UC Berkeley
Econ 221 - Industrial Organization Seminar

Title
Does Bankruptcy Protection Harm the Airline Industry?

Permalink
https://escholarship.org/uc/item/0s40v0x9

Author
Lee, Hwa Ryung

Publication Date
2009-04-28

eScholarship.org Powered by the California Digital Library
University of California

Does Bankruptcy Protection Harm the Airline Industry?
Empirical Study on Bankruptcy and Low Cost Carrier Expansion in the Airline Industry

Hwa Ryung Lee
Department of Economics, UC Berkeley

April 2009

Preliminary and Incomplete

ABSTRACT

The idea of bankrupt airlines' potential harm to the industry focuses on whether non-bankrupt rivals' profitability and financial health deteriorate due to abnormal activities of bankrupt airlines. However, a more relevant question would be whether bankrupt airlines harm *efficient* non-bankrupt rivals' profitability and the industry efficiency declines as a result. This paper attempts to answer this question by examining fare and capacity change of bankrupt airlines and non-bankrupt rivals. Focusing on the 1,000 most travelled domestic routes in each quarter from 1998Q1 to 2008Q2, we find that bankrupt legacy airlines reduce fare as well as capacity significantly in the periods surrounding bankruptcy and, during the same period. During the same period, non-bankrupt rivals' fare and capacity is largely unaffected on average but low cost carriers (LCC) not in bankruptcy increase fare as well as capacity. The route-level capacity seems to decrease a little but it stays pretty stable in overall periods. As a result, the mix of capacity seems to change in favor of efficient firms as LCCs replace relatively high-cost bankrupt airlines' capacity. So, bankrupt airlines do not seem to worsen the situation but more efficient airlines might have been expedited even more if bankrupt airlines have actually been liquidated. This result raises another interesting question of what it takes for efficient firms with lower cost to take markets from relatively inefficient incumbents. Bankruptcy seems one factor that spurs low cost airlines' expansion. The fraction of LCC growth since 1998 to the second quarter of 2008 explained by filling in reduced capacity by bankrupt airlines is estimated to be about 10%. Other factors stimulating low cost carrier expansion will be investigated and compared to bankruptcy effects.

1 Introduction

Do loose bankruptcy laws allow inefficient airlines to survive and underprice their efficient rivals, harming the industry? This paper attempts to see how bankrupt airlines behave, how their non-bankrupt competitors respond, and how the industry efficiency changes as a result.

Bankrupt airlines do not necessarily disappear from market right away. The United States has a unique bankruptcy code called Chapter 11 which, unlike liquidation bankruptcy of Chapter 7, permits bankrupt firms to reorganize themselves under protection from creditors when the firms are believed to have higher value as a going-concern than immediate liquidation value. Some people criticize bankrupt firms under protection harm non-bankrupt rivals in the airline industry. Chapter 11 allows inefficient airlines to survive and harm even their healthier counterparts by lowering fares below what rivals charge and/or keeping capacity in the system that otherwise would have been eliminated, they content. It is not hard to find a story of non-bankrupt airlines complaining about bankrupt firms' underpricing and exacerbating overcapacity problem. The following is the quote from an article on entrepreneur.com:

> According to Robert Crandall, a former CEO of American Airlines, bankrupt airlines enjoy competitive advantages over rivals not in bankruptcy. A bankrupt airline can defer debt payments, modify labor agreements, and postpone pension contributions. Crandall theorizes that a bankrupt airline can lower its financing and operating costs, thereby luring customers away from competitors by offering lower prices. Similarly, Nigel Milton, Virgin Atlantic's government affairs manager, said, "Chapter 11 is a type of state aid. The playing field gets tilted more and more against US." These lower prices have the effect of forcing nonbankrupt airlines to reduce costs and shrink their profit margins, perhaps bringing these carriers closer to bankruptcy themselves.[1]

Non-bankrupt airlines' worries are not groundless. Under bankruptcy protection, bankrupt airlines may renegotiate with workers and suppliers so enjoy greater cost advantage over other airlines, which can lead to underpricing that hurts other airlines' profitability. Even without cost advantages, they have an incentive to price aggressively to generate cash and reduce the likelihood of bankruptcy filing or immediate liquidation. The tendency to trigger a fare war under financial distress is reported by Busse (2002).

However, lower fare during bankruptcy does not necessarily mean that bankrupt airlines harm non-bankrupt airlines by forcing them to match the distressed fare and lowering their profitability. For one, travelers would discount bankrupt airlines to give non-bankrupt airline more room for setting higher price than bankrupt airlines, which makes fare cut by bankrupt airlines less effective. In this case, fare cut by non-bankrupt airlines will not be significant. Borenstein and Rose (1995) find that the fare cut by bankruptcy filing airlines seems to start prior to the actual filing but dissipates quickly during bankruptcy and their rivals do not change fare significantly during the same period. Recently Ciliberto and Schenone (2008) looked at the changes in price and capacity during and after Chapter 11 bankruptcy. They find that non-bankrupt rivals do not cut fares to match bankrupt airlines' fare. They also report that bankrupt airlines reduce capacity but non-bankrupt rivals marginally reduce or even increase capacity. Government Accountability Office (2005) also find that, when dominant airlines reduce capacity for some reasons such as filing for bankruptcy or dropping hub airports, the reduced capacity is quickly filled by other airlines.

