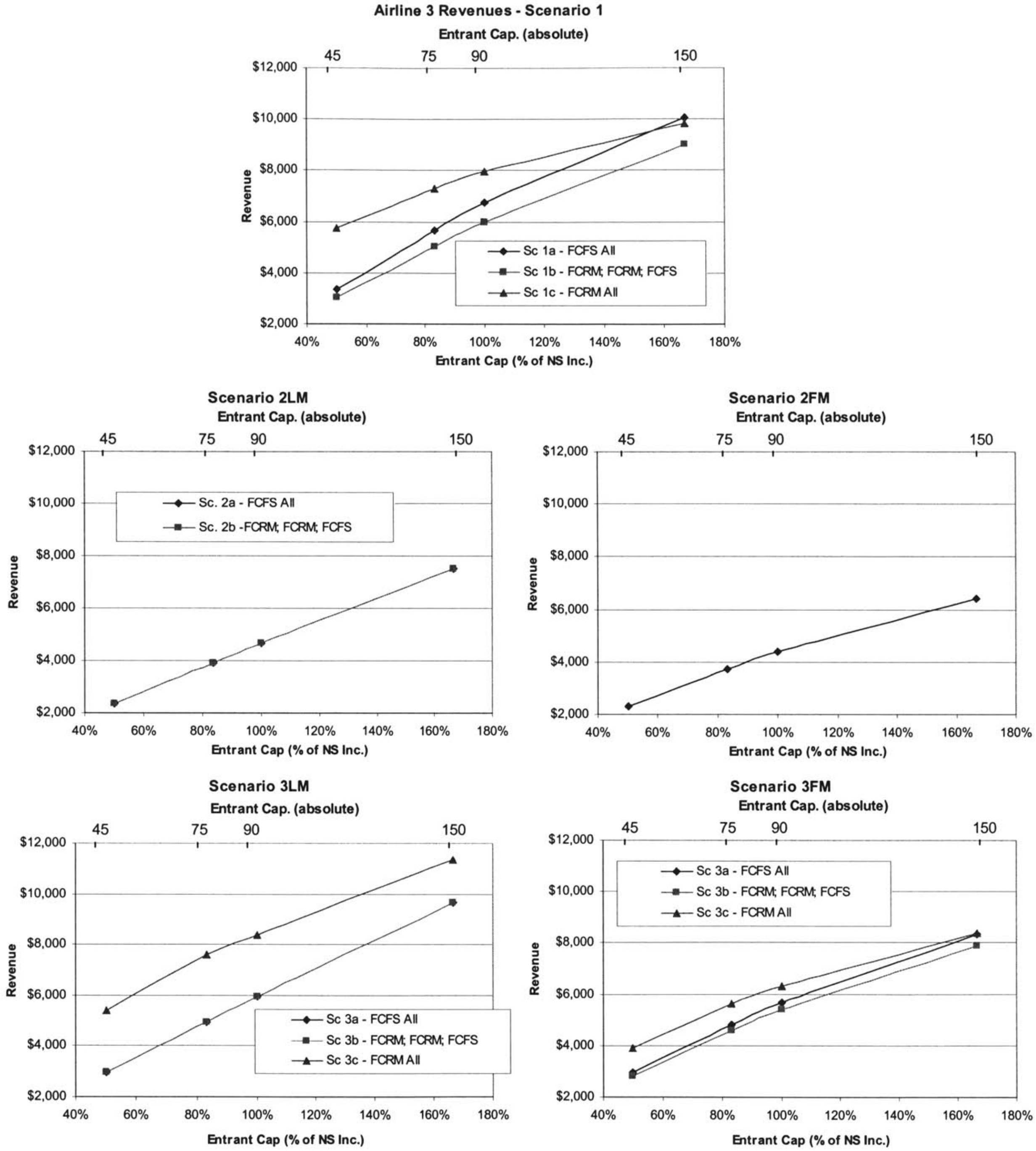


Figure 6.31: Airline 3 revenues by scenario as a function of the competitive revenue management situation and new entrant capacity

Figure 6.32 illustrates the impacts of revenue management on new entrant average fares, and particularly the change in average fare trends under FCRM. Average fares decrease with increasing new entrant capacity when it uses FCRM, whereas they increase in the cases where the new entrant accepts seat requests on an FCFS basis. Note that under Scenario 1, the new entrant has a higher average fare when all carriers use FCFS at high capacity than when all carriers use FCRM. At high capacity, and under FCFS acceptance of seat requests, the incumbent carrier fills-up sooner and leaves the high fare traffic to the new entrant carrier, hence the higher average fare.

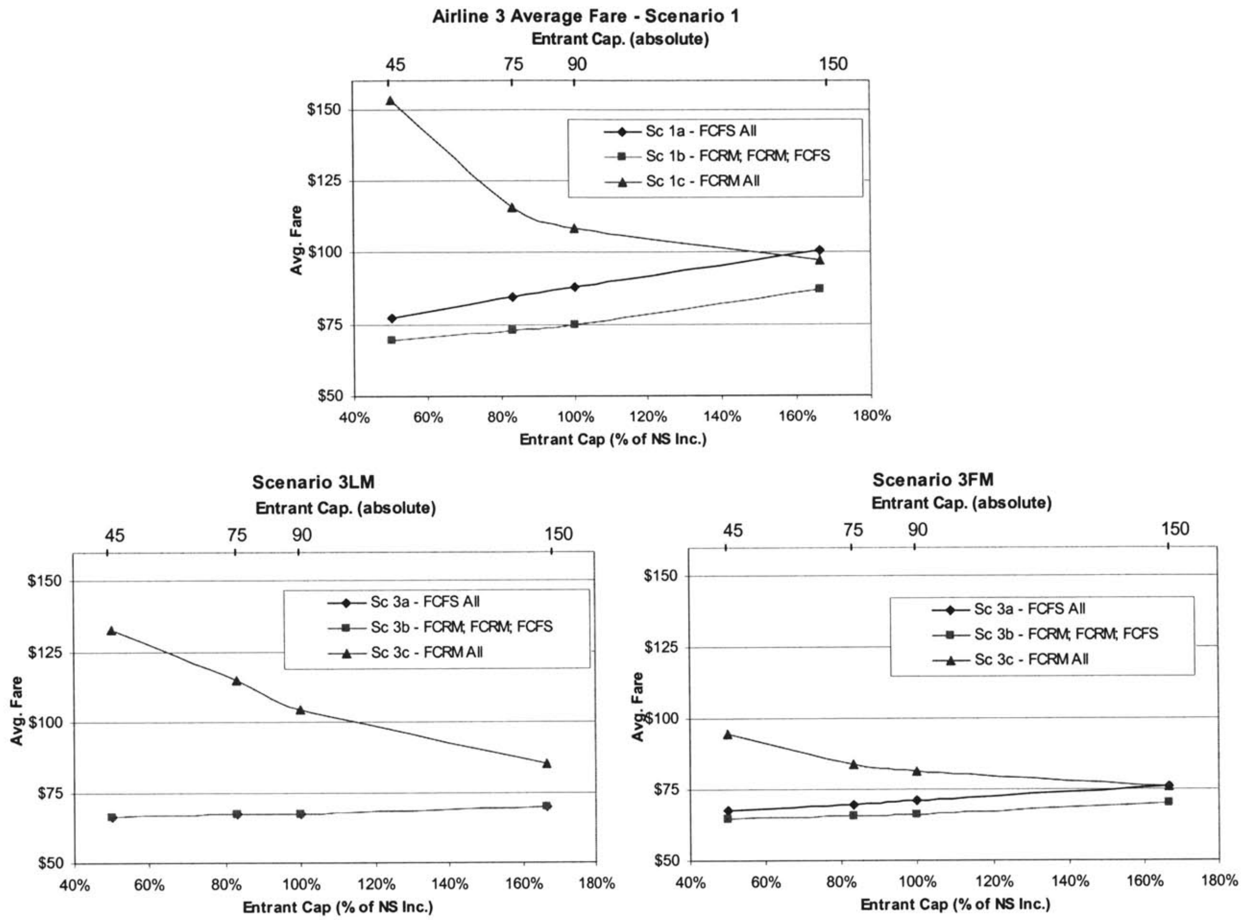


Figure 6.32: Airline 3 average fares by scenario as a function of the competitive revenue management situation and new entrant capacity

These revenue management effects on the new entrant carrier are expected effects, but nonetheless highlight the importance and influence of revenue management when studying aggregate measures of airline performance, such as average fares or revenues.

Relative Average Fares of Incumbent and New Entrant Carriers

The relative average fare of the incumbent and new entrant carriers are also significantly affected by the revenue management situation, as shown in Figure 6.33. In particular, scenarios 1, 3_{LM} and 3_{FM} provide three interesting cases of the effect of revenue management on relative average fares. In Scenario 1, when all carriers use FCFS, the new entrant starts out with a lower average fare than the nonstop incumbent, but, as its capacity increases, so does its average fare (as previously explained). When only the incumbents use FCRM, Airline 1's average fare remains consistently higher than that of Airline 3. Finally, when all carriers use FCRM, then the new entrant's average fare is initially higher than that of the incumbent, and gradually decreases as new entrant capacity increases. Scenario 3_{FM} exhibits similar behavior – we had explained that scenarios 1 and 3_{FM} were similar due to the symmetric fares on all three competitors, albeit with different fare products. Scenario 3_{FM} has a smaller spread between average fares and revenue management cases, because of the lesser product differentiation in this case. Scenario 3_{LM} presents a variation of the results observed in scenarios 1 and 3_{FM}.

These results show that the relative average fare between carriers is highly dependent on the competitive revenue management situation and fare structure, and the relative new entrant capacity. They also illustrate the inappropriateness of these measures in assessing the response of incumbents to entry.

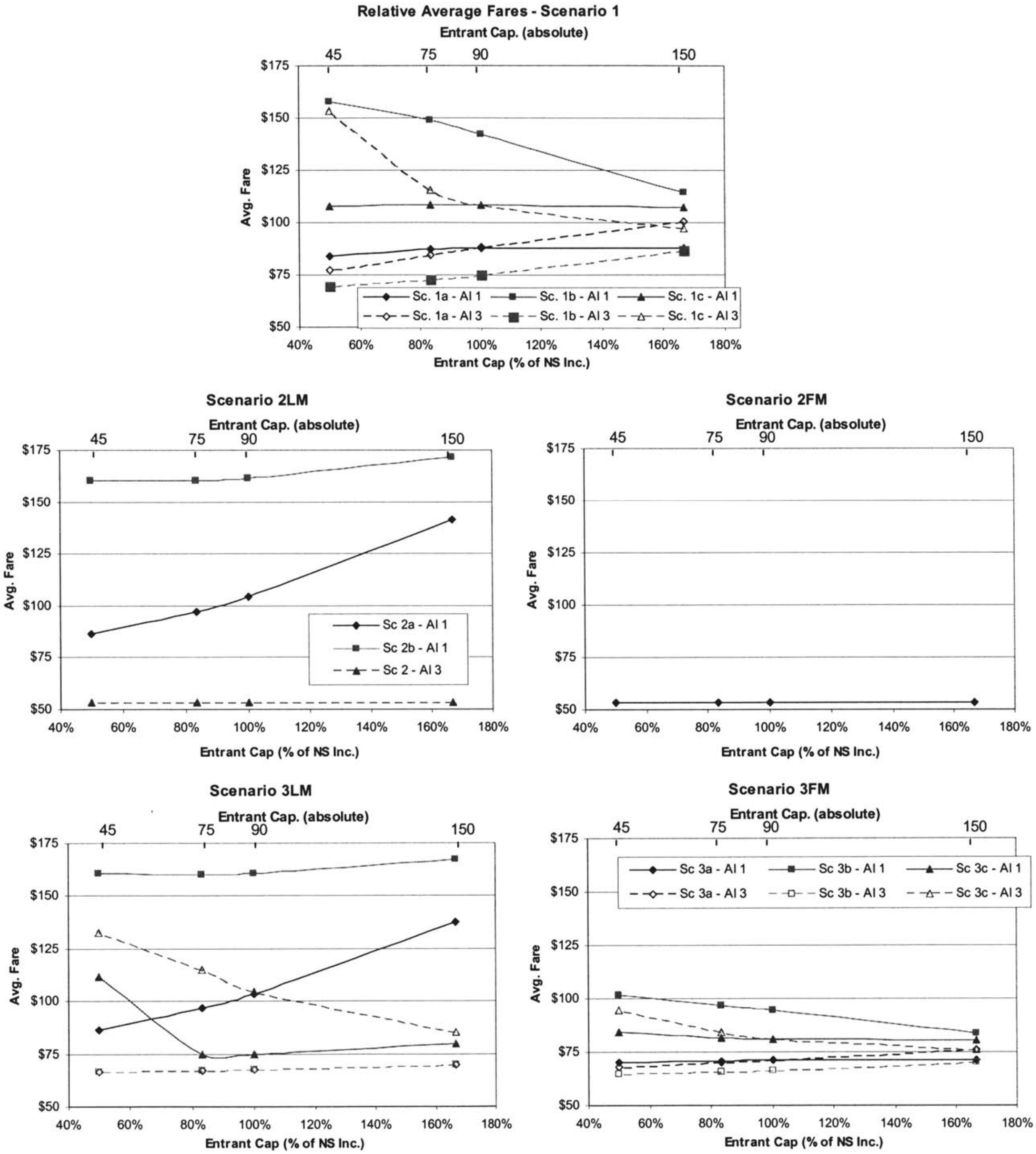


Figure 6.33: Relative average fares by scenario as a function of the competitive revenue management situation and new entrant capacity (a: FCFS on all carriers; b: FCRM on incumbents, FCFS on entrant; c: FCRM on all carriers)

6.2.3. Summary

The previous discussion of the effect of revenue management on incumbent revenue performance and traditional measures of airline performance in general has illustrated the importance of revenue management in explaining the changes in aggregate measures of airline performance, and more specifically on average fare, traffic and revenues. Our results have highlighted that:

1. The impact of revenue management on traditional measures of airline performance is closely tied to relative new entrant capacity and relative fare structure between competitors (limited or full match, i.e. symmetric or asymmetric fare structure).

2. Revenue management affects aggregate measures of airline performance in very different ways depending on the scenario and leads to very different outcomes within any given scenario, as a function of increasing new entrant capacity.

    - Under the assumption of revenue management on either the incumbents only or on all carriers, the effect of increasing new entrant capacity is far greater (and negative) on incumbent revenues and average fares. Only in the case of Scenario 2_{LM} is this not true, only because of the extreme dilution of traffic towards the new entrant, from low-fare passengers up (as previously discussed).

    - Under the assumption of no revenue management, the nonstop incumbent carrier's revenues also decrease with increasing new entrant capacity, but are relatively less affected by entry.

    - Finally, product differentiation on the new entrant (and on the incumbent carriers when they match the new entrant's fares) plays a critical role in the relative effect of revenue management. More product differentiation (in Scenario 1) bestows more leverage on the incumbent carriers who are thus able to extract more revenues from passengers. As a consequence, they are relatively more affected by low-fare entry than when fare products are less differentiated (Scenario 3_{FM}). Asymmetric situations whereby the new entrant carrier offers a less differentiated fare structure not matched by the incumbent carriers leads to greater revenue losses on the incumbents, but also to greater average fares, as the incumbent carriers are then able to maintain the high fare traffic.

3. Use of revenue management generally leads to revenue increases on the airlines using revenue management. Given that the incumbent carriers use FCRM, the fact that the new entrant also moves to FCRM increases the competitiveness of the market and thus can lead to a decrease in incumbent revenues.

These results thus reinforce Chapter 5 findings that such aggregate measures of airline performance as average fares provide insufficient information to assess the response of an incumbent carrier to low-fare entry.

6.3. Sensitivity Analysis

The results presented in Chapter 5 and the first part of Chapter 6 depend on some of the modeling assumptions in PODS. In particular, we identified three critical parameters for which we test the sensitivity of the results:

1. Connecting time on Airline 2. As discussed in Chapter 5, Airline 2 offers only connecting service in the market, with a total travel time of 5h43 compared to 1h16 on airlines 1 and 3.
2. Business/Leisure mix. Market parameters are set to reproduce a market where 35% of the traffic is business traffic, while the remaining 65% are business travelers.
3. Leisure willingness-to-pay curves (demand curves). Market demand is based on willingness-to-pay curves described in Chapter 5. In particular, traffic stimulation following entry is dependent upon the shape of the leisure demand curve, which we modify here.

In the following paragraphs we discuss the sensitivity of results with respect to these three parameters. Our results will show that while results respond to changes in these parameters, the general conclusions drawn from previous simulations in Chapter 5 and Chapter 6 remain unchanged.

6.3.1. Connecting Time on Airline 2

In order to test for the sensitivity of results to the length of the connection through Airline 2's hub, we decreased the total travel time on Airline 2 according to Figure 6.34. This sensitivity analysis only involves decreasing the connecting time on Airline 2 as the total travel time on Airline 2 was already quite high.