If bankrupt airlines shrink their operation so as to reduce expenses, this may present new openings for other airlines to increase their presence. Then, who takes advantage of this opportunity and how does the resulting change affect industry efficiency? If expanding non-bankrupt airlines are more efficient than bankrupt airlines, then the average efficiency may even improve, not deteriorate, on bankrupt routes. This paper confirms that bankrupt airlines reduce capacity and non-bankrupt airlines increase it. Collectively, the capacity in route-level

[1] http://www.entrepreneur.com/tradejournals/article/168283785_2.html

shows little change. Composition of capacity, however, changes in favor of more efficient competitors. That is, allocative efficiency increases.

Figure 1 to Figure 3 show the quarterly fares (in 2000$) of the airlines serving the route from ATL (William B. Hartsfield Atlanta International Airport, Atlanta, Georgia) to CLT (Charlotte/Douglas International Airport, Charlotte, North Carolina) from the first quarter of 1998 to the second quarter of 2008. Q1_fare is 25% percentile fare, Q3_fare is 75% percentile fare, and Med_fare is median fare of an airline serving the route (Figure 1: Delta (DL), Figure 2: US Airways (US), and Figure 3: AirTran Airways (FL)). Delta and US Airways have been present throughout the period and dominant in the market. The dashed line is when US Airways filed for bankruptcy (for twice) and the solid line is when Delta filed for bankruptcy. The shaded areas are the periods during bankruptcy.[2]

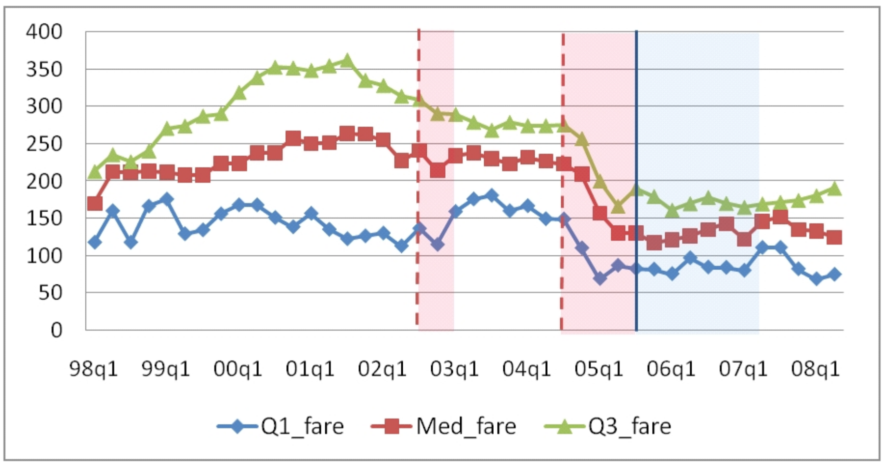

Figure 1: Bankruptcy and Fare Change: US Airways

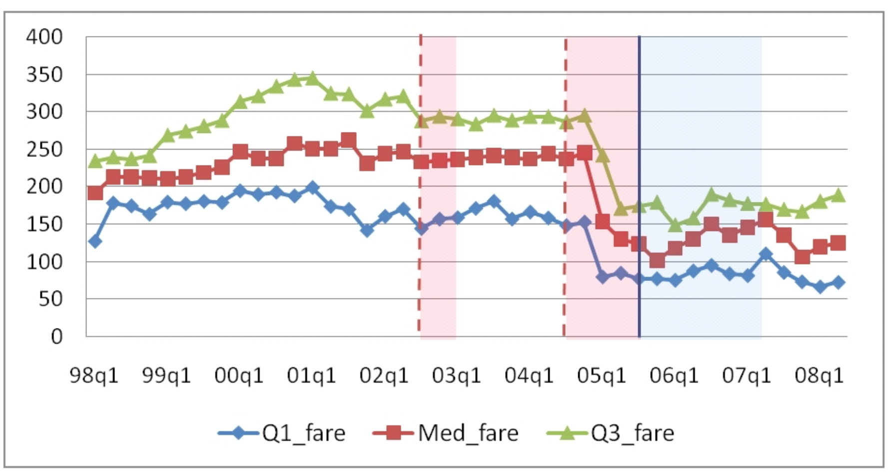

Figure 2: Bankruptcy and Fare Change: Delta

[2]For the exact date of bankrupt filings and emergence, see Table 2 (Airline Bankruptcy Filings).

From Figure 1 and 2, we can see the fare cuts by bankrupt firms precede the actual bankruptcy filings, which may be due to negative demand shock or desperate move of financially distressed firms to raise liquidity. The fare cut seems to continue during bankruptcy. Non-bankrupt rival seems to cut fare during the same period. These graphs suggest that bankrupt airlines may adopt aggressive pricing, potentially lowering profitability for non-bankrupt rivals serving the route.

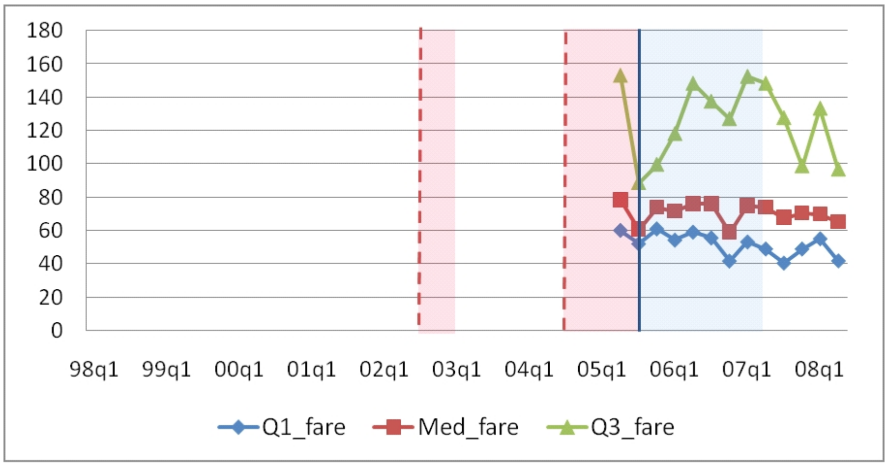

Figure 3: Bankruptcy and Fare Change: AirTran Airways

Figure 3, however, suggests a different story. A low-cost carrier (LCC) AirTran enters the route[3] while US Airways is under bankruptcy protection and Delta is about to file for bankruptcy. If the presence of a bankrupt airline in a route leads to lower profitability for all other carriers, no airline would want to enter the route. The low-cost carrier entry may suggest that a bankrupt firm may present a new opportunity for efficient firms with low cost structure to expand somehow. In the empirical sections, we will see that bankrupt airlines reduce capacity and non-bankrupt rivals fill the gap. Especially low cost airlines seem to expand their services significantly in response to bankrupt airlines' reduced capacity. As we will see later, bankrupt airlines' capacity cut seems to offer new openings for low-cost airlines.

In addition, the steep decline of fares during the second bankruptcy of US Airways does not seem to be due to bankruptcy. Rather, low-cost carrier entry seems to be the factor. AirTran lowers fare upon Delta's bankruptcy filing but do not seem to continue the fare cut, especially for the higher range of fares while Delta is under bankruptcy protection. Still, its fare level is pretty low compared to the incumbent airlines Delta and US Airways and this low-cost carrier presence seems to pose more pressure to lower price than the presence of bankrupt airlines does.

When it comes to the question of whether bankrupt airlines harm non-bankrupt airlines, an important part we need to think about is how efficient non-bankrupt airlines are relative to bankrupt airlines. If bankrupt airlines expedite inefficient airlines' exit, that is good. If bankrupt airlines harm efficient airlines' profitability

[3] We consider only carriers with at least 1% passenger share on a route. So, the entry or presence on a route means a carrier has no less than 1% passenger share.

and financial health, that could be bad. If bankrupt airlines improves efficiency by reducing excess capacity and efficient non-bankrupt airlines fill the gap, that would be great. All stories are possible in theory. This paper attempts to answer which is the case empirically.

In particular, we will use price and quantity data before, during, and after bankruptcy period to see when the bankruptcy begins to affect the industry and whether the bankruptcy effect persists. We divide bankrupt airlines and non-bankrupt airlines into two groups, respectively, based on whether a bankrupt airline is legacy carrier or not and whether a non-bankrupt rival is a low-cost carrier.

Comparison between legacy and non-legacy bankrupt airlines can be informative for several reasons. First of all, legacy and non-legacy airlines may enter into bankruptcy for different reasons. For example, legacy carriers may file for bankruptcy to get rid of legacy burdens such as high labor costs from strong union and many senior workers. So the likelihood of emergence would be higher and they would be able to become a stronger competitor once they emerge. Other carriers, on the other hand, would be more vulnerable to route-specific negative shocks due to smaller network size. Also, they may have less room to cut costs significantly or have a lower value as a going concern than immediate liquidation. So the likelihood of emergence from bankruptcy, strategies under bankruptcy protection, and rivals' reaction to bankruptcies could be different.

Also we will separate the low cost airlines' response to rival's bankruptcy from that of the average non-bankrupt firms. The difference in response is estimated to be large and significant. Throughout the paper, we mean lower cost by "efficiency".

The short conclusion is that (1) bankruptcy filing airlines start the fare and capacity cut prior to the actual filing, (2) average non-bankrupt rivals cut fare but not as much as bankrupt airlines do, (3) bankrupt airlines' reduced capacity is filled mostly by non-bankrupt low cost airlines and those airlines even increase fare during rivals' bankruptcy, and (4) the total capacity in route-level decreases a little while some airlines serving the route are bankrupt but it stays pretty stable in overall periods surrounding bankruptcies.

Low cost airlines' expansion during rival's bankruptcy (especially when large network carriers are bankrupt) raises another interesting question. Given the long history of the airline industry since deregulation, the growth of low cost carrier has occurred mostly in recent years (in 2000's). That is, lower cost is not all it takes for efficient firm to take markets from less efficient incumbents. A discrete event forcing a firm to cut capacity such as September 11 or bankruptcy filing is necessary to urge an incumbent firm to cut back on capacity. So, next question would be what are the factors that allow efficient firms, that is, low cost airlines to increase their presence and how much fraction of the low cost carrier growth can be explained by other carriers' bankruptcy relative to other factors. From the estimation results, the fraction of LCC capacity growth explained by filling in bankrupt rivals' reduced capacity is about 10% of the LCC growth since 1998 and about 15% since 2000 until the second quarter of 2008. Other factors such as Sep11, merger, and fuel cost shock will be examined in the future.

The remainder of this paper proceeds in the following steps. Section two describes sample construction and variables used in empirical analysis. Section three discusses econometric specifications and estimation results. Section four examines how the estimation results change over various other specifications for robustness check. Finally, Section five concludes.