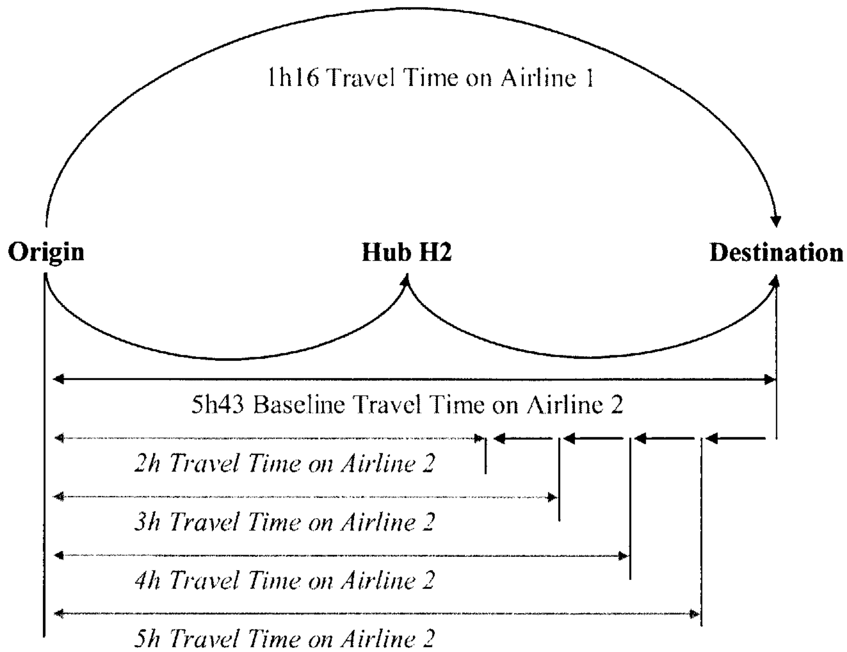


Figure 6.34: Sensitivity test on connecting time on Airline 2

Our simulation results show that changing connecting time on Airline 2 does not affect the relationship between Airline 1 and Airline 3's average fares, as shown in Figure 6.35. It does however have an impact on the actual values of individual carrier's average fares, revenues and traffic, since Airline 2's overall path quality increases as the total travel time decrease.

Generally speaking, the effect of the change in Airline 2's schedule is a decrease in Airline 1 and Airline 3 revenues (by up to 5% each in the case of FCRM on all carriers, in Scenario 0 for Airline 1 and Scenario 1[50] for Airline 3). Conversely, Airline 2's revenues increase by up to 80% (but remain lower than those of Airline 1). This effect on revenues is accompanied by a slight decrease in traffic on the nonstop carriers, as Airline 2 diverts a few passengers. The effect on average fares is a slight decrease on airlines 1 and 3 (as shown in Figure 6.35), and a slight increase on Airline 2.

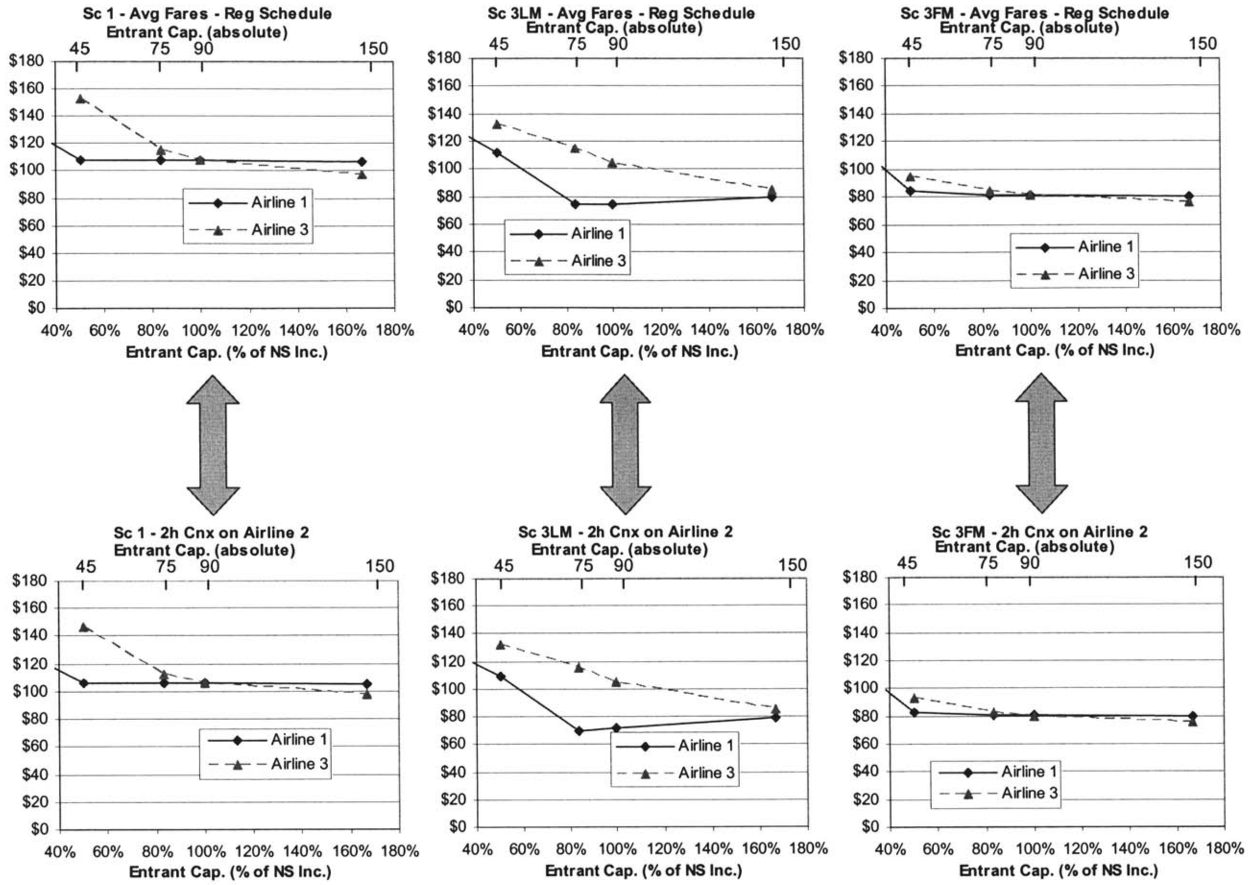


Figure 6.35: Sample of sensitivity of results to changes in Airline 2 travel time, FCRM on all carriers

Our simulation results therefore show the robustness of previously simulated results with respect to changes in Airline 2's schedule, and more specifically a decrease in total travel time on the connecting carrier.

6.3.2. Business/Leisure Mix of Demand

Given the changes the cyclicality of the airline business and its dependence on the state of the economy, the mix of business and leisure passengers changes. We therefore tested our results with respect to their sensitivity to the change in passenger mix. Figure 6.36 shows the various situations tested, with a focus on an increase in the proportion of business traffic, which is less sensitive to price, but more to convenience.

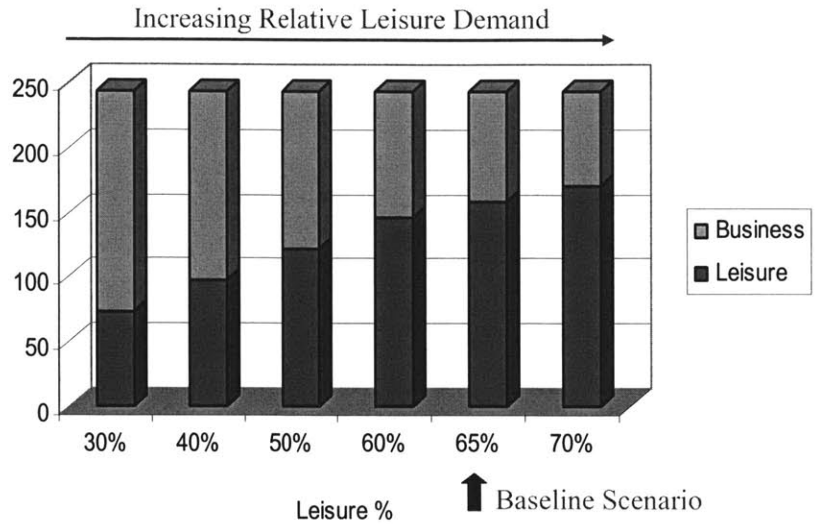


Figure 6.36: Change in business/leisure mix of traffic

Our simulation results show that individual airline performance is affected by the change in business/leisure mix of traffic. Individual airline revenues decrease as the mix of leisure passengers increases (since they have a lower willingness to pay), but the split of revenues (revenue share) between airlines 1 and 3 is unaffected. Airline 2's revenues are even less affected, as it remains the less attractive choice.

As revenues decrease, loads increase, since the airlines – when they use FCRM or not – are increasingly willing to carry all traffic, given the lower probability that higher fare passengers will show up. As a direct consequence, the average fare on airlines 1 and 3 decreases as the proportion of leisure passengers increases.

Without going into all the details, the general conclusions from previous discussions hold, and the relationships between aggregate measures of airline performance, relative new entrant capacity, competitive revenue management situation and fare structures are maintained. As the proportion of business passengers increases, the relative gains of revenue management decrease slightly since the need to protect seats for late-booking passengers becomes less critical, as most of the passengers are now late-booking business passengers.

Scenario 3_{LM}, however, presents somewhat different results as the leisure mix of passengers varies. Figure 6.37 and Figure 6.38 show the change in average fares on both nonstop carriers as the mix of leisure passengers changes from 65% (in the standard case) to 40% at the extreme of our sensitivity tests. These figures show that the behavior of average fares does not change as a function of the new entrant's capacity and the competitive revenue management situation. Individual carrier average fares increase because of the greater proportion of passengers willing to pay a higher fare. On Airline 1, the average fare increases quickly with increasing new entrant capacity under Scenario 3_{LM} with FCFS on all carriers, until it starts decreasing at very high new entrant capacity. This decrease is a consequence of the new mix of passengers combined with the increased capacity on Airline 3 which can now divert more high fare passengers. This effect is similar to what we observed in the case of Scenario 2_{LM} on Airline 1.

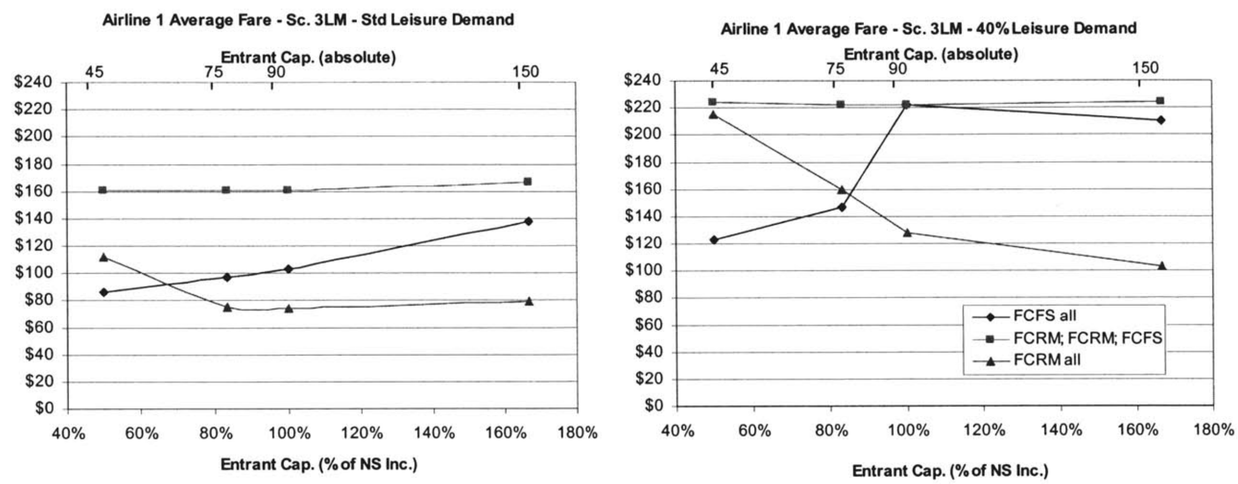


Figure 6.37: Effect of leisure mix on Airline 1 average fares

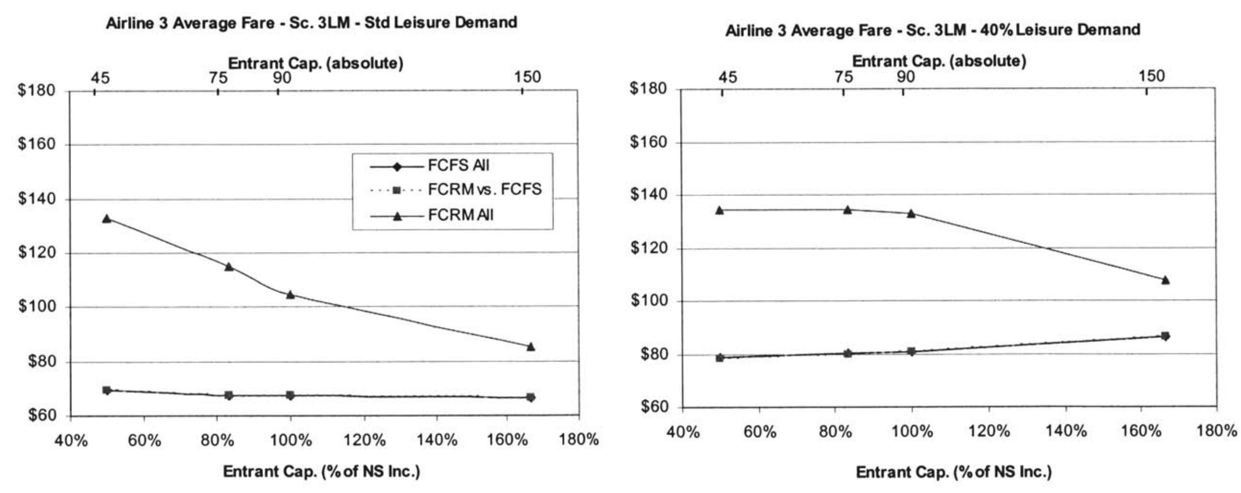


Figure 6.38: Effect of leisure mix on Airline 3 average fares (FCFS all and (FCRM; FCRM; FCFS) overlap in both cases)

The bigger change occurs when focusing on relative new entrant and incumbent average fares when all carriers use FCRM (in the other two cases, the relative values of new entrant and incumbent average fares remain the same). Under the assumptions of standard demand, the new entrant's average fare was greater than that of the incumbent carriers, under all capacities tested. Under the assumptions of high leisure demand, the new entrant's average fare starts at a lower level than that of the incumbent carrier, and eventually becomes higher than that of the incumbent carrier, at high new entrant capacity, as the new entrant's average fare decreases slower than that of the incumbent carrier. This result is the consequence of the asymmetric fare structures between the two carriers. Indeed, at low entrant capacity, Airline 3, although it is protecting for late-booking high fare passengers, is constrained as to how many of these passengers it can carry. As a result, given the high business demand, Airline 1 is relatively unaffected by the diversion of traffic and carries numerous passengers at its Y class fare. This fare is much higher than that of the Y class fare on the new entrant, which biases the incumbent's average fare high. When the new entrant's capacity increases, it is able to divert more passengers and thus affects the incumbent's average fare.

Overall, our simulation results show that the conclusions from Chapters 5 and 6 generally hold and are relatively insensitive to changes in the mix of business and leisure passengers. The only notable change occurs in the case of Scenario 3_{LM}, under extremely high leisure demand. This case further highlights the importance of relative new entrant capacity, as the relationship between the two nonstop carriers' average fares eventually returns to that of standard demand levels, at high new entrant capacity.

6.3.3. Leisure Willingness-to-Pay (Demand) Curve

Our final sensitivity test studies the effect of changes in the leisure demand curve on aggregate measures of performance and the relationships previously established in Chapters 5 and 6. Figure 6.39 shows the simulated changes in leisure demand curve. These changes affect leisure passengers' willingness to pay the higher fares in the market, along with the amount of stimulation created by the lower Q fare.

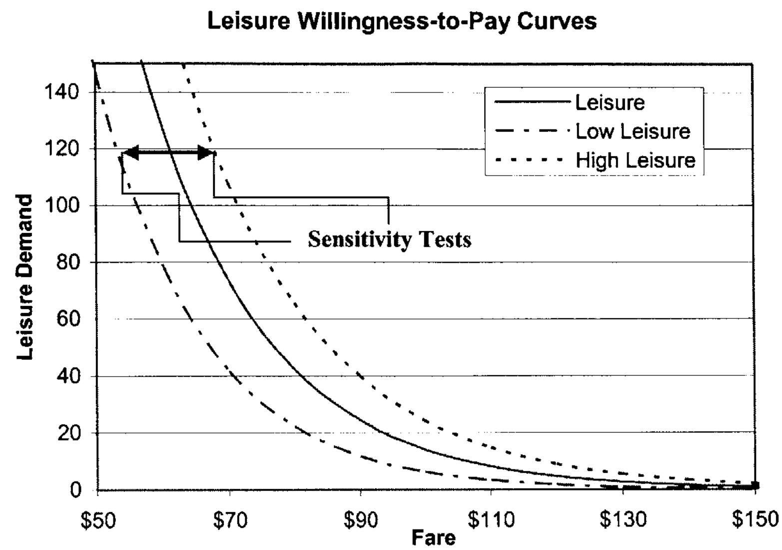


Figure 6.39: Simulated change in leisure demand curve

As mentioned in Chapter 5, the demand curves in PODS depend on two parameters, the "emult" and the "basefare". In these sensitivity tests, we modify only the basefare value, in order to preserve the shape of the demand curve.

Once again, results show that the change in demand curve – using either the "low" or the "high" curves shown in Figure 6.39 – does not significantly affect the performance of the three competitors. The major trends are that revenues generally decrease on all three carriers as leisure demand decreases, as does traffic. However, since the business willingness-to-pay has not changed (i.e. business demand curves remain constant), the average fare on all three carriers tends to increase under the "low" setting. Conversely, under the "high" setting, opposite results are observed.

Under Scenario 3_{LM} with all carriers using FCRM, results are once again slightly more affected by the change in the "basefare" settings than any other scenario. Figure 6.40 shows the effect of the decrease in traffic stimulation and leisure willingness-to-pay on Airline 1 and Airline 3 average fares as a function of increasing new entrant capacity and the competitive revenue management situation. It first illustrates that the impact on the new entrant's average fare is minimal since it is the airline offering the lower fares in this asymmetric scenario and therefore maintains most of its traffic. On Airline 1, however, the effect is much more apparent. In scenarios 3_{LM} with FCFS on all carriers or FCRM on the incumbents only, the average fares on Airline 1 are higher with a lower basefare as there are fewer leisure passengers traveling. The overall effect of increasing new entrant capacity and the relative positioning of the incumbent and new entrant average fares remain unchanged. In this scenario (Scenario 3_{LM} with all carriers using FCRM), at high new entrant capacity, the incumbent's average fare increases significantly and becomes higher than that of the new entrant. This effect is the consequence of the decrease in leisure traffic. At high entrant capacity, the lack of capacity constraints on Airline 3 allow it to carry more and more of the lower fare demand. These passengers are thus diverted, which leads to an apparent increase in Airline 1's average fare. Revenue-wise however, Airline 1's revenues decrease with increasing new entrant capacity.