2 Data

2.1 Sample Construction

There are two main data sets used in the analysis; the Airline Origin and Destination Survey Data Bank 1B (DB1B) and the Air Carrier Statistics database (T-100 data bank). Both are available from the Bureau of Transportation Statistics of the U.S. Department of Transportation.[4] First, the Airline Origin and Destination Survey DB1B is a 10% sample of airline tickets from reporting carriers collected by the Office of Airline Information of the Bureau of Transportation Statistics. The data set includes origin, destination and other itinerary details such as ticket price, number of passengers transported, ticketing (i.e. marketing) carrier, operating carrier, distance of the itinerary, number of stops (number of coupons used in a itinerary), whether the ticket is a round trip, etc., on a quarterly basis.[5]

Second, we restrict our attention to U.S. domestic airline market so use T-100 Domestic Market (U.S. Carriers) and T-100 Domestic Segment (U.S. Carriers) data from the Air Carrier Statistics database. The "market" data includes a monthly air carrier passenger traffic information by enplanement for operating carrier, origin, destination combination each time period. The "market" data records the passengers that enplane and deplane between two specific points, regardless of the number of stops between the two points. This market definition is comparable to the origin and destination pair in DB1B. On the other hand, the "segment" data contains the number of seats available,the number of scheduled departures and departures performed, by operating carrier, origin, and destination. Unlike in the "market" data, the "segment" is composed of a pair of points served or scheduled by a single stage.[6]

A route is defined as a pair of origin and destination (on an airport basis) and each route is regarded as one market. A route is treated in a direction-manner in the sense that, if origin and destination airports are switched, it is considered to be a different route. Direction matters because demand conditions are different even between the same two end points, depending on which way passengers are heading.[7] Using the T-1000 Domestic Market database, we pick the 1000 largest routes in each quarter from 1998Q1 to 2008Q2, based on passenger enplanements. The 1000 routes represent a significant portion of airline market demands. For instance, in 2007, the number of passengers who travelled the 1000 largest routes is about 60% of the total demand. The impact of bankruptcy may be heterogenous over market size. So, this analysis focuses on the 1000 most travelled routes in each quarter for the forty two quarters.

The observation unit in DB1B is itinerary level. We aggregate the data to carrier level using the number of passengers as a weight. So, we have one observation for a (ticket) carrier[8] on a route in a give time (year,

[4] http://www.transtats.bts.gov/

[5] The data is recorded when a ticket is used, not when it is purchased, so the timing of the change in an airline's competitive behavior and the market outcome may not be exact. However, if most people buy tickets within one or two monthes ahead of an actual flight date, this may not be a big problem.

[6] For example, if Southwest operates only connecting flights from San Francisco airport (SFO) to Chicago Midway airport (MDW), the flights will be recorded in DB1B and the "market" data but not in the "segment" data.

[7] For example, when Superbowl is held in Tampa, Florida, demands for tickets going to and coming from Tampa would be different.

[8] A ticket carrier and an operating carrier can be different for the same itinerary. We choose a ticket carrier over an operating carrier because a ticket carrier sets a price even though other carrier may actually operate the service.

quarter) in the final data set. In the route-level analysis, itinerary level observations are aggregated to route-level so that we have one observation for a route in a give time. Again, observations are weighted with number of passengers. Besides, we drop tickets if a carrier has less than 1% passengers on a route in a given time or fares less than 20 dollars. All market fares used in analysis are inflation adjusted in 2000 dollars.[9] Table 1 is the list of main airlines in the final data set by carrier group. Those eighteen carriers account for about 98% of the sample.

Table 1. Airline List by Carrier Group

Carrier group	Carrier Name	Code	Status *
	American Airlines	AA	
	Continental Airlines	CO	
	Delta Airlines	DL	Emerged from bankruptcy
Legacy	Northwest Airlines	NW	Emerged from bankruptcy
	United Airlines	UA	Emerged from bankruptcy
	US Airways	US	Emerged from bankruptcy twice
	Alaska Airlines	AS	
	Southwest Airlines	WN	
	ATA Airlines	TZ	Emerged but liquidated later
	JetBlue Airways	B6	
Low Cost	AirTran Airways	FL	
	Frontier Airlines	F9	Under Ch 11
	Spirit Airlines	NK	
	American West Airlines	HP	Merged by US
	Midway Airlines	JI	Liquidated
Others	Midwest	YX	
	Hawaiian Airlines	HA	Emerged from bankruptcy
	Trans World Airlines	TW	Bankrupt then merged by American

* Status change from 1998 to 2008

Bankruptcy data is constructed mainly from Lynn M. LoPucki's Bankruptcy Research Database (BRD) [10] and "U.S. Airline Bankruptcies & Service Cessations" listed on Air Transportation Association (ATA) website.[11] BRD contains Chapter 11 filings of public companies with assets over $100 million that are required to file a form 10-K with SEC. The list of bankruptcy filings on ATA web page includes both Chapters 7 and 11, regardless of the size of a bankrupt airline. However, the web page says the list is "loose, unofficial". So,

[9] Consumer Price Index - All Urban Consumers is available from http://data.bls.gov/cgi-bin/surveymos.