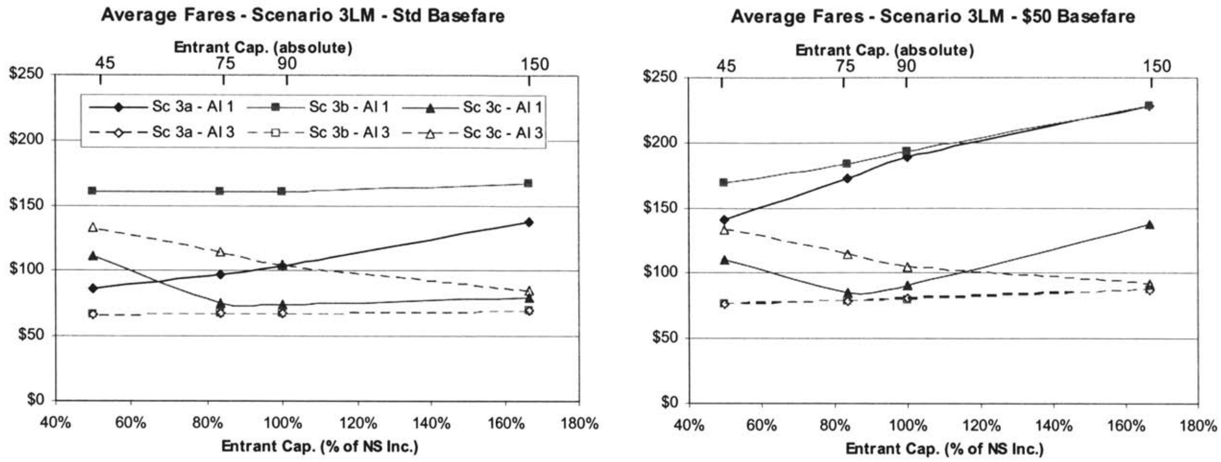


Figure 6.40: Effect of change in leisure demand curve on average fares in Scenario 3_{LM} (a: FCFS on all carriers; b: FCRM on incumbents, FCFS on entrant; c: FCRM on all carriers)

In summary, changes in leisure demand stimulation simulated here show that the trends in the results (identified in Chapters 5 and 6) are relatively insensitive to change in demand curves. The most noticeable change occurs in Scenario 3_{LM} and is once again a consequence of the asymmetry in the fare structures between incumbents and the new entrant carrier.

6.3.4. Conclusions

Sensitivity tests show that, overall, the trends and important factors identified in previous discussions are unaffected by changes in the simulation parameters. These sensitivity tests emphasized the importance of the competitive fare structures between incumbent carriers, as well as the critical role of relative new entrant capacity and competitive revenue management settings in assessing the impacts of entry on traditional measures of airline performance.

6.4. Conclusions: Lessons Learned from the Single Market Case

The simulation results in this chapter have highlighted the importance of revenue management in understanding the dynamics of low-fare entry in a single market case, and its impact on traditional aggregate measures of airline performance. In particular, our simulations show that the use of revenue management can lead to various effects on the incumbent carrier's average fare, revenues or traffic. For example, without revenue management, under Scenario 3_{LM} assumptions, Airline 1's average fare increases with increasing new entrant capacity, whereas it decreases when all carriers use revenue management. Under Scenario 1 settings, Airline 1's revenues decrease with increasing new entrant capacity in all cases, but tend to decrease relatively more when only the incumbent carriers use revenue management.

Similarly, these results also illustrate the effect of revenue management on relative average fare between the incumbent and new entrant carrier. For example, the incumbent's average fare is always higher than that of the new entrant carrier under Scenario 3_{LM} when all carriers use FCFS acceptance of seat requests, or when only the incumbent carriers use FCRM. When all carriers use FCRM, however, the new entrant's average fare is higher than that of the incumbent carrier in all cases tested.

These simulations consequently highlight the importance of revenue management in understanding the behavior of aggregate measures of airline performance following low-fare entry. These simulations also drew attention to the importance of the relative fare structure between competing carriers. Indeed, we discussed the close tie between the symmetry (or asymmetry) of the fare structure of the incumbents and new entrant carrier and the competitive revenue management situation. We showed in Section 6.2.2 that the effect of revenue management on aggregate measures of airline performance is different depending on whether the fare structures are identical or not on the competing carriers. In other words, whether the incumbent carriers fully match the new entrant's fare structure affects the performance of all carriers and also has an impact on the effect of entry on average fares, revenues and traffic.

Finally, these results also re-emphasized the importance of the factors that we had identified in Chapter 5 as critical in understanding the effect of entry on aggregate measures of airline performance. In particular, the relative capacity of the new entrant carrier still plays a major role in understanding the effects of entry.

Overall, these simulations results show that average fares – and other measures of airline performance such as revenues and traffic – provide a very incomplete picture of the competitive situation and certainly do not provide any indication as to the price response of incumbent carriers to low-fare entry.

Our simulations implicitly recognize the importance of the path quality on airline revenue performance by modeling Airline 2 as a connecting carrier, but do not actually model flows of connecting passengers on a network. In Chapter 7, we will simulate a full network situation with a low-fare carrier entering a subset of Airline 1's market in order to assess the impact of connecting traffic, and the potential mitigating effects of carrying more connecting traffic for Airline 1.

CHAPTER 7

EXTENSION OF RESULTS TO A LARGE NETWORK ENVIRONMENT: ENTRY IN TEN MARKETS

In Chapters 5 and 6, we focused on the impacts of low-fare entry in a single market case, and highlighted the importance of relative new entrant capacity in the market, as well as pricing and revenue management effects on traditional measures of airline performance. The results showed that traditional measures of airline performance paint a very incomplete picture of the competitive response of incumbent carriers to low-fare entry.

In this chapter, we expand the research to a larger network where the incumbent network carriers now carry connecting passengers in addition to local market passengers. The purpose of this study is to illustrate the added complexity in a large network environment and further demonstrate the inadequacy of traditional measures of airline performance in explaining responses to entry. In particular, the focus will be on the impacts of the flows of connecting passengers on aggregate measures of airline performance.

In the first section, we discuss the approach and the scenarios chosen to represent entry in a large network environment. In the second section, we present the results and findings of the simulation.

7.1. Approach

We once again use the Passenger Origin Destination Simulator (PODS) to simulate this larger competitive airline network. In this chapter, we focus on the case of entry with a two-tier fare structure and with full match from the incumbent carriers (previously referred to as Scenario 3_{FM}). We chose to model only this case of entry because it best replicates low-fare entry according to the following observations:

1. Low-fare carriers usually enter a market with lower fares than previously offered by the incumbent carriers, and with a simplified fare structure.
2. Incumbent network carriers almost always match the new entrant's fare structure, in order to remain competitive and in an attempt to maintain their market share (in the local market with low-fare competition).

Measures of airline performance are still unquestionably affected by the pricing strategy of the new entrant and the response of the incumbent carriers, as previously illustrated and discussed.

To illustrate the effect of entry and incumbent revenue management in this low-fare airline environment, we simulate a competitive airline network, with a set of three competing airlines offering service in this network. Airlines 1 and 2 represent the incumbent network carriers offering service in all the markets in the network, either nonstop, or connecting through their hub. The new entrant carrier (Airline 3) offers only nonstop service in a subset of Airline 1's nonstop local markets, the ten markets with the highest local demand from Airline 1's hub.

7.1.1. Simulated Network

The network in which the three competing carriers operate is represented as a network of 40 cities, in addition to two individual airline hubs (42 cities in total). Figure 7.1 shows a geographical layout of the network overlaid on a map of the US. It also shows the two network airlines' hubs, H1 and H2.

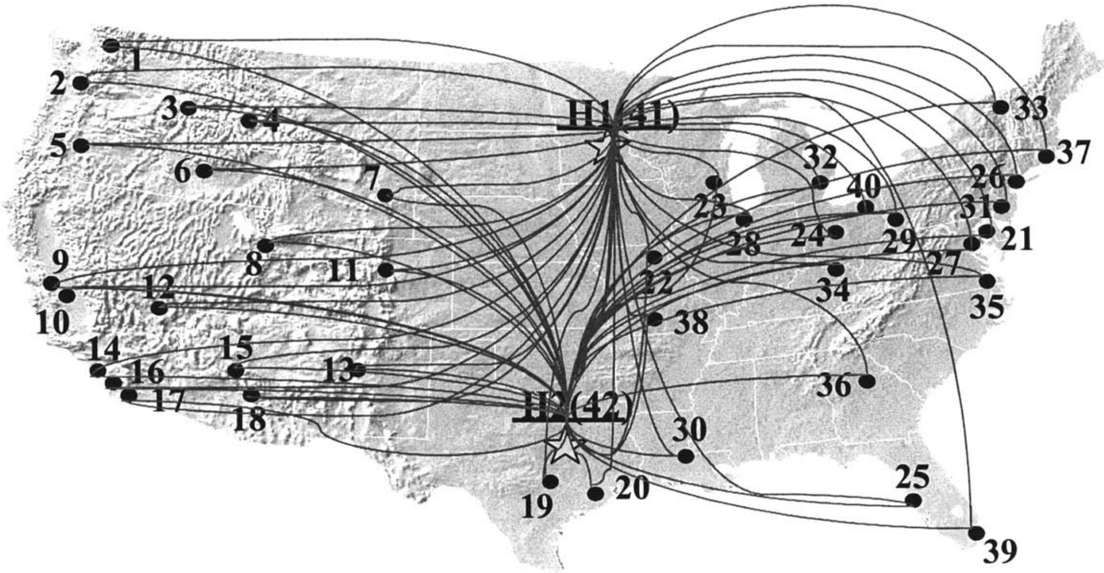


Figure 7.1: Simulated incumbent networks

Traffic on this network flows only from West to East given that each network airline offers service only from western spoke cities (1 through 20) to its hub, and from its hub to eastern spoke cities. As a result, 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. Consequently, 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 from H1 to eastern cities (c.f. Figure 7.2), and therefore competes directly with Airline 1's nonstop service in these markets.

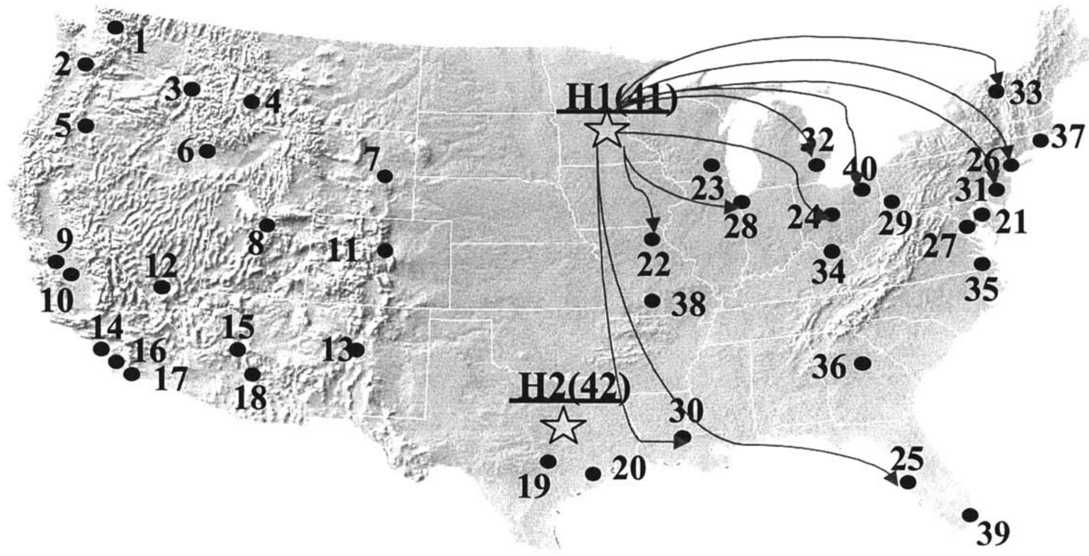


Figure 7.2: New entrant carrier network

Frequencies and Capacity

Each of the two incumbent network carriers offer 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 serves three daily banks allowing for connections from western cities towards eastern cities. The new entrant's flights coincide with the incumbent carrier's flight departures in the local market, 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).

In terms of capacity, the incumbent carriers each 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, with three possible capacity levels of 30, 50 or 70 seats per flight (all flight legs on the new entrant carrier have the same capacity within a scenario).

7.1.2. Individual Market Parameters

Each market in the network is defined by a set of market parameters including average daily demand, mix of business and leisure traffic within the market, price-demand curves for each passenger type, as discussed in Chapter 5, Section 5.1. In this network, passenger demand is split identically in each of the 482 markets, with 35% of demand being business oriented and the remaining 65% being leisure demand. The difference between leisure and business passengers resides in business passengers' willingness to pay a higher fare, sensitivity to fare restrictions, and booking behavior. Figure 7.3 shows the willingness to pay curves of leisure and business passengers in a sample market.

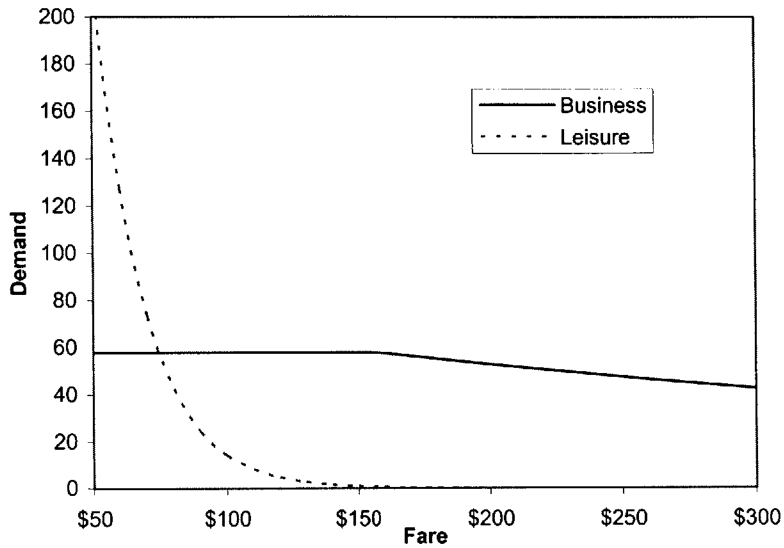


Figure 7.3: Willingness to pay curves in PODS for a sample market

Pricing in Markets without Low-Fare Competition

In the 472 markets without low-fare competition, the incumbent carriers offer a set of four fare classes, differentiated according to the "traditional" structure found at legacy network carriers. The highest fare, in Y class, is unrestricted and does not require any advance purchase. The second highest fare, in B class, includes a Saturday night stay and a seven-day advance purchase requirement, but is cheaper than the full fare. M and Q classes have even more severe restrictions and advance purchase requirements, as summarized and illustrated in Table 7.1. In addition, when there is no low-fare competition in the network, the incumbent carriers use the standard fare structure in all markets.

Fare Class	Fare	Restriction	A/P
Y	$400	None	None
B	$200	Sat[14]	7 days
M	$150	Sat[14], NR[15]	14 days
Q	$100	Sat[14], NR[15], CF[16]	21 days

Table 7.1: Sample incumbent market fares according to the standard fare structure

[14] **Sat**: Saturday night stay requirement
[15] **NR**: Non-refundability
[16] **CF**: Change Fee

New Entrant Network Presence

As previously mentioned, the new entrant carrier operates in the ten local markets from Airline 1's hub with highest daily passenger demand. The new entrant carrier operates three daily flights, departing at the same times as Airline 1's own flights. We chose to model these flights to depart at identical times to avoid the added effect of schedule preference for local passengers, and focus on the effect of entry, revenue management and network flows on airline performance. Table 7.2 shows the percentage of legs, markets, passengers and revenue-passenger miles (RPMs) affected by the low-fare competition in the ten markets chosen.

	Total		Network-Level		Leg-Level	
	Legs	Markets	Passengers	RPMs*	Passengers	RPMs
Affected	30	10	878	595,306	2,740	1,856,086
Total	126	482	7,200	9,524,153	10,629	10,371,190
Percent	**24%**	**2%**	**12%**	**6%**	**26%**	**18%**

Table 7.2: Percentage of Airline 1's affected market, legs, traffic and RPMs upon low-fare entry

While the total number of legs and local markets affected represents about 25% of Airline 1's local network, the total number of markets affected is only 2% of the 482 markets served by Airline 1's connecting network. Similarly, the number of passengers and RPMs affected at the market level are also smaller than at the leg level, as shown in Table 7.2.

7.1.3. Simulated Scenarios

As previously mentioned, we focus our simulations on the case of two-tier entry, matched by the incumbent carriers. We also refer to this scenario as "two-tier entry in a large network" or "Scenario 3_{FM} in a large network". In order to assess the impact of entry and revenue management, we also simulate the case of the two incumbent carriers competing alone in the network as our baseline scenario.

Baseline Scenario (No Low-Fare Competition)

In the baseline scenario, the two network carriers are competing against each other and offer service in all 482 markets in the network, either nonstop or with connections through each carrier's hub. The fare

* RPMs are Revenue Passenger Miles, i.e. the number of miles flown by revenue-passengers, or the sum of the distances flown by each individual (paying) passenger. RPMs are the typical measure of airline consumption.

structure in each market follows the standard fare structure, as described earlier and illustrated in Table 7.1.

To test for the effect of revenue management on Airline 1's revenues, we allow this carrier to use either leg-based fare class revenue management (referred to as FCRM, and discussed in Chapter 5, Section 5.2.1), or network-based origin-destination revenue management (referred to as Network RM). In the case of FCRM, we use a combination of Booking Curve detruncation, Pick-up forecasting, and Expected Marginal Seat Revenue algorithm (Belobaba, 1987 and 1992), as used by many airlines and extensively described in the PODS and Revenue Management literature (e.g. Gorin, 2000) and introduced in Chapter 5, Section 5.2.1. Under the application of leg-based fare class revenue management, advance purchase requirements and restrictions 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[17]. For Network RM, we use the same combination of detruncation and forecasting (now done at the origin-destination itinerary and fare level rather than at the fare class level), but replace the seat allocation algorithm by Displacement Adjusted Virtual Nesting (DAVN), as described by Lee (1998). DAVN, unlike EMSRb, differentiates between local and connecting passengers by evaluating the cost (revenue loss) of displacing a local passenger when accepting a request for a connecting seat.

Entry with a Two-Tier Fare Structure

In this second scenario, the new entrant carrier offers a simplified two-tier fare structure in the ten markets where it operates, as illustrated in Table 7.3. In addition to the simplified fare structure, the new entrant carrier also decreases the lowest available fare (now in M class) by $10 relative to the lowest pre-entry available fare (then in Q class).

Fare Class	Fare	Restrictions	Advance Purchase
Y	$200	No	No
M	$90	Sat, NR	14

Table 7.3: Sample fares and fare classes under the two-tier fare structure

The incumbent carriers fully match the simplified fare structure in these ten markets, but maintain their standard fare structure in all other markets.

[17] This is true in the case of high demand flights. On flights with low demand, the revenue management system actually opens up low-fare availability to allow passengers to book in all fare classes.

To test the effect of revenue management, we allow for the incumbent carriers to use alternative revenue management algorithms, while the new entrant carrier uses leg-based fare class revenue management (FCRM). The incumbent carriers use either leg-based fare class revenue management (FCRM) or network-based origin-destination revenue management (Network RM), as described above. Table 7.4 summarizes the competitive revenue management cases tested in our simulations of a large network environment.

Airline	No Entrant	Two-Tier Entry
Airline 1	FCRM or Network RM	FCRM or Network RM
Airline 2	FCRM or Network RM*	FCRM or Network RM*
Airline 3	Not applicable	FCRM

Table 7.4: Summary of cases tested

7.2. Results

In this section, we discuss the effect of entry, fare match and revenue management in the case of two-tier entry in a large network and compare our findings to conclusions from previous chapters. In a first sub-section, we briefly remind the reader of the revenue benefits of Network RM in a competitive airline network without low-fare competition. We briefly explain the reasons for the revenue gains. In the second section, we study how entry, network flows and revenue management combined affect individual carrier performance in this large network environment. We focus on the effect of entry, network flows and revenue management on traditional measures of performance, and how results differ from the single market case, as presented in Chapters 5 and 6.

7.2.1. Effect of Network RM and Network Passenger Flows without Low-Fare New Entrant Competition

The effects of Network RM in a competitive airline network are well documented. It has been shown (Lee, 1998) that the benefits of Network RM can be attributed to a better management of local and connecting passengers relative to FCRM: When the airlines use FCRM, they do not differentiate between local and connecting passengers in their acceptance of booking requests, which can lead the displacement of one or more local passengers by a connecting passenger, or the displacement of a connecting passenger

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* Network RM used by Airline 2 only when Airline 1 also uses Network RM

by a local passenger. This effect can be relatively minor when flights are not heavily demanded, but becomes much more critical on high demand flights.

For example, when two flights have high local demand, it is often a better policy to reject connecting passengers to later accept two local passengers whose combined revenue contribution is higher than that of the connecting passenger. Conversely, if one of the two flights has low demand, it might be a better idea to accept a connecting passenger over a local passenger (even on the high demand flight), if the contribution of the connecting passenger is higher than that of the local passenger on the high demand flight (since the connecting passenger will not be displacing a local passenger on the low demand flight).

Our results also show that all carriers using Network RM benefit from it: When all competitors use Network RM, they all benefit from it (relative to FCRM), rather than staying at the same revenue level. In other words, Network RM increases the "industry's" revenues as a whole, rather than simply redistributing revenues amongst competitors. Figure 7.4 shows the breakdown of revenues for both competitors without new entrant competition and the gains (or losses) from Airline 1 using Network RM alone, or both airlines using Network RM. In particular, Figure 7.4 shows that Airline 1 benefits from using Network RM whether it is the only airline using Network RM or if both competitors do. When both competitors use Network RM, the relative gains over FCRM are 0.8% for Airline 1 and 1.55% when only it uses Network RM. Concurrently, when Airline 1 alone uses Network RM, Airline 2 loses 0.8% in revenues (relative to FCRM on both competitors), but gains 0.7% when both carriers use Network RM (again relative to FCRM on both carriers).

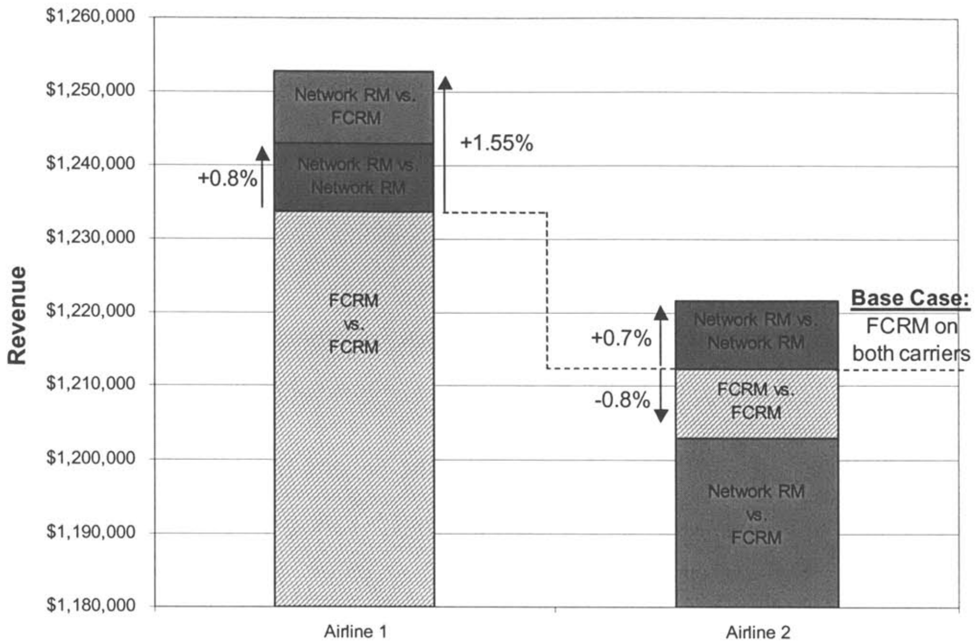

Figure 7.4: Airline 1 and Airline 2 revenues as a function of the competitive revenue management situation (w/o entrant competition)

The reader is referred to Lee (1998) for more detail on the effect of Network RM on both incumbent carriers' revenues, local and connecting traffic and load factors. In essence, Network RM, in this simulated network environment, increases revenues and changes the mix of local and connecting passengers to maximize individual carriers' revenues.

7.2.2. Effect of Network RM and Network Passenger Flows with Low-Fare New Entrant Competition

We previously established that the following factors strongly impact the incumbent carriers' performance measures: Relative new entrant capacity, competitive revenue management situation and pricing decisions by all carriers. We showed that traditional measures of airline performance do not provide sufficient information to conclude to unfair competition following entry in the single market case. In this section, our goal is to provide additional insights on the effect of entry in a larger network. We focus on a single case of entry – the most likely (and most frequently observed) strategy according to which the new entrant carrier enters the market with a simplified and reduced fare structure, while the incumbent carriers fully match the entrant's fare structure (only in the markets with entry). We also assume that the entrant chooses to enter markets with high demand. This study shows that revenue management and new entrant capacity still play a significant role in the apparent response of the incumbent carriers, as measured by traditional measures of entry (average fares, market share, etc.). In addition, this study also shows that network passenger flows significantly complicate the picture and lead to additional effects.

In this discussion, we first look at network level effects of entry, which give a broad picture of the effect of entry, capacity and revenue management on incumbent and new entrant performance. We then focus on more detailed market-level measures, which highlight the added complexities in a network environment. This discussion will center on the effects on Airline 1 and Airline 3, as Airline 2 is not directly impacted by entry, and the effects are therefore much smaller on that carrier, as shown for example in Figure 7.5.

Network-Level Effect of Entry

The first major impact of entry (and fare match) is a decrease in total revenues for both incumbent carriers. As summarized in Table 7.2, 2% of Airline 1's markets and 26% of its leg-level passengers are impacted by the new entrant carrier (Airline 3). Entry leads to a decrease in Airline 1's revenues, by 5% to 6% depending on the new entrant's capacity. In addition, Airline 2's revenues also decrease following entry, but only by 0.5% to 0.6%, increasingly so with increasing new entrant capacity. Figure 7.5 and Figure 7.6 illustrate the impact of entry, fare match, new entrant capacity and competitive revenue management settings on incumbent carrier revenues.

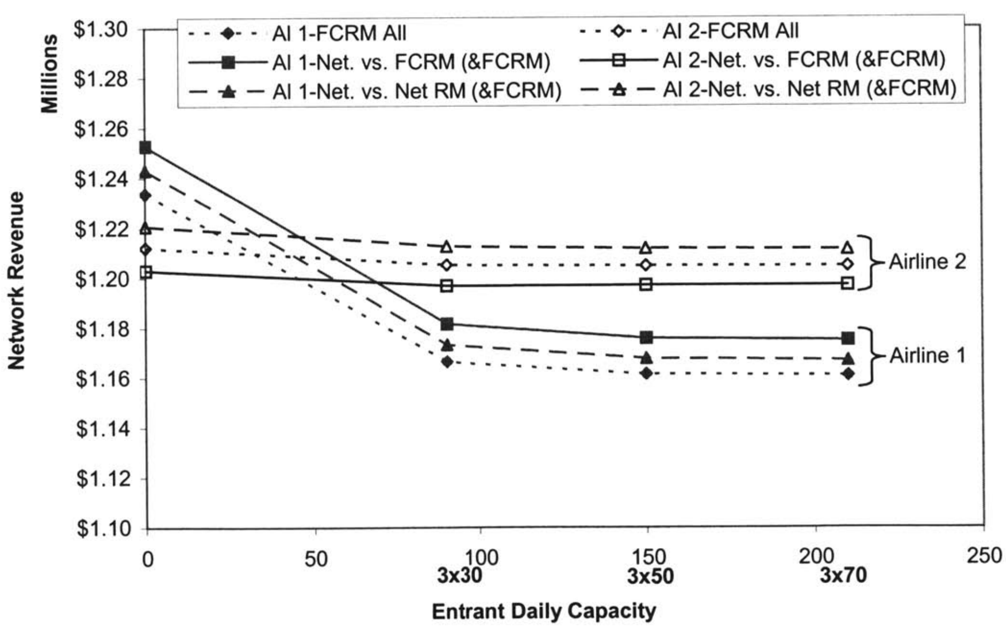

Figure 7.5: Incumbent carrier revenues as a function of new entrant capacity and competitive revenue management situation

Figure 7.5 shows that the combination of fare match and entry has a greater impact on Airline 1's revenues than increasing new entrant capacity (given that the entrant is already competing and that the incumbents have matched its fares). This result reflects the combined effects of entry and the lower fare structure on the incumbent network carriers as they match the entrant's two-tier fare structure in the ten "low-fare" markets. As new entrant capacity increases, revenues decrease on both carriers, but more slowly than upon entry (and fare match). In addition, Figure 7.5 also shows that revenue management leads to revenue gains on both incumbent carriers, as previously described without new entrant competition. Airline 1's revenues are highest when it is the only carrier using Network RM, somewhat lower when both incumbents use Network RM, and even lower when both carriers use FCRM. Conversely, Airline 2's revenues are at their lowest when Airline 1 is the only carrier to use Network RM. When both carriers use FCRM, Airline 2's revenues are somewhat higher, due to the lack of competition for connecting passengers from Airline 1. Finally, when both carriers use Network RM, Airline 2's revenues increase because Airline 2 now balances its loads of local and connecting traffic to maximize its revenues. These results already highlight the impact of revenue management by itself on incumbent carrier revenues and further illustrates that this effect is independent of new entrant competition.

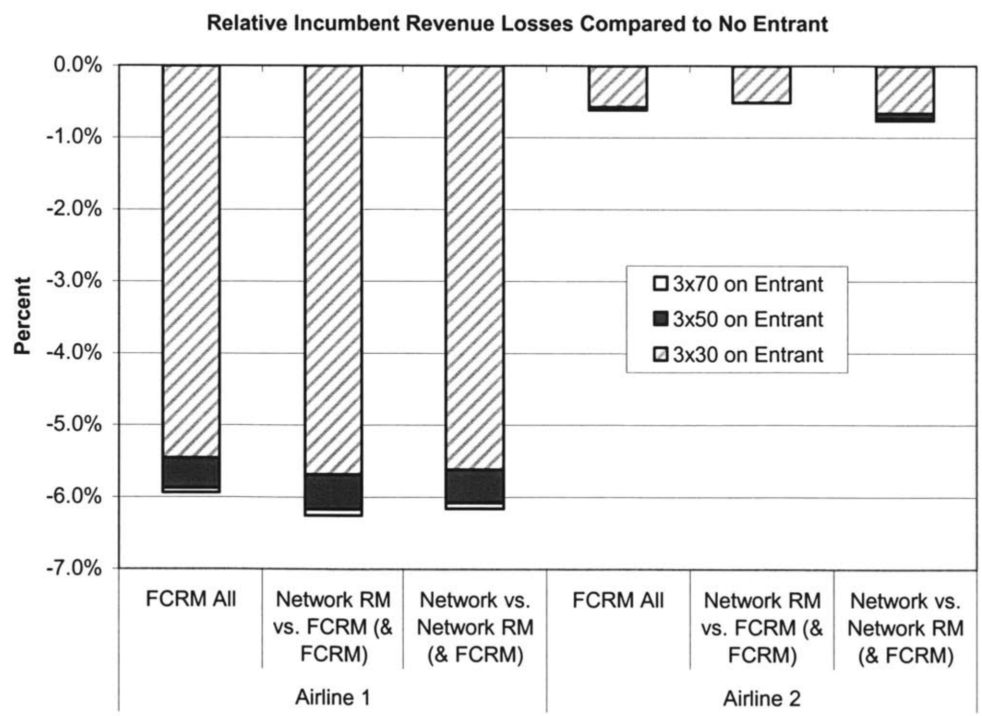

Figure 7.6: Incumbent revenue losses as a function of the competitive revenue management situation and new entrant capacity, relative to the same revenue management methods on the incumbents, without low-fare competition

Figure 7.6 shows that the relative losses on both incumbent carriers increase with new entrant capacity, regardless of the competitive revenue management situation, given the competitive revenue management situation. For example, compared to Airline 1 using Network RM and Airline 2 using FCRM without low-fare competition, when competing against the new entrant under the same revenue management conditions on the incumbents and FCRM on the new entrant, Figure 7.6 shows that the relative revenue losses range between 5.7% and 6.2% on Airline 1 and are about 0.5% on Airline 2. In addition, the magnitude of the revenue loss is the same in all scenarios, but varies greatly from Airline 1 to Airline 2, as we already explained that Airline 2 is far less affected by entry. Figure 7.7 shows the revenue gains attributable to Network RM on Airline 1, and illustrates that in all cases of entry (or even without low-fare competition), Airline 1 gains from Network RM, irrespective of whether it is the only carrier to use Network RM. It also shows that the incumbent's relative revenue gains due to Network RM tend to decrease as new entrant capacity increases. This is a consequence of the decrease in load factors on Airline 1 following entry (c.f. Table 7.5): This decrease in average load factors diminishes the ability of Airline 1 to benefit from revenue management in general, hence the decrease in relative revenue gains from Network RM on Airline 1.

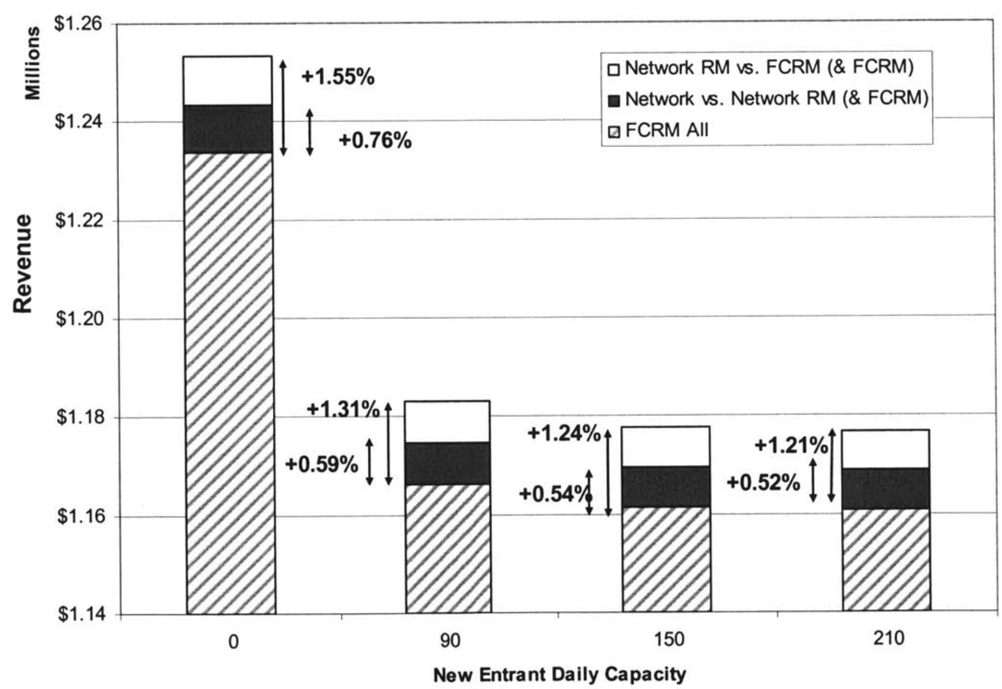

Figure 7.7: Airline 1 revenues and relative gains from Network RM as a function of new entrant capacity (per local market)

While these results confirm that Network RM leads to an increase in incumbent revenues, they also highlight the robustness of the revenue gains attributable to Network RM under the assumption of low-fare competition: Low-fare competition does not affect the potential for revenue gains from revenue management. The performance of incumbent carriers under low-fare competition had not previously been assessed in other research work, and this simulation shows that it is beneficial for the incumbent carriers to continue to use Network RM under the assumption of low-fare competition in a subset of their markets.