[10] http://www.webbrd.com/bankruptcy_research.asp

[11] http://www.airlines.org/economics/specialtopics/USAirlineBankruptcies.htm

when the dates of bankruptcy filing, emergence, or service cessation do not match between the two sources, we searched for news articles on a specific bankruptcy event and picked the more accurate one. From these sources, we construct the history of airline bankruptcies that we are interested in. Table 2 shows all bankruptcy events that we will account for in the analysis. There are twenty one bankruptcy filings between 1998Q1 to 2008Q2. Among them, bankruptcy filing airlines emerged in ten cases,[12] went out of business after bankruptcy protection in nine cases, and ceased services right away in two cases. It is noteworthy that all legacy airlines have been successful to emerge from bankruptcy.

Table 2. Airline Bankruptcy Filings

Carrier Name	Date of Filing	Ch.	Date of Emergence	Date of Service Cessation
Kiwi International (KP)	Mar 23, 1999	11		Dec 8, 1999
Eastwind Airlines (W9)	Sep 30, 1999	7		
Tower Air (FF)	Feb 29, 2000	11		Dec 7, 2000
Pro Air (P9)	Sep 19, 2000	11		Sep 19, 2000
National Airlines (N7)	Dec 6, 2000	11		Nov 6, 2002
Midway Airlines (JI)	Aug 14, 2001	11		Oct 30, 2003
Trans World Airlines (TW)*	Jan 10, 2001	11		Dec 1, 2001
Sun Country Airlines (SY)**	Jan 8, 2002	7	April 15, 2002	
Vanguard Airlines (NJ)	July 30, 2002	11		Dec 19, 2004
United Airlines (UA)	Dec 9, 2002	11	Feb 2, 2006	
US Airways (US) 1st	Aug 11, 2002	11	Mar 31, 2003	
Hawaiian Airlines (HA)	Mar 21, 2003	11	June 2, 2005	
ATA Airlines (TZ) 1st	Oct 26, 2004	11	Feb 28, 2006	
US Airways (US) 2nd	Sep 12, 2004	11	Sep 27, 2005	
Aloha Airlines (AQ) 1st	Dec 30, 2004	11	Feb 17, 2006	
Delta Airlines (DL)	Sep 14, 2005	11	April 25, 2007	
Northwest Airlines (NW)	Sep 14, 2005	11	May 18, 2007	
Independence Air (DH)	Nov 7, 2005	11		Jan 5, 2006
Aloha Airlines (AQ) 2nd	Mar 31, 2008	7		
ATA Airlines (TZ) 2nd	April 3, 2008	11		April 3, 2008
Frontier Airlines (F9)	April 10, 2008	11		

* Trans World is merged by American,

** Sun Country's bankruptcy procedure was converted from Ch.7 to Ch.11

[12] Frontier Airlines filed for bankruptcy in the second quarter of 2008 and are still under bankruptcy protection. The case is regarded as an emergence case in the analysis. However, treating this case as liquidation does not change the results.

2.2 Variables

In the empirical analysis, we will see how bankrupt airlines set price and quantity right before, during, after bankruptcy and non-bankrupt rivals behave in response to them. Thus, the bankruptcy-related variables are constructed in the manner that we can capture how a bankrupt firm's and its competitors' behaviors change over time in the periods surrounding bankruptcy. We construct bankruptcy-related variables as an interaction between carrier identity (based on whether bankrupt or not and whether legacy carrier or not) and time periods (pre, during, and post bankruptcy periods). Previous studies did not consider non-bankrupt airlines' response after a bankrupt airline exits a market. "After exit" period is intended to see how remaining airlines react to bankrupt airlines' exit as an attempt to cut expenses. If a bankrupt airline that served the route at some point in a year prior to bankruptcy filing exits the route during bankruptcy and does not show up in the data for one year after they disappear, then we regard the event as a bankrupt airline's exit from the route.

Table 3 is the list of bankruptcy-related variables. We will define the same variables for legacy bankruptcy filings and others separately. By "legacy bankruptcies", we mean that a bankruptcy filing airline of interest is a legacy carrier. By "others", we mean that a bankruptcy filing airline of interest is a low cost or other carrier (that does not belong to either legacy or low cost carrier group). $Legacy\_Bankrupt[T_B]_{irt}$, for example, is a dummy variable that is triggered on if a legacy carrier files for bankruptcy in current quarter and $Legacy\_NonB[T_B - 1]_{irt}$ is a dummy variable indicating that a carrier is serving the route where some other legacy carriers file for bankruptcy in next quarter. $Legacy\_NonB[T_{Exit} + 1, T_{Exit} + 2]_{irt}$ has one if a carrier not in bankruptcy is serving a route that a legacy bankrupt airline exited from one or two quarters ago. Similarly, $Legacy\_NonB[T_{Exit} + 3\tilde{}]_{irt}$ has one if a carrier non in bankruptcy is in a route in the periods from three quarters after a legacy bankrupt airline exited from the quarter to the previous quarter of its comeback to the route. We assume that an airline exited from the route if the airline ticket data does not show up for consecutive four quarters after they first disappear. [13]