On the new entrant carrier, network revenue numbers show that increasing new entrant capacity leads to increasing revenues (Figure 7.8). A more interesting result is that new entrant revenues can increase when Airline 1 switches to Network RM, while the new entrant continues to use FCRM. This result occurs in the case of high new entrant capacity (50 or 70 seats per flight). We will explain this effect in more detail, but it is a consequence of Airline 1's ability to differentiate between local and connecting passengers and the decreasing revenue contribution of local market passengers with increasing new entrant capacity. As a result, the incumbent carrier focuses more on connecting passengers, which ultimately benefits the new entrant by spilling local traffic which is then carried by Airline 3.

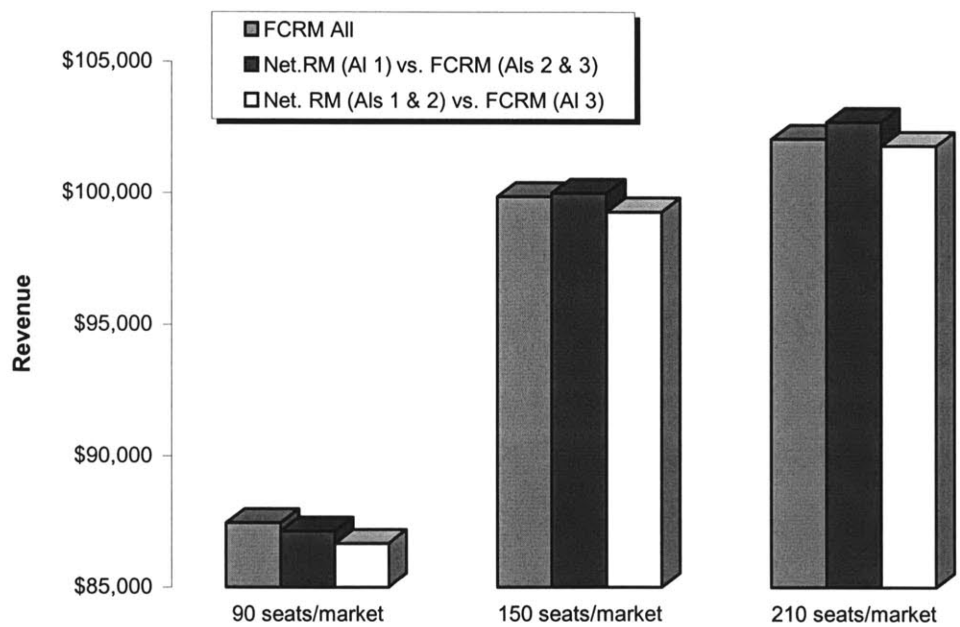

Figure 7.8: New entrant revenues as a function of its capacity and the competitive revenue management situation

Table 7.5 summarizes network-level measures of airline performance for the simulations discussed above. Even at the network level, our results show that new entrant capacity plays a very important role on incumbent carrier performance, as does the competitive revenue management situation. Network flows also have a significant impact on the results, as we have observed that the new entrant carrier can benefit from Airline 1 using Network RM, relative to Airline 1 using FCRM. This result differs from previous results showing that the new entrant's revenues increased only when it matched the incumbent carriers' more advanced revenue management method (Scenario $3c_{FM}$ in Chapter 6).

The effects of revenue management, network flows, new entrant capacity and response of the incumbent carriers, although apparent at the total network level (as highlighted in this section), become even more evident when focusing on market-level measures of airline performance (such as average fares, revenues and traffic).

		Revenues			ALFs		
	NE Cap	FCRM All	Net vs. FCRM & FCRM	Net. vs. Net. & FCRM	FCRM All	Net vs. FCRM & FCRM	Net. vs. Net. & FCRM
Airline 1: Incumbent	**0**	$1,233,694	$1,252,809	$1,243,013	84.54	84.90	83.93
	3x30	$1,166,354	$1,181,603	$1,173,192	84.33	84.81	83.90
	3x50	$1,161,462	$1,175,822	$1,167,756	84.36	84.70	83.88
	3x70	$1,160,733	$1,174,835	$1,166,774	84.36	84.69	83.87
Airline 3: New Entrant	**3x30**	$87,458	$87,140	$86,670	75.00	75.33	75.01
	3x50	$99,851	$99,983	$99,277	54.32	55.20	54.74
	3x70	$102,057	$102,697	$101,788	39.76	40.71	40.28
		RASM			**Market Share (RPM)**		
Airline 1: Incumbent	**0**	$0.101	$0.102	$0.101	49.2%	49.4%	49.1%
	3x30	$0.095	$0.096	$0.096	48.2%	48.4%	48.2%
	3x50	$0.095	$0.096	$0.095	48.1%	48.2%	48.0%
	3x70	$0.095	$0.096	$0.095	48.1%	48.2%	48.0%
Airline 3: New Entrant	**3x30**	$0.144	$0.143	$0.142	2.1%	2.1%	2.1%
	3x50	$0.098	$0.099	$0.098	2.6%	2.6%	2.6%
	3x70	$0.072	$0.072	$0.072	2.6%	2.7%	2.7%

Table 7.5: Revenues, average load factors, revenues per available seat mile (RASM) and market share by airline pre- and post-entry

Market-Level Impacts of Entry

We now explore market-level results to explain the impact of network flows on aggregate measures of airline performance and how their behavior in response to entry and fare match differs from our results in the single market case. In addition, we explain the impact of Network RM on the new entrant's revenues, and more specifically the reason for the observed revenue gains on the new entrant when Airline 1 moves to Network RM.

This section is divided into three subsections. In the first subsection, we focus on the impact of entry on the incumbent carriers and describe the effect of entry on market-level measures of performance. We examine how flows of network (connecting) passengers affect these measures and add to the effect of revenue management and new entrant capacity. In the second subsection, we focus on the effect of network flows and revenue management on the new entrant carrier, and explain why the new entrant can gain revenues as a consequence of Airline 1's move to more advanced Network RM. Finally, we briefly compare the performance of the incumbent relative to that of the entrant, as affected by the network environment and competitive revenue management situation.

Incumbent Carrier (Airline 1)

As previously discussed, the incumbent carrier is affected by the new entrant's capacity and the competitive revenue management situation in the market. The choice of revenue management system on the incumbent carrier then modifies the flow of connecting passengers to maximize network revenues on the incumbent carrier, which in turn affects local market performance (on Airline 1 and all other carriers).

As observed in Chapters 5 and 6 in the single market case, incumbent average fares decrease with increasing new entrant capacity in all ten markets with entry. This decrease in average fare following entry occurs regardless of the revenue management situation. In addition, as previously mentioned, the initial effect of entry and match on incumbent average market fares is far greater than the effect of increasing new entrant capacity (because of the change in fare structure on the incumbents, in addition to the effect of entry). For example, on average in the ten markets affected by entry, the average incumbent market fare decreases by 25% to 32% (depending on the revenue management situation) following entry with 30 seats per flight on the new entrant carrier and match of the fare structure. By comparison, when the new entrant's capacity increases from 30 to 70 seats per flight, the incumbent's average market fare decreases by 1% to 2.5% depending on the competitive revenue management situation. Figure 7.9 shows the impact of entry and increasing new entrant capacity on incumbent average local market fare.

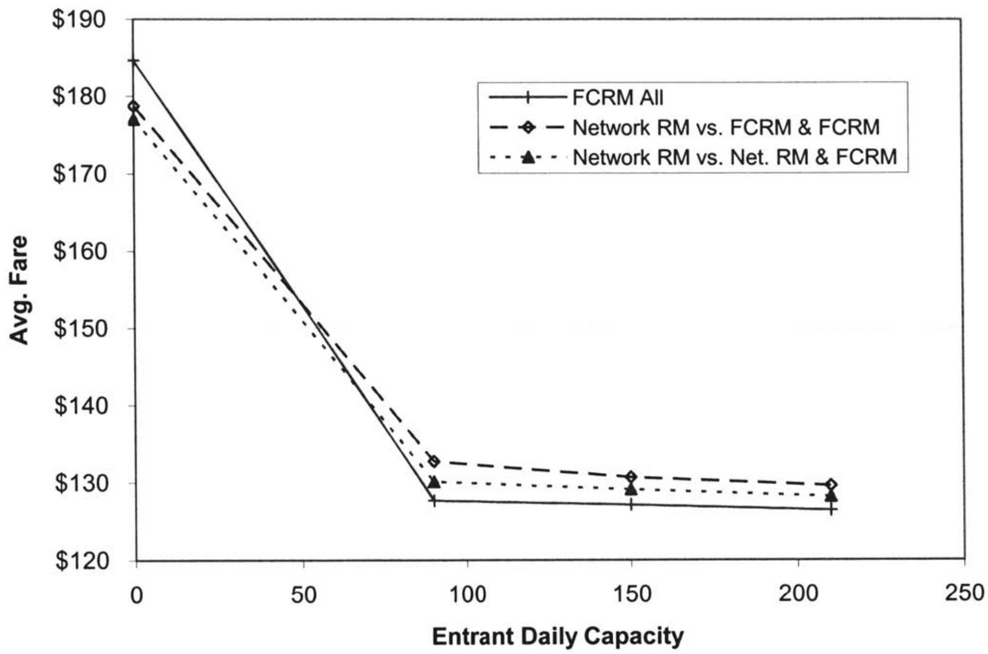

Figure 7.9: Incumbent average local market fare (averaged over 10 markets with entry)

Another less intuitive result is that the effect of revenue management is now quite different from what we observed in the single market case. Indeed, as shown in Figure 7.9, without new entrant competition, when Airline 1 uses Network RM, its average fare in the ten markets with entry decreases relative to FCRM on all carriers, and further decreases when both incumbent carriers use Network RM. By comparison, in the single market case, when either of the incumbent carriers used FCRM (rather than FCFS), the average market fare increased on the incumbent carrier. This relationship between average fares in various cases of revenue management remained unchanged as new entrant capacity increased. In this case, Figure 7.9 shows that the ranking of average local market fare on Airline 1 changes as a function of revenue management and pre- and post-entry. Post-entry and fare match, Airline 1's average local market fare under FCRM on all carriers is the lowest of the three competitive revenues management scenarios, when it was the highest pre-entry. Concurrently, the average fare under Network RM on Airline 1 alone becomes the highest fare. This change in average local market fare rankings is a direct consequence of the flows of network passengers: Pre-entry, since the ten local markets of interest are among the most heavily demanded markets in the network, FCRM will generally allocate a high amount of seats to higher fare class passengers, regardless of whether they are on connecting or local itinerary, and thus potentially sell a relatively higher number of full fare local seats, thus increasing the average market fare. In addition, as shown in Figure 7.10.1, under FCRM, Airline 1 sells relatively fewer low-fare local seats than connecting low-fare seats (in Q class), thereby getting lower revenues by displacing pairs of local passengers whose total revenue contributions might have exceeded the connecting fare. By comparison, when the incumbent network carrier (Airline 1) uses Network RM, it manages its inventory of local and connecting seats in a better way (revenue-wise) relative to FCRM, which translates into an increase in local passenger traffic in all fare classes, as shown in Figure 7.10.1. The underlying explanation is that two local passengers (including low-fare passengers) bring a higher revenue contribution than a single connecting passenger in the same fare class. As a result, more local passengers are able to travel and local market revenues increase with Network RM on the incumbent carrier. The incumbent's average market fares decrease, as the incremental revenues come disproportionately from low-fare local passengers. When both incumbent network carriers switch to Network RM, this effect is further accentuated (because Airline 2 becomes more competitive in managing its mix of local and connecting traffic, and competes with Airline 1 for high fare connecting traffic), and Airline 1's average market fare decreases even more.

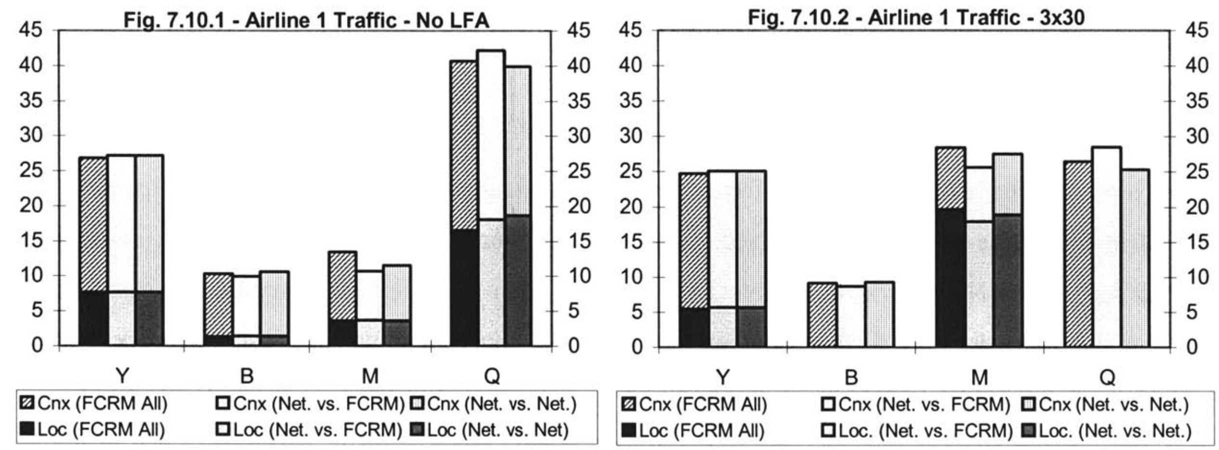

Figure 7.10: Airline 1 traffic by fare class (pre-entry and post-entry as a function of competitive revenue management settings)

Post-entry and fare match, with Network RM, Airline 1 still manages its mix of local and connecting passengers differently than with FCRM by accounting for the potential revenue loss associated with displacing local passengers. In this case, Network RM allows Airline 1 to realize that the contribution of local passengers has severely decreased (because of the switch to a two-tier structure in these ten markets, the decrease of the lowest available market fares and the increase in competition for local traffic), and to therefore focus more on connecting passengers. The overall impact of the changes in passenger traffic shown in Figure 7.10.2 is an increase in local market average fare when Airline 1 uses Network RM alone by up to 4% (relative to FCRM) and an increase by up to 2% when both incumbent carriers use Network RM (relative to FCRM). In this last case, the average local market fare on Airline 1 is lower than when it was the only carrier using Network RM, because of increased competition between incumbents for connecting traffic. These results therefore highlight the effect of network flows (and revenue management) on the incumbent carrier's average fares, revenues and mix passenger traffic in the ten markets with low-fare competition.

Figure 7.11 shows local market revenues and average fares on Airline 1 in the ten local markets with low-fare competition and highlights the change in Airline 1's revenues and average fares with entry and revenue management.

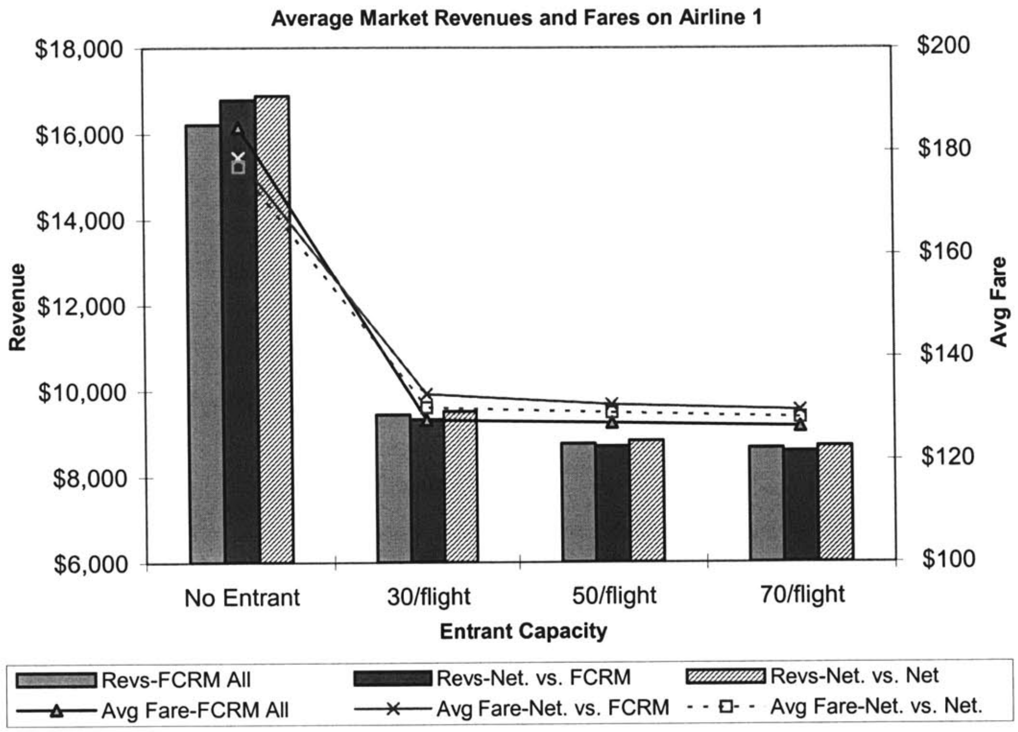

Figure 7.11: Airline 1 revenues and average fares in 10 markets with entry

Figure 7.11 also shows that Airline 1's local revenues increase when both incumbent carriers use Network RM, relative to the case where only Airline 1 was using Network RM. The reason is that when Airline 2 becomes more conscious of the difference between local and connecting passengers (with Network RM), it also improves on its mix of local and connecting passengers, and thus forces Airline 1 to revise its own optimization of local and connecting passenger mix. As a result, Airline 1's local revenues increase while its average fare decreases (relative to the case where Airline 1 is the only carrier to use Network RM), since it has now become important to carry more local passengers because of the increased competition for connecting traffic. The increase in revenues however comes from lower fare local passengers, which causes the decrease in local average market fare on Airline 1 (c.f. Figure 7.11). Figure 7.12 shows the average traffic per leg on Airline 1 on the legs affected by entry, as well as the mix of local and connecting passengers in each of these cases. It illustrates the decrease in local market traffic under low-fare competition, when the incumbent carriers move to Network RM. Figure 7.12 also shows that compared to no entrant competition, the effect of Network RM is quite different. Indeed, without low-fare competition, Network RM on the incumbent carrier leads to an increase in the percentage of local market traffic carried, as the revenue contribution of local passengers is greater and the incumbent carrier thus benefits from carrying more of them. With low-fare competition, this proportion tends to decrease. By comparison, low-fare competition leads to a decrease in the contribution of local passengers, which Network RM recognizes, thus leading to the increase in connecting traffic. When both carriers use Network RM, increased network competition leads to an increase in the competition for connecting traffic between airlines 1 and 2, which forces the incumbent (Airline 1) to rely even more on local traffic. Without low-fare competition, this translates into an even greater increase in the proportion of local traffic. In addition, as shown in Figure 7.12, when both carriers use Network RM, Airline 1's load factors increase, as Airline 1 now allows more passengers to travel in order to increase its revenues, since it cannot increase its per passenger revenue contribution (average fare) given the increased competition for both local and connecting traffic.