Table 3. Variable List: Carrier-Level Bankruptcy-Related Variables

	Period	Bankrupt	NonB
Pre B	[T_B-2]	" " $\_Bankrupt[T_B - 2]_{irt}$	" " $\_NonB[T_B - 2]_{irt}$
	[T_B-1]	" " $\_Bankrupt[T_B - 1]_{irt}$	" " $\_NonB[T_B - 1]_{irt}$
During B	[T_B]	" " $\_Bankrupt[T_B]_{irt}$	" " $\_NonB[T_B]_{irt}$
	[T_B+1]	" " $\_Bankrupt[T_B + 1]_{irt}$	" " $\_NonB[T_B + 1]_{irt}$
	[T_B+2~T]	" " $\_Bankrupt[T_B + 2\tilde{}T]_{irt}$	" " $\_NonB[T_B + 2\tilde{}T]_{irt}$
Post B	[T+1,T+2]	" " $\_Bankrupt[T + 1, T + 2]_{irt}$	" " $\_NonB[T + 1, T + 2]_{irt}$
	[T+3~]	" " $\_Bankrupt[T + 3\tilde{}]_{irt}$	" " $\_NonB[T + 3\tilde{}]_{irt}$
After Exit	[T_{Exit}+1, T_{Exit}+2]	(No Observations)	" " $\_NonB[T_{Ex} + 1, T_{Ex} + 2]_{irt}$
	[T_{Exit}+3~]		" " $\_NonB[T_{Ex} + 3\tilde{}]_{irt}$

" " = Legacy if legacy bankruptcies, Oth if others.

T_B: Quarter of bankruptcy filing, T: Last quarter in bankruptcy, T_{Exit}: Quarter of a bankrupt airline's exit from a route

[13] Detailed descriptions about the bankruptcy related variables are in Table A1-A2 in Appendix A.

Table 4 is route-level bankruptcy-related variables. Route-level analysis is intended to see the capacity change in total on bankruptcy-affected routes, as a result of financial distress, bankruptcy, emergence, or bankrupt airlines' exit. The comparison group is the routes where any carrier is not bankrupt. Table 5 is the list of other variables used in the analysis. Summary statistics on these variables are in the Appendix A3.

Table 4. Variable List: Bankruptcy-Affected Routes

	Period	Legacy Bankruptcies	Others
Pre B	[T_B-2]	$Legacy\_B\_route[T_B-2]_{rt}$	$Oth\_B\_route[T_B-2]_{rt}$
	[T_B-1]	$Legacy\_B\_route[T_B-1]_{irt}$	$Oth\_B\_route[T_B-1]_{rt}$
During B	[T_B]	$Legacy\_B\_route[T_B]_{irt}$	$Oth\_B\_route[T_B]_{rt}$
	[T_B+1]	$Legacy\_B\_route[T_B+1]_{irt}$	$Oth\_B\_route[T_B+1]_{rt}$
	[T_B+2˜T]	$Legacy\_B\_route[T_B+2\tilde{}T]_{irt}$	$Oth\_B\_route[T_B+2\tilde{}T]_{rt}$
Post B	[T+1, T+2]	$Legacy\_B\_route[T+1,T+2]_{irt}$	$Oth\_B\_route[T+1,T+2]_{irt}$
	[T+3˜]	$Legacy\_B\_route[T+3\tilde{}]_{irt}$	$Oth\_B\_route[T+3\tilde{}]_{irt}$
After Exit	[T_{Exit}+1, T_{Exit}+2]	$Legacy\_B\_route[T_{Exit}+1,T_{Exit}+2]_{irt}$	$Oth\_B\_route[T_{Exit}+1,T_{Exit}+2]_{irt}$
	[T_{Exit}+3˜]	$Legacy\_B\_route[T_{Exit}+3\tilde{}]_{irt}$	$Oth\_B\_route[T_{Exit}+3\tilde{}]_{irt}$

T_B: Quarter of bankruptcy filing, T: Last quarter in bankruptcy, T_{Exit}: Quarter of a bankrupt airline's exit from a route

Table 5. Variable List: Other Variables

	Variable	Unit	Description
Price	Med_fare_{irt}	2000$	Median fare of a carrier i on route r at time t
	$Q1\_fare_{irt}$	2000$	25% percentile fare of a carrier i on route r at time t
	$Q3\_fare_{irt}$	2000$	75% percentile fare of a carrier i on route r at time t
Capacity	N_seats_{irt}	1,000	# of available seats by a carrier i on route r at time t
	$N\_seats\_all_{rt}$	1,000	Total # of available seats on route r at time t
	N_dprts_{irt}	100	# of performed departures by a carrier i on route r at time t
	$N\_dprts\_all_{rt}$	100	Total # of scheduled departures on route r at time t
Route Characteristics	$LCCin_{rt}$		Dummy: 1 if LCC serves route r at time t, 0 otherwise
	$SWin_{rt}$		1 if Southwest serves route r at time t, 0 otherwise
	HHI_{rt}	1/1000	Herfindahl-Hirschman Index
Carrier Characteristics	$Network_{it}$	1/1000	Number of routes a carrier i is serving at time t
	Net_origin_{irt}	1/1000	# of routes from the origin of route r a carrier i is serving at time t
	Net_dest_{irt}	1/1000	# of routes to the destination of route r a carrier i is serving at time t
	$Direct_{irt}$	1	Fraction of direct flights tickets of a carrier i on route r at time t
	$Round_{irt}$	1	Fraction of round trip tickets of a carrier i on route r at time t
	$Codeshr_{irt}$	1	Fraction of tickets of a carrier i on route r at time t operated by a different carrier
	Mkt_share_{irt}	1	Market share of a carrier i on route r at time t in terms of passenger enplanement

3 Empirical Model and Results

This section discusses econometric models and estimation results as an attempt to answer the questions given in each subsection. In the process, we will see how bankrupt airlines behave and others respond, altering the shape of the industry. The first question is whether a bankrupt firm harms its average competitors not in bankruptcy by underpricing and exacerbating excess capacity problem.

3.1 Does a Bankrupt Firm Harm Non-Bankrupt Rivals?

Price and quantity are the main strategic tools that firms use in market. Thus, looking at how price and quantity level change (or do not change) in the periods surrounding bankruptcy can be informative. We will study how bankrupt airlines behave and how their competitors respond using the following econometric specification:

$$Y_{irt} = Legacy\_Bankrupt'_{irt} \cdot \alpha + Legacy\_NonB'_{irt} \cdot \beta + Oth\_Bankrupt'_{irt} \cdot \gamma + Oth\_NonB'_{irt} \cdot \lambda \\ + X_{irt} \cdot \phi + Time_t \cdot \theta + u_{irt}$$

where an observation unit is a carrier i $(= 1, 2, \cdots, 51)$ on a route r $(= 1, 2, \cdots, 1447)$ at time t $(= 1998Q1, 1998Q2, \cdots, 2008Q2)$, Y_{irt} is a dependent variable, $\ln(Med\_fare_{irt})$ or $\ln(N\_seats_{irt})$, $Legacy\_Bankrupt_{irt}$ $(Oth\_Bankrupt_{irt})$ is a 7×1 vector of bankrupt-carrier dummies of a carrier i on a route r at time t in legacy (other) bankruptcies, for each time period from two quarters before bankruptcy filing to post-bankruptcy periods, $Legacy\_NonB_{irt}$ (Oth_NonB_{irt}) is a 9×1 vector of non-bankrupt competitor dummies in the same period in legacy (other) bankruptcies for each period from two quarters before bankruptcy filing to post-bankrupt periods plus the periods after bankrupt legacy airline exited from a route, X_{irt} is a set of constant and control variables such as $LCC\ in$, $SW\ in$, HHI, Net_origin, Net_dest, $Network$, $direct$, $Round$, and $Codeshr$ if a dependent variable is $ln(Med\_fare)$ and $LCC\ in$, $SW\ in$, HHI, and $Codeshr$ if a dependent variable is $ln(N\_seats)$,[14] $Time_t$ is a set of time-specific dummies for each year, quarter pair and quarter dummies for Florida route,[15] and u_{irt} is the combination of time-invariant route-carrier fixed effect (δ_{ir}) and random shock to a carrier's fare on a route at specific time (δ_{irt}), i.e. $u_{irt} = \delta_{ir} + \delta_{irt}$.[16]

We estimate the specification with the fixed effect model with carrier-route pair as a panel ID. The fixed effect model is chosen to allow an individual effect to be correlated with other explanatory variables including bankruptcy-related variables. We assume that the effect of a specific carrier-route pair on fare/capacity level has a time-invariant component (δ_{ir}) and random shock component (δ_{irt}). While the time-invariant component is captured by carrier-route dummies, the random component varies over time and thus are treated as usual

[14] See Table 5 for the description of variables. Some control variables, such as network variables, fraction of direct flights and round trips, seems to be related to fare premium or discount but not to quantity level. So, those variables are dropped in quantity equations.

[15] As for the quarter dummies for Florida route, see the paragraph on panel ID below.

[16] Detailed descriptions on the specification is in Appendix B.

normal error terms (i.e. $\delta_{irt}\tilde{}N(0, \sigma^2)$).[17] We will adopt the fixed effect model in every estimation in this paper, so the carrier-route pair dummy variables are included in all carrier-level analyses and route dummy variables are included in all route-level analyses.

Again, the panel ID in the basic econometric specification is a carrier-route pair. However, since airline market is often characterized by seasonality (.e.g. demand conditions in the first quarter differ form those in the third quarter), carrier-route-quarter combination may be another appropriate candidate for the panel ID. There is a trade-off between these two choices of the panel ID. If we choose carrier-route-quarter combination, we can control for seasonal adjustment. However, we will have much shorter data periods[18] that we can use to estimate "but for" fare/capacity level, which may lead to a biased estimation of counterfactual patterns. On the other hand, though choosing carrier-route pair has disadvantage that we do not control for quarterly adjustment by a carrier on a route, it allows us to have much longer data periods[19] that we can depend on to estimate counterfactual fare/capacity level but for bankruptcy events.

This study chooses carrier-route pair as a panel ID as the objective of this study is to see how market competition changes in the periods affected by bankruptcy, compared to normal periods. We instead add quarter dummies if origin or destination airports are located in Florida in addition to time specific dummy variables (from 1998Q2 to 2008Q2: base.= 1998Q1). Time specific dummy variables are intended to control for aggregate demand/supply shocks common to all routes and carriers or common quarterly movement in fare or capacity. Quarter dummy variables for the route originated from or destined to Florida region are included because quarterly pattern is similar for most of routes (demand highest in the third quarter and lowest in the first quarter) but the pattern is reversed in Florida region (demand lowest in the third quarter and highest in the first quarter). As we will see later in this section, the estimated coefficients for time specific dummies and Florida quarter dummies show the expected pattern.[20]

We estimate bankruptcy effect in pre-bankruptcy periods (one and two quarters prior to bankruptcy filing) separately, as a bankruptcy filing airline will begin to experience financial distress at some point prior to the actual bankruptcy filing and this may alter the airline's pricing and quantity setting strategies. Since bankrupt airlines usually stay under bankruptcy protection for a while, we will see how their fare/capacity levels change over time during bankruptcy. After re-emerging from bankruptcy, the bankrupt airline may change their strategies or go back to their old strategies before bankruptcy filing. So post-bankruptcy periods are also estimated separately. If the distressed airline change its strategy, this will lead its competitors to change their strategies too. Thus we will see non-bankrupt airlines' responses as well as bankrupt airlines in each period. In addition, we will also look at how non-bankrupt airlines set price and quantity after a bankrupt airline actually exits from a route. If these airlines are better off after the bankrupt firm disappears from the market, this may imply that a quick liquidation, instead of operation under bankruptcy protection, boosts remaining firms' profitability.