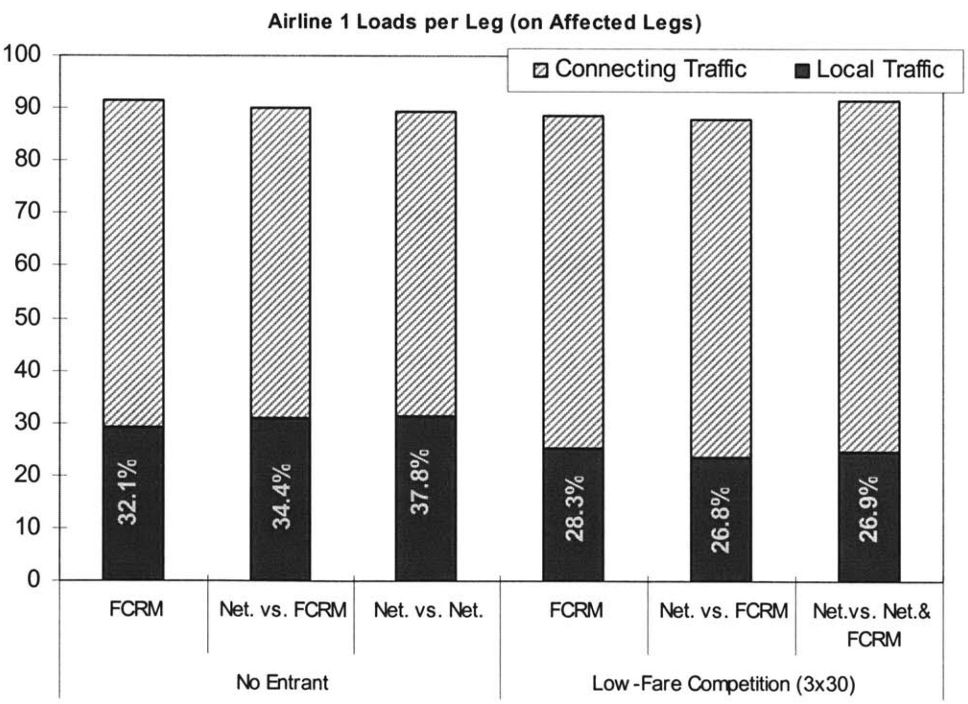

Figure 7.12: Average loads and mix on airline 1's legs affected by low-fare entry

Finally, Figure 7.13 illustrates the effect of entry on incumbent and new entrant market shares, computed over the ten local markets with low-fare entry. It shows the substantial decrease in market share following entry, regardless of the competitive revenue management situation, and the additional impact of increasing new entrant capacity on Airline 1's market share. In addition, as shown on Figure 7.13, and as explained earlier, Airline 1's market share also depends on the competitive revenue management situation as follows: When all carriers use FCRM, the inability of the incumbents to distinguish between local and connecting passengers leads to higher market share in the ten markets with low-fare competition. When Airline 1 uses Network RM, it spills lower fare local traffic and thus loses market shares relative to FCRM on all carriers. Finally when both incumbents use Network RM, Airline 1 carries slightly more local traffic to compensate for the increase in competition for connecting traffic.

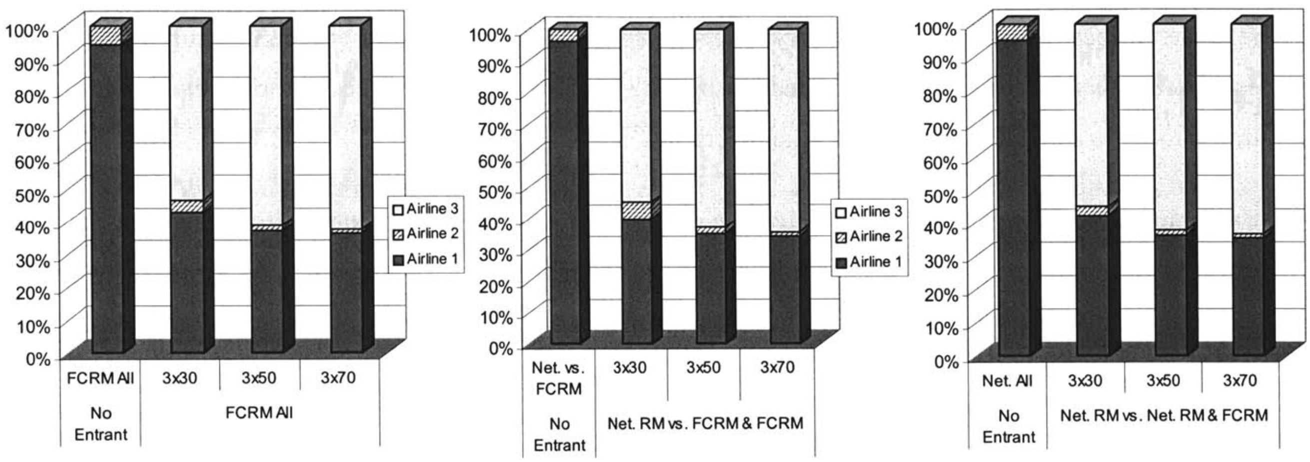

Figure 7.13: Incumbent and new entrant market share in the ten markets with low-fare entry, pre- and post-entry, as a function of the competitive revenue management situation

These simulation results thus establish the importance of the flows of network traffic and their effect on local market revenues, market shares and average fares on the incumbent network carriers. Flows of network passengers are tightly linked to revenue management in that they enable network revenue management systems to increase network revenues by tweaking local and connecting traffic at the network level.

New Entrant Carrier (Airline 3)

We already observed the effects of new entrant capacity on total entrant revenues and noted that new entrant revenues can increase (c.f. Figure 7.8 and Figure 7.14) when only Airline 1 uses Network RM, at high new entrant capacity, relative to FCRM on Airline 1. In this section, we explain why this is the case, and thus highlight the joint impact of revenue management and flows of network traffic on the new entrant carrier, while incumbent average local market fares increase (relative to FCRM), as discussed in the previous section.

The changing mix of local and connecting passengers on the incumbent carrier explains the potential revenue gains on the new entrant carrier. At low entrant capacity, the new entrant carrier fills up relatively quickly. As a result, the incumbent carrier is able to extract relatively higher fares from a portion of the local passengers (late-booking, high willingness-to-pay passengers). When only it uses Network RM, the incumbent carrier focuses on these higher fare passengers, forcing lower fare passengers on the new entrant carrier. Since the entrant carrier's capacity is limited, its revenue per passenger (and thus average fare) decreases when Airline 1 uses Network RM, which consequently leads to a decrease in local revenues (on Airline 3). When both incumbents switch to Network RM, Airline 1 must now increase its reliance on local traffic (because of Airline 2's better management of local and connecting traffic takes away some of Airline 1's former connecting traffic). As a result, the new entrant loses even more local traffic to Airline 1 and its revenues further decrease.

By comparison, at higher entrant capacity, the entrant is able to accept all requests for seats. This has the effect of diluting some of the former full fare traffic towards the lower fare class. As a result, when the incumbent carrier switches to Network RM, local traffic becomes very unattractive, relative to connecting traffic. Local passengers are therefore spilled to the new entrant carrier, into its lower fare class. These passengers do not displace high fare passengers (given the entrant's high capacity) and only lead to an increase in the new entrant's revenues (but a decrease in its average market fare). However, when both incumbent carriers use Network RM, it again becomes more important for Airline 1 to carry more local traffic (even low-fare local traffic) to compensate for the loss in connecting traffic incurred by Airline 2's use of Network RM. This directly impacts Airline 3's revenues, hence the loss in revenues (relative to FCRM on all carriers).

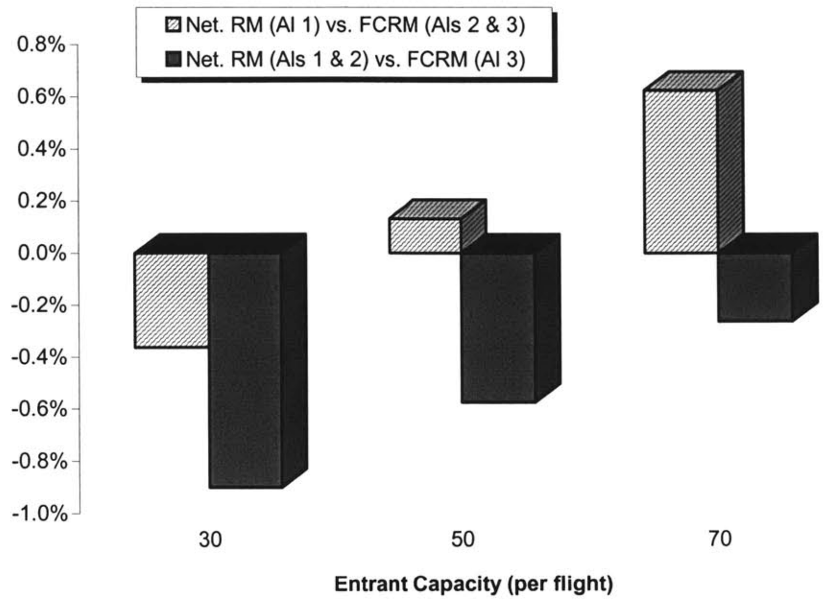

Figure 7.14: New entrant relative revenue variation as a function of its capacity and the competitive revenue management situation (compared to FCRM on all carriers, with 30, 50 or 70 seats per flight on the new entrant carrier)

We have therefore shown that flows of network passengers, when managed by the nonstop incumbent carrier using advanced network revenue management, can lead to an increase in new entrant revenues: Airline 1 becomes more selective in the passengers it chooses to carry, and therefore rejects some of the local traffic whose revenues have become too diluted (by the entrant's presence), thus allowing the new entrant carrier to increase its traffic and consequently its revenues. This somewhat unexpected result further highlights the importance of network flows and revenue management in understanding the effects of entry on aggregate measures of airline performance.

Figure 7.15 summarizes the new entrant's average fare in each of the ten markets with entry, as a function of new entrant capacity and competitive revenue management settings. It shows in particular that at high new entrant capacity, its average market fare tends to decrease when Airline 1 uses Network RM. Combined with the revenue increase, this reinforces the observation that the new entrant carries more traffic, albeit at lower fares. When both incumbents use Network RM, the new entrant's average fare increases (compared to the case where Airline 1 is the only carrier using Network RM), which illustrates the loss in lower fare traffic on the new entrant carrier when the incumbent carriers become more competitive for connecting traffic, and are therefore forced to also focus more on local market traffic.

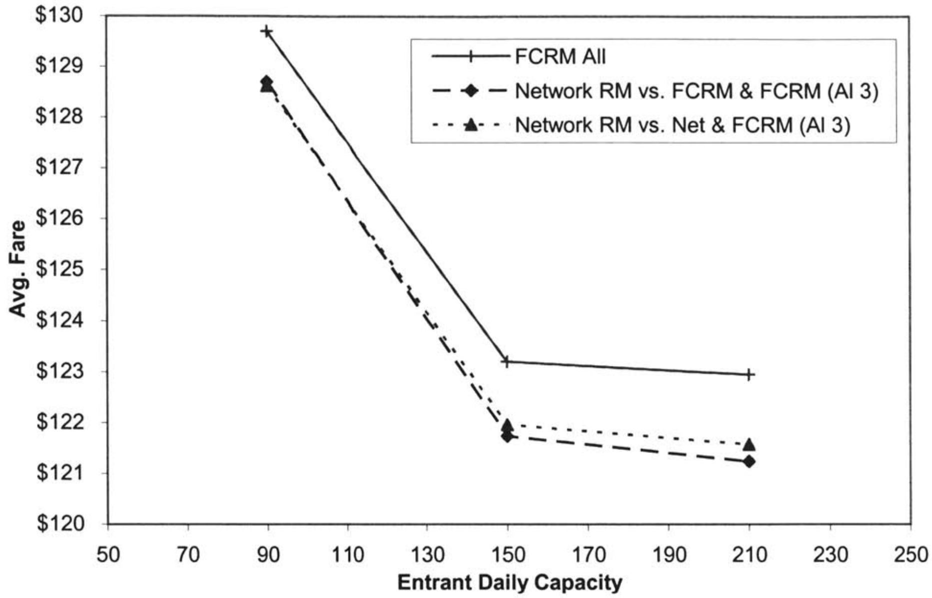

Figure 7.15: New entrant average fare as a function of its capacity and the competitive revenue management situation

Comparison of Measures of Airline Performance

We now compare Airline 1 and Airline 3's average fares and revenues in the ten markets with entry, given the network environment. Figure 7.16 shows the total local market revenues in the ten markets with low-fare competition, in the case where all carriers use FCRM. It shows that Airline 1's local market revenues remain higher than those of the new entrant carrier at low entrant capacity, but decrease and drop below those of the new entrant as its capacity increases. This relationship is comparable to the relationship observed in Chapter 6. The difference is the capacity level (on the new entrant) at which both carriers extract the same revenues from the local market. In the single market case, under Scenario 3_{FM} with symmetric fares and symmetric revenue management, the airline with the greater capacity achieved the higher local market revenues. Now, given the availability of network passengers in addition to local market traffic, Airline 3 gets a disproportionate share of local market revenues at a lower capacity level. This capacity value is influenced by the choice of markets with entry, the network flows and the relative revenue contribution of connecting passengers (as compared to that of local market passengers).

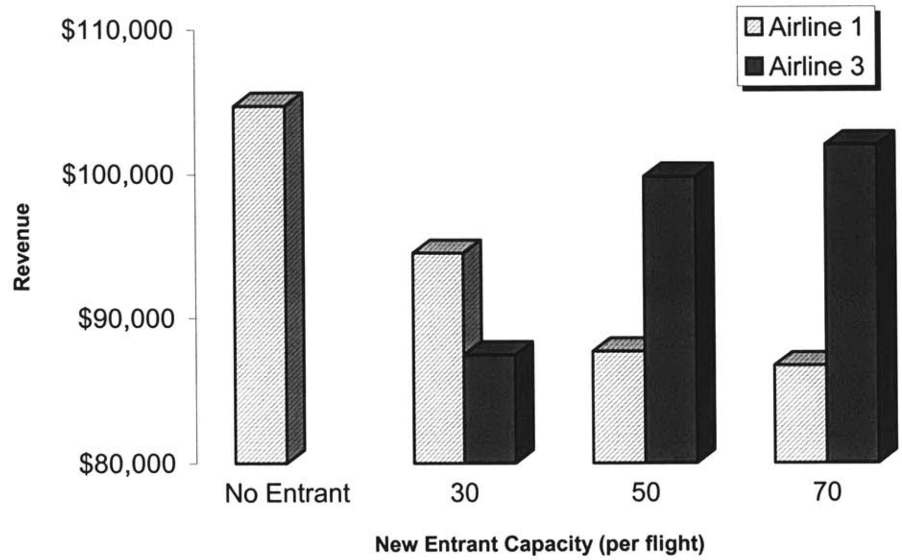

Figure 7.16: Airline 1 and 3 revenues in the ten markets with low-fare entry - FCRM on all carriers

In the other two competitive revenue management situations, this picture (Figure 7.16) is similar, thus indicating that the relative revenues between Airlines 1 and 3 are mostly influenced by new entrant capacity and less by competitive revenue management settings.

These results illustrate the importance of the flows of network passengers. Without connecting traffic, as simulated in the single market case, under symmetric revenue management and symmetric fares, 50% of capacity translates into 50% of traffic and revenues in the market. When connecting passengers also travel on local flight legs, these relationships do not hold anymore and individual carrier performance is affected, as previously discussed.

Figure 7.17 shows the average market fare on both Airline 1 and Airline 3 and illustrates the relative impact of new entrant capacity and revenue management on average fares. The first observation is that new entrant capacity has a much greater effect on the new entrant's average fare than on the incumbent's: As its capacity increases, the new entrant dilutes local market revenues and therefore experiences a decrease in its own average market fare. By comparison, the incumbent carrier also experiences a decrease in average market fare, but to a lesser extent since Airline 1 is able to trade local passengers for connecting passengers, when the local passengers' revenue contribution becomes too low (relative to that of connecting passengers).

Figure 7.17 also shows that the new entrant's average market fare can be higher than that of the incumbent carrier, but typically isn't anymore (contrary to some of the scenarios simulated in Chapter 6).

We had established in Chapter 6 that the carrier with the smaller capacity had the higher average fare. In this network context, this simple relationship no longer holds, for two reasons:

1. Given the network dimension of the airline problem, it is impossible to differentiate local capacity from connecting capacity on a particular flight leg, for the incumbent carrier. This point refers to the dichotomy of supply and demand (c.f. Chapter 3, Section 3.2).

2. Because of network flows, the revenue management system is willing to reject local passengers in return for higher fare connecting passengers, which was not an option in Chapter 6. As a direct consequence, the number of local passengers changes as a function of the connecting traffic carried on the flight legs in the ten markets, which directly affects the average market fare.

As a result, the network carrier is able to maintain a higher average local market fare by carrying local passengers paying relatively higher local fares and mixing in connecting traffic when the revenue contribution (i.e. fare) of local passengers becomes lower than that of the connecting passengers.

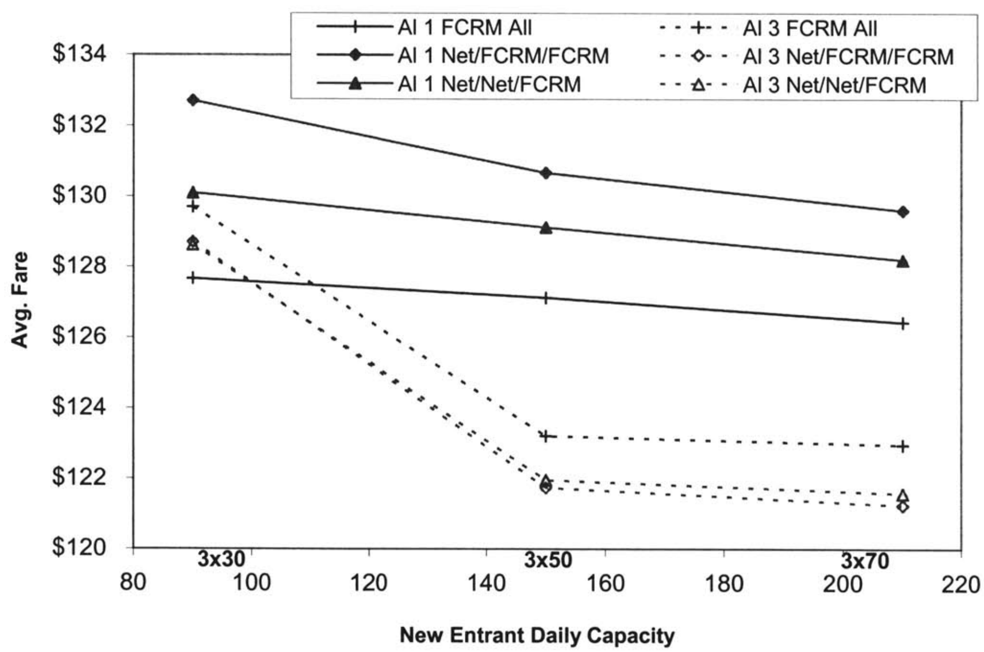

Figure 7.17: Average market fare on airlines 1 and 3 as a function of new entrant capacity

Figure 7.17 also illustrates the impact of revenue management on the relative fare of airlines 1 and 3. When all carriers are using FCRM, the new entrant's local market fare can be higher than that of the incumbent carrier, at low entrant capacity. In this case (30 seats per flight on the new entrant), the incumbent carrier does not differentiate between local and connecting passengers, and is therefore carrying more local passengers, but at relatively lower average fares. The new entrant carrier, since its capacity is limited, is able to keep a high percentage of full fare passengers. When the incumbents use Network RM, Airline 1's average fare increases, as it trades low-fare local passengers for higher fare connecting passengers. At the same time, some of these rejected low-fare local passengers travel on Airline 3, which decreases its average fare slightly and leads to the inversion of the incumbent's and the new entrant's relative average fares.

At higher entrant capacity, Network RM has the same effect on the new entrant's and the incumbent's average fare, but the incumbent's average fare remains substantially higher than that of the new entrant's. The explanation here is that the new entrant's large capacity leads to a decrease in average fare, since the additional passengers carried are mostly low-fare local passengers (who were previously unable to travel for lack of available capacity). The incumbent once again trades these undesirable (revenue-wise) passengers for connecting passengers, and thus maintains a higher average local market fare.

7.3. Conclusions

Simulation in a larger network shows that relative new entrant capacity and revenue management still play an important role in the effect of entry on incumbent (and new entrant) performance: Revenues, average fares, market share and load factors are diversely affected by entry, as a function of revenue management and entrant capacity. In addition, the general conclusions from Chapters 5 and 6 still hold, in that increasing new entrant capacity and the competitive revenue management situation have a dramatic effect on traditional aggregate measures of airline performance, which thus should not be used an indicator of incumbent response to entry.

Furthermore, the simulation shows that network flows have an additional impact on the performance of incumbent carriers in three ways:

- First, they allow the incumbent carrier to mitigate the impact of entry at the total network level by replacing local market traffic with connecting traffic.
- Second, they also have a very important impact on the change in average market fare on the incumbent carrier. Since the incumbent carrier does not need to focus as much on local traffic, its average market fare is less affected by entry than it was in the single market case. In addition, the impact of relative new entrant capacity (on average fares only) is attenuated, once again because of network flows of passengers.

- Third, although average fares are less affected by entry in a network environment, local market revenues tend to suffer more from entry than in the single market case, for the same reasons that explain the lesser effect on local market average fares. The incumbent carriers adjust their mix of local and connecting passengers to recognize the revenue dilution created by the low-fare carrier in the local markets. They therefore focus on high fare local market traffic and forego low fare traffic, which reduces local market revenues.

In terms of the relative impact of increasing new entrant capacity on relative average fares of the nonstop incumbent and the new entrant, the simulation results show that it is the new entrant's average local market fare that is most affected by its capacity, and the competitive revenue management situation, although incumbent revenues are also severely affected by increasing new entrant capacity. In other words, given that the new entrant operates in the network, its average market fare is more affected by a change in new entrant capacity than the incumbent's average market fare.

The simulation results also show that the new entrant can benefit from Network RM on Airline 1 in the case where it has relatively high capacity and Airline 1 is the only carrier using Network RM. Figure 7.18 summarizes the effect of Airline 2's revenue management system on the new entrant's revenues. The less aggressive the competition for connecting traffic, the less competitive the local market and the more revenues the new entrant gets. In particular, when Airline 2 does not use Network RM, it does not differentiate between local and connecting passengers at the flight leg level, and is therefore less aggressively competing for connecting traffic with Airline 1. As a result, if Airline 3's capacity is low, its effect on the average fare paid by local passengers is low, that is the revenue dilution in the local market is low because it is limited by the entrant's capacity. Local traffic thus remains attractive for Airline 1 which then negatively affects Airline 3's revenues. Conversely, when Airline 2 uses Network RM, it makes the distinction between local and connecting traffic, which leads to an increase in competition for connecting traffic between the two incumbent network carriers. As a result, Airline 1 is forced to carry more local traffic in those markets with high local demand, to mitigate the increased competition for connecting traffic. This directly affects Airline 3's revenues which decrease as Airline 1 takes away more local traffic.

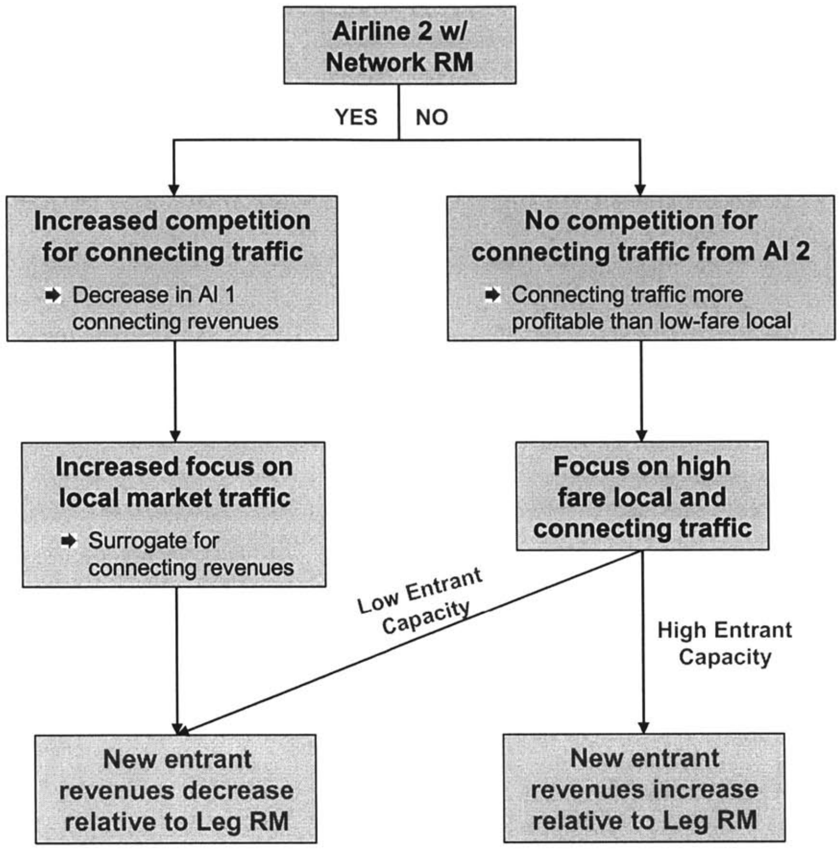

Figure 7.18: Effect of Airline 2's revenue management system on new entrant revenues, given Airline 1 uses Network RM

CHAPTER 8

CONCLUSIONS

The preceding chapters have studied the effects of low-fare new entrant competition in the airline industry by first focusing on case studies and then by simulating various cases of entry with the Passenger Origin Destination Simulator. The case studies have demonstrated that average fares, local market revenues and traffic provide little information with respect to the nature of incumbent response to low-fare entry, and whether the response is predatory. In addition, these case studies have also provided us with valuable information with respect to the factors affecting the performance of incumbent and new entrant carriers following entry. The simulations have enabled us to test the effects of entrant capacity, entrant pricing strategy and response from the incumbent carriers, revenue management, and network flows of passengers on these same measures of airline performance. The simulation results have clearly shown that these factors have a substantial individual effect and combined impact on average market measures and that they should not be overlooked or ignored when attempting to establish predatory conduct in airline markets.

This chapter concludes this dissertation by summarizing the important findings of this research and its relevance in understanding competition in the airline industry. We then discuss potential extensions and future research directions to be explored.

8.1. Research Findings and Contributions

The findings and contributions of this research can be separated into two major categories. First, this research has identified the critical factors explaining new entrant and incumbent carrier performance following low-fare entry in a market, or a subset of incumbent markets. These factors are new entrant capacity relative to incumbent capacity, pricing strategy of the new entrant carrier and response from the incumbent airline, use of revenue management by some or all competitors, and flows of network passengers. Second, this research has also illustrated the individual effects of each of these factors, as well as their combined impact on average market fares, local market revenues and local market traffic, through the use of simulation. We have shown that these aggregate measures of airline performance do not provide sufficient information regarding the performance of incumbent or new entrant carriers, or on the competitive response of incumbent carriers to infer predatory conduct. Furthermore, this research has shown that the incumbent carrier's revenue maximizing response to entry varies as a function of the competitive revenue management situation and the entrant's pricing strategy.

Previous research efforts based most of their conclusions regarding incumbent carrier performance and response to low-fare entry on average fares, revenues and traffic. Some incumbent carrier responses to entry have even raised the question of predatory pricing based on the analysis of these average market measures. Building on these findings, we observed that entry generally leads to a decrease in incumbent revenues and average fare, an increase in traffic, and that the incumbent's average fare tends to remain higher than that of the new entrant carrier in the market. Suspicion of predatory pricing has been raised in some cases where the incumbent carrier's average fare is equal to, or drops below that of the new entrant carrier, while traffic increases and revenues decrease. However, as our two case studies clearly highlight in Chapter 4, these traditional measures of airline performance paint a very incomplete picture of the actual response of incumbent carriers to low-fare entry. For example, despite the different perception of competitive behavior in the Atlanta-Orlando market (not generally regarded as anti-competitive) and in the Detroit-Boston market (often presented as potentially anti-competitive), we have shown that incumbent local market traffic, revenues and average fare responded similarly to low-fare entry. Yet, the competitive outcome of entry in these particular markets was quite different: Spirit failed to establish itself in the Detroit-Boston market (and exited the market within two quarters of entry), while AirTran succeeded in the Atlanta-Orlando market.

These case studies brought to light some of the factors explaining the effect of entry on aggregate measures of airline performance. These factors are entrant capacity (relative to the incumbent carrier) and pricing response of the incumbents to entry. In addition, affecting the outcome of competitive interactions between incumbents and new entrant carriers in these case studies are the effects of competitive revenue management and flows of network passengers. These last two factors have consistently been ignored in the analysis of competitive airline markets, and yet play a critical role in understanding the effects of entry on aggregate measures of airline performance, as we have shown in this research.

Given these factors, we simulated a single market case of entry in order to illustrate their effects on individual airline performance. We showed in Chapter 5 that, when all carriers use fare class revenue management (FCRM), increasing relative new entrant capacity generally leads to a decrease in incumbent revenues, traffic and market share following entry. The effect on average fares, however, is dependent on the combined effects of price response to entry and relative new entrant capacity. Under symmetric fares (identical fares on both the incumbent and the new entrant), the incumbent's average fare decreases with increasing new entrant capacity. When the incumbent carrier only matches the lowest available fare in the market (asymmetric fares), its average fare can actually increase as new entrant capacity increases. Equally importantly, the relative average fare between the nonstop incumbent and the new entrant carrier depends both on the competitive pricing situation (symmetric or asymmetric fares) and new entrant capacity relative to that of the incumbent carrier. Under full match cases, the carrier with the greater capacity has the lower average fare. Under limited match and under the assumption of entry with a two-tier fare structure (Scenario 3_{LM}), the new entrant's average fare remains consistently higher than that of the incumbent carrier, regardless of the new entrant's tested capacity level. These simulations underscore the importance of both new entrant capacity and pricing strategy of the incumbent and new entrant carriers (and revenue management) in explaining the effects of entry on average fares, traffic and revenues. In addition, while the incumbent carrier never actually undercuts the new entrant's fare structure, the simulation results show that there are a wide variety of possible effects of entry on average market measures.

The explanation of the effects of relative new entrant capacity and competitive incumbent response on aggregate measures of airline performance also relied heavily on the competitive revenue management situation (that is, whether one or all competitors use revenue management). Chapter 5 highlighted the effects of new entrant capacity, entrant pricing strategy, and competitive incumbent response, and further uncovered the additional impacts of revenue management on traditional aggregate measures of airline performance. In Chapter 6, we consequently simulated entry in a single market environment, but allowed the use of revenue management by all competitors to change so as to assess its effect on traditional measures of airline performance. In each of the scenarios of entry tested in Chapter 5, we observed that changing the competitive revenue management situation affected each carrier's average fare as well as the relative ranking of average fares between carriers. In particular, our simulation results show that in the case of entry with a two-tier fare structure on the new entrant carrier, fully matched by the incumbent carriers, the nonstop incumbent's average fare remains consistently higher than that of the new entrant when only the incumbents use revenue management. Conversely, when all carriers use the same revenue management method (or lack thereof), the carrier with the greater capacity has the lower average fare. In contrast, when the incumbent carriers do not match the fares on the new entrant carrier, the competitive pricing situation, combined with revenue management, leads to very different effects on the competitors' average fares. With no revenue management on the new entrant carrier, the incumbent carrier's average fare consistently increases with increasing new entrant capacity and remains higher than that of the new entrant, as it diverts more and more traffic. However, when all carriers use revenue management, the incumbent carrier's average fare then drops sharply and remains lower than that of the new entrant carrier, because of the revenue management system's ability to differentiate between low-fare and high-fare traffic on all competitors in the market. These results highlight the importance of revenue management by itself, as well as the combined effects of revenue management, pricing strategy of the incumbent and new entrant carrier, and relative new entrant capacity in explaining the effects of entry on aggregate measure of airline performance. They also emphasize the lack of information provided by these measures.

Our simulations in Chapters 5 and 6 thus showed that entry leads to a decrease in revenues and traffic on the incumbent carriers, while total market revenues and traffic tend to increase. The effect on average fares, both on individual carriers and between carriers, depends greatly on the relative capacity of the new entrant carrier, the competitive pricing situation and the use (or absence) of revenue management on some or all competitors. These results, which reflect the competitive effects of entry in any industry, further emphasize the importance of the pricing and capacity strategy of the airline (in this single market case). The simulations revealed the often ignored importance of airline revenue management – along with pricing and new entrant capacity – in explaining the performance of individual carriers, as well as the irrelevance of average fares, local market revenues and traffic in assessing the nature of an incumbent's response to entry. In addition, our results also showed that, contrary to common perception, matching the new entrant's pricing strategy does not always provide the "best" (i.e. revenue-maximizing) response to entry by the incumbent carriers. Careful consideration of the competitive environment (use of revenue management by some or all competitors, new entrant capacity and pricing strategy) should be the determinant of incumbent response to entry.

While Chapters 5 and 6 provided interesting insights into the factors affecting the performance of airline competitors in a single market environment, these simulations intentionally left out the effects of network passenger traffic, which is an essential component of a network carrier's passenger and revenue stream. In Chapter 7, we extended our simulations to a larger network environment where we modeled a low-fare new entrant carrier operating in a subset of markets of one of the incumbent network carriers, and offering a simplified two-tier fare structure fully matched by the incumbent carriers. Our results show that network flows of passengers have a significant impact on individual carrier performance, an impact which adds on to the previously described effects of relative new entrant capacity, competitive pricing and revenue management. As a consequence of these flows of passengers, the incumbent carrier is able to focus less on local market traffic upon low-fare entry, which leads to a decrease in the effect of entry on average local market fare (in the markets with entry). Conversely, the effect on revenues and traffic is even more pronounced than in the single market case. Our results also highlight the importance of revenue management in such a network environment, including the finding that advanced network revenue management can potentially benefit the new entrant carrier by focusing the incumbent carriers on connecting traffic rather than on lower fare local traffic. These results therefore reinforce that relative new entrant capacity, and competitive pricing and revenue management affect measures of average fare, revenue and traffic, but also highlight the dampening effect of flows of network passengers with respect to the decrease in the incumbent carrier's average fare after entry (as compared to the single market case).

Additional findings from these network simulations include the robustness of revenue management gains in a low-fare world – relative revenue gains from network revenue management, as shown in Chapter 7, are relatively unaffected by low-fare entry. This effect had not been previously tested for, and provides important insights for traditional network carriers operating in a low-fare environment.

Finally, this research has provided considerable insights into the competitive behavior of airline markets faced with low-fare competition. These findings should provide a basis for policy-makers and airline executives when evaluating the response of incumbent carriers to low-fare entry. In particular, the focus of competitive analyses should both be on pricing responses to entry as well as on the impacts of revenue management and network flows of traffic. These insights should be used when applying a rule of reason, as advocated by Joskow and Kelovorick (1979), Dodgson et al. (1991), or Spector (2001).

8.2. Application 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, we discuss three typical observations leading to suspicion of predatory conduct and show, based on our results, how these findings may be ambiguous and 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.

In the following sections, we discuss each of these effects of entry on average market measures 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.

8.2.1. Lower Incumbent Carrier Average Fare Relative to Entrant Average Fare

Our simulation results show that a lower average fare on the incumbent carrier should not be used as an indication of predatory pricing. For example, as shown in Figure 8.1, the incumbent carrier's average market fare is consistently lower than that of the new entrant carrier, despite the limited response strategy of the incumbent carrier. The explanation for this result is that under the assumption of entry with a two-tier fare structure, as is the case in this example, the fact that the entrant carrier is offering a differentiated fare structure, but at lower fares than the incumbent, and using revenue management, leads to diversion of the incumbent's high fare business traffic, and affects its average fare.

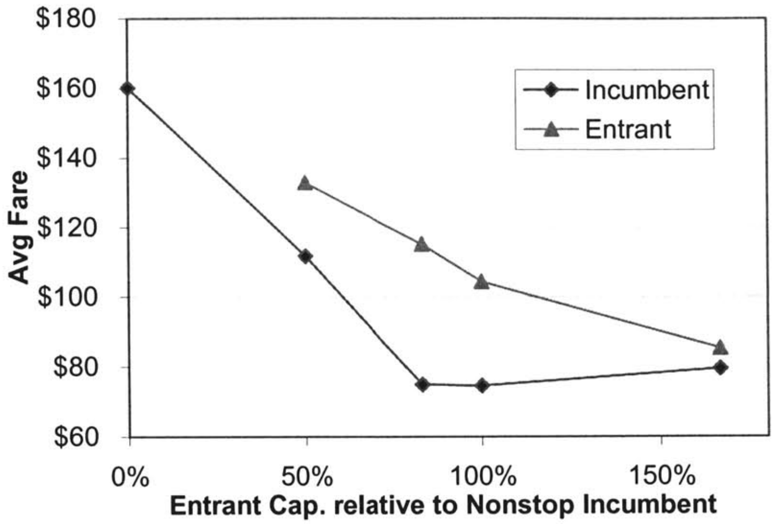

Figure 8.1: Average market fares on the incumbent and new entrant carrier, under Scenario 2_{LM} with FCRM on all carriers

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

Our 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 8.2, 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, Figure 8.2 shows that the incumbent carrier's average fare is lower under the more aggressive response strategy (full match) only at low entrant capacity. The explanation for this result lies in the amount 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.

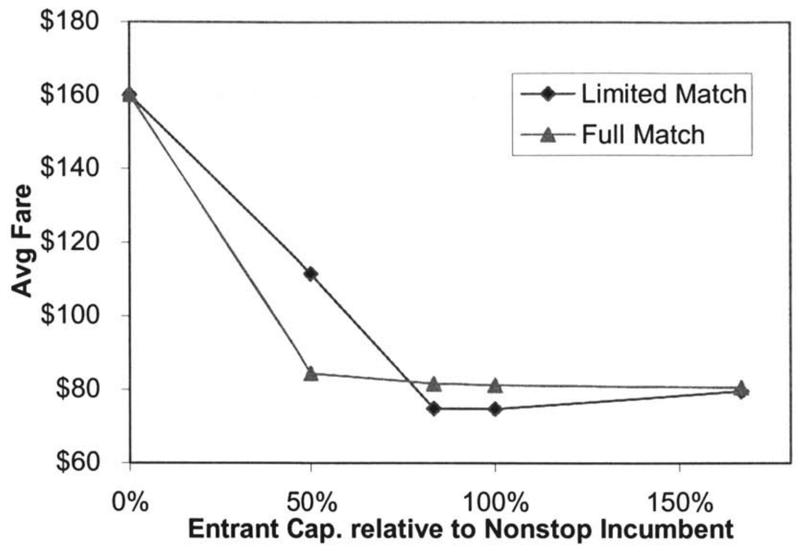

Figure 8.2: Incumbent carrier average fare as a function of the incumbent pricing response - Scenario 2 with FCRM on all carriers

8.2.3. 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 8.3, under Scenario 2 assumptions 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. The less aggressive limited match response does not allow the incumbent carrier to retain as much traffic in the local market, and 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.

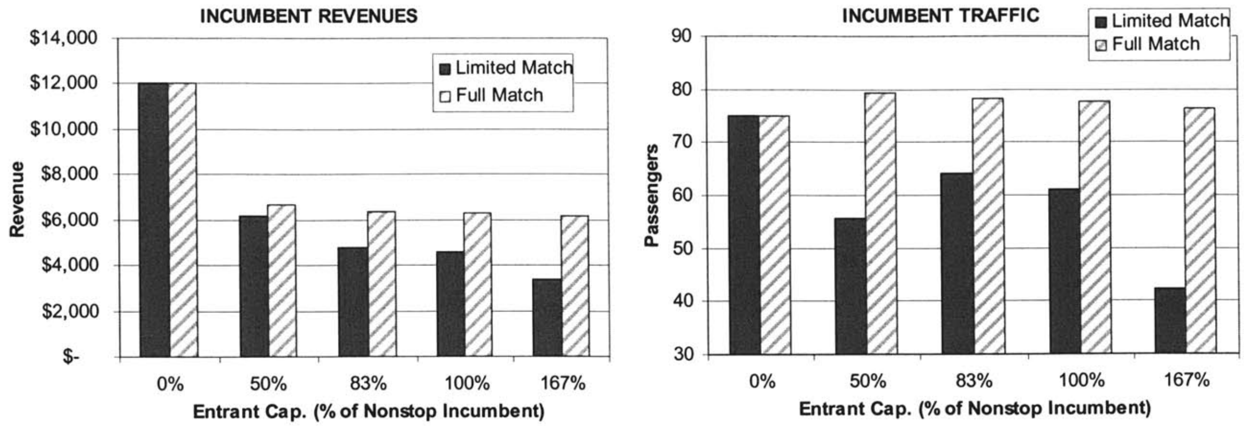

Figure 8.3: Incumbent carrier traffic and revenues as a function of its pricing response - Scenario 2 with FCRM on all carriers

In addition, 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 lower decrease in total network revenues. 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 emphasizing that revenues don't provide information on the nature of the competitive response of incumbent carriers faced with low-fare competition.

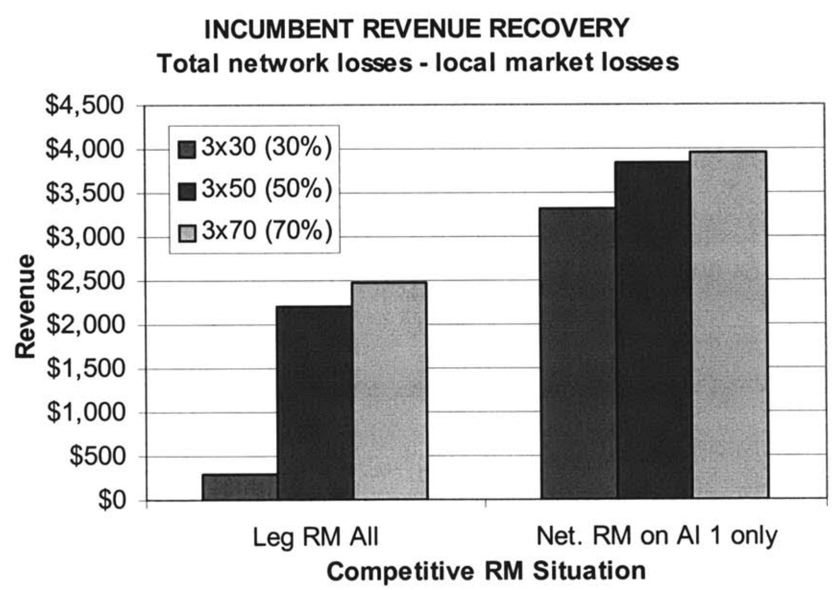

Figure 8.4: Difference between local market revenue losses and total network revenue losses on the incumbent carrier under low-fare entry in a network environmnet (as simulated in Chapter 7)

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, appear to be very misleading and to potentially lead to erroneous conclusions regarding predatory conduct in the airline industry.

Finally, in its 1998 publication, the US DOT defines predatory practices as price cuts or capacity increases that:

- Cause the incumbent to forego more revenues than all of the New Entrant's capacity could have diverted from it, or
- Result in substantially lower operating profits (or increased operating losses) than would a reasonable competing strategy.

Our results have shown that neither of these conditions should be used as indications of predatory conduct, as such effects could follow from low-fare entry despite any sort of response other than a limited match from the incumbent carriers, as highlighted in Figure 8.5. It illustrates that, despite a limited match response from the incumbent carrier, the decrease in its revenues at low entrant capacity is greater than the revenues of the entrant carrier. These, and other results, emphasize the difficulty in establishing predation in the airline industry and the inadequacy of some existing approaches.

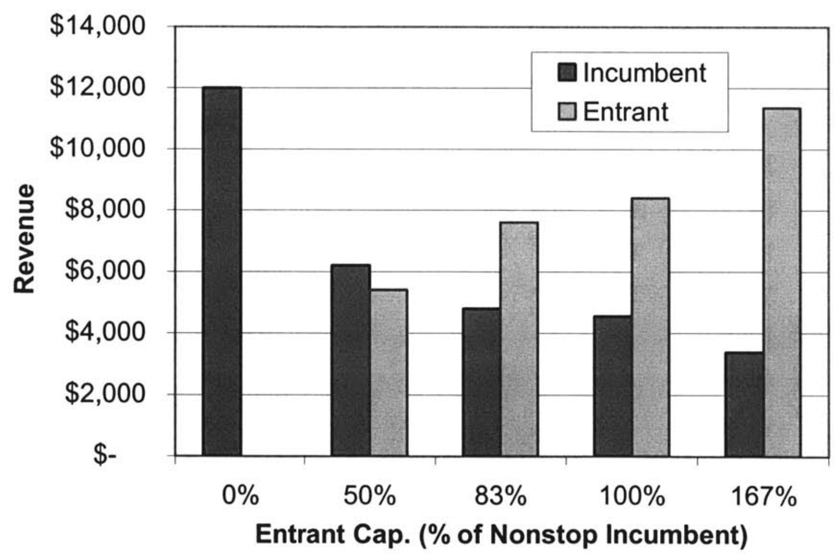

Figure 8.5: Incumbent and new entrant revenues under Scenario 2_{LM} with FCRM on all carriers

These results clearly show that guidelines such as the ones discussed above provide very poor guidance regarding the potential for predatory pricing or predatory behavior in the airline industry. In particular, such approaches at best indicate the potential for predatory behavior, but do not provide a conclusive indication of predation. In addition, they ignore the effects on average market measures of new entrant capacity, incumbent and new entrant pricing strategies, use or absence of revenue management on the incumbent and new entrant carrier, and flows of network passengers. Evaluation of competitive responses to low-fare entry should therefore take into account all of these factors which are specific to the airline industry.

8.3. Future Research Directions

This research has presented important findings related to industry-specific attributes such as revenue management and network flows of passengers and their effect on traditional measures of airline performance. However, this research did not attempt to provide a definitive answer or test to predatory practices in the airline industry, but rather strived to offer a more complete look at the characteristics of the airline industry and their effects on competition.

As we discuss in the following sections, further research directions should be centered on three major directions:

1. New entrant size and presence in the incumbent carrier's network.
2. Improved passenger choice modeling to better reflect airline passenger behavior.
3. Definition of a metric or test to measure the validity of claims of predatory behavior.

8.3.1. New Entrant Size and Presence in the Incumbent Carrier's Network

The results presented in Chapter 7 discuss the impacts of entry in a large network environment and the effects of network revenue management and network flows of passengers on aggregate measures of airline performance. The size of the network, as well as the extent of the new entrant carrier's presence in the incumbent's network, are certain to influence the simulation results. An important extension of this research would therefore be to determine to what extent the new entrant carrier's presence in the network (much in the same fashion as the new entrant's relative capacity played a very important role throughout this thesis) has an impact on the performance of the incumbent carriers and their ability to mitigate the effect of entry on their revenues, fares and traffic. Current growth of low-fare new entrant carriers has dramatically increased the exposure of network carriers to low-fare competition. Network carriers are increasingly likely to be facing competition from multiple low-fare new entrant carriers, thus impacting increasing proportions of their overall network operations.

In addition, our simulations also focused on modeling point-to-point low-fare new entrant carriers. While this type of low-fare new entrant carriers is currently prevalent in the airline industry, there are also a number of low-fare new entrant carriers operating out of "focus cities" closely resembling hubs (as discussed in Chapter 2). As a consequence, these carriers are also able to divert connecting traffic from network carriers, which has a potential to further affect network carrier performance.

Finally, the possibility of interlining between carriers was also ruled out, thus eliminating the transfer of passengers between a network carrier on a portion of her trip and a low-fare competitor on another portion of her trip. This type of passenger behavior, while infrequent, also has an effect on the type of traffic carried by the network carriers, and thus has the potential of affecting the outcome of low-fare new entrant competition. For example, a passenger switching from connecting travel on the incumbent carrier from origin to destination through the carrier's hub, to half of its travel on the incumbent carrier and the other half on the new entrant carrier, changes, in the view of the network carrier, from being a connecting passenger to a local passenger, even though she was still connecting, but on another carrier. This effect will affect the network carrier's revenue management system and potentially lead to additional impacts on measures of performance.

Testing for these three effects would provide additional valuable understanding of the competitive interactions between incumbent and new entrant carriers in the airline industry.

8.3.2. Passenger Choice Modeling

As discussed in Chapter 5, Section 5.1., the Passenger Origin Destination Simulator is organized along four major components: The historical database, the forecasting engine, the revenue management optimizer and the passenger choice model. The choice model is single-handedly the most critical simulation component and determines the choice of individual passengers. It is therefore crucial that the choice model represent passenger behavior as realistically as possible. Chapter 6, Section 6.3 presented a discussion of the sensitivity of results to some of the major modeling assumptions (schedule, demand curves and mix of business and leisure passengers), and showed that the results were quite robust to changes in these settings. The passenger choice model, however, is dependent upon a set of assumptions regarding the behavior of air travel passengers. Among the most critical assumptions are the following:

1. Passenger demand can be segmented between leisure and business passengers, and each segment behaves differently. While this assumption was true before 2001, it remains unclear whether this segmentation of passenger demand is still a valid one. Travel demand has been greatly affected by both the economic downturn in 2001 and the event of September 11, 2001. Further research on this change in passenger demand would provide additional insights on the behavior of air

travelers and potentially allow for modifications to the PODS choice model to better reflect reality.

2. Passengers choose to travel based on a decision window, which gives each passenger an earliest allowable departure time and a corresponding latest allowable arrival time. While this assumption was generally true pre-2001, the rapid development of the internet sales channel, along with the capability to search for the lowest available fare, has the potential to change the behavior of air travel passengers with respect to schedule preference. Further research on the actual behavior of passenger with respect to schedule preference, and on the effect of fare search capabilities on previously described results, constitutes an important next step to this research and to the PODS simulator.

Other parameters such as the marketing tools available to the airlines were also left out of the simulation. For example, as discussed in Chapter 3, frequent flyer programs constitute very important means to ensure passenger loyalty, and are likely to play a part in the choice of passengers faced with low-fare competition. In addition, other marketing tools, which are more and more prominently publicized in the airline industry, also affect passenger choice and were not modeled here. For example, leg-room, seat comfort or in-seat televisions all affect passenger choice.

8.3.3. Definition of a Metric to Evaluate Claims of Predatory Behavior

Finally, probably the most challenging task is the definition of a metric on predatory behavior in the airline industry. This research has focused on the effects of relative new entrant capacity, competitive pricing and revenue management, and network flows of passengers on traditional measures of airline performance and thereby established that these aggregate measures of performance do not provide sufficient information as to the response of incumbent carriers to entry or to the actual performance of individual carriers, particularly in a network environment.

In accordance with previous work on predatory behavior, we find it important to study each individual case of alleged predation carefully, and to use a rule of reason to assess whether the claims of predatory behavior are relevant. As second step in the determination of whether predation has occurred involves the use of a test of predatory behavior. However, as discussed in Chapter 3, none of the cost-based tests advocated by Areeda and Turner (1975) or Joskow and Klevorick (1979) can be directly applied to the airline industry because of the importance of network flows of traffic and the mix of local and connecting traffic on local flight legs resulting in the dichotomy of supply and demand. At the same time, the output limitation or price maintenance requirements advocated by Williamson (1977) and Baumol (1979) cannot apply to the airline industry, which is a seasonal industry where prices and demand vary tremendously within the course of a one year period.

As a result, the design of a metric or test of predatory behavior, specific to the airline industry, constitutes a very challenging potential extension to this research. The interactions between capacity, pricing, revenue management and network flow effects should be accounted for in the design of such a metric, and make its definition and creation all the more challenging.

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