[17] We report Robust Standard Errors in the regression analysis to account for potential heterogeneity.

[18] Then the panel data becomes yearly data set for each carrier-route-quarter combination. So, we have eleven years of observation at most.

[19] The panel data is a quarterly data set for carrier-route pair. So, we have fourty two quarters of observation at most.

[20] The estimation results do not change qualitatively even if we do not include quarterly dummies for Florida region. Choosing carrier-route-quarter combination changes the estimation results a bit in the sense that the fare change is larger before filing for bankruptcy than during bankruptcy procedures. Other than that, the estimation results are similar.

The basic empirical approach is in the same spirit with the difference-in-difference. We will compare a bankruptcy-affected airlines' pricing and quantity setting behavior to the normally expected behavior of those airlines' without bankruptcy. Sufficient number of observations on tickets unaffected by bankruptcy will allow us to estimate unbiased counterfactual patterns of fare/capacity set by airlines. Those data unaffected by bankruptcy (so can be used to estimate the counterfactuals absent bankruptcy events) come from two sources: data from periods prior to bankruptcy and data from routes where no airline is bankrupt. We have at least five quarters ahead of bankruptcy filing and, for most of bankruptcy cases, we have more than two years ahead of bankruptcy filings. Among the 1000 largest routes each quarter, at least some routes are not affected by bankruptcy.

Table 6 reports the estimation results. Since the dependent variable is logarithm of fare (or capacity), the estimated coefficients are interpreted as a semi-elasticity, i.e. % change in median fare (or capacity) in response to a unit change of RHS variable. In this model, after accounting for carrier-route individual (fixed) effects, the estimates for bankruptcy-related variables are interpreted as the change in fare (or capacity) of the same airline on the same route when affected by bankruptcy.

The first regression result is on fare change by bankruptcy filing airlines and their rival airlines. Fares decrease about 3.5 to 5.9% even before a legacy carrier files for bankruptcy. Once a legacy airline files for bankruptcy, the median fare is lower about 10.4 % than before they experience financial distress but the size of fare cut decreases over time. Other bankrupt carriers do not seem to change fare significantly prior to the actual filing but cut fare during bankruptcy.

As prices are strategic complements, non-bankrupt rivals seem to follow the fare cut by a bankrupt airline but only by 2.3 to 3%. This result looks like a distressed firm harming healthier counterparts by engaging in aggressively low price. However, there are two things we need to note. First, the fare cut by non-bankrupt airlines is no larger than average quarterly fare change. The average quarterly fare change of an airline on a specific route is about 3% (see Figure 4 for the estimated coefficients on time specific dummies).[21] Also, the estimated coefficients of quarter dummies for Florida region, although not reported in the table, are 0.028 for the first quarter, -0.059 for the third quarter, and almost zero for the second quarter, meaning that the same carrier sets fare up about 2.8% in the first quarter and down about 5.9% in the third quarter compared to the second and fourth quarters in the Florida region, holding other factors including the nationwide fare change constant. Second, more importantly, we are not sure yet whether efficient rivals are harmed by bankrupt airlines. As we will see in the next section, low cost airlines do not seem to match bankrupt airlines' low fare. Rather, they raise fare than before. This result means that efficient rivals with lower cost level are not negatively affected by bankrupt airlines.

[21] For all time specific dummies, base is 1998Q1. So, the estimated change is % change compared to the level in 1998Q1. Recall that all fares are inflation adjusted so the estimated change is also inflation adjusted.

Table 6. Estimation Results: Bankruptcy Effects on Fare and Capacity

Dependent Var.	$ln(Med\_fare)$				$ln(N\_seats)$			
	Legacy bankruptcies		Others		Legacy bankruptcies		Others	
Variable	Bankrupt	NonB	Bankrupt	NonB	Bankrupt	NonB	Bankrupt	NonB
[T_B-2]	-.0347***	.0030	.0095	-.0028	-.1777***	.0360**	.1020***	-.0185
	(.0055)	(.0036)	(.0065)	(.0033)	(.0311)	(.0152)	(.0221)	(.0158)
[T_B-1]	-.0586***	-.0127***	-.0092	-.0033	-.2716***	.0292*	-.0688*	-.0336*
	(.0056)	(.0036)	(.0073)	(.0032)	(.0361)	(.0166)	(.0359)	(.0179)
[T_B]	-.1035***	-.0297***	-.0494***	-.0049*	-.1414***	.0524***	-.0039	-.0432**
	(.0076)	(.0039)	(.0092)	(.0042)	(.0357)	(.0161)	(.0416)	(.0211)
[T_B+1]	-.0969***	-.0252***	-.0261**	-.0000	-.1958***	.0385**	-.1390***	-.0930***
	(.0081)	(.0039)	(.0122)	(.0051)	(.0372)	(.0166)	(.0427)	(.0212)
[T_B+2-T]	-.0755***	-.0225***	-.0332*	-.0261***	-.2917***	.0824***	-.1565***	-.0449**
	(.0080)	(.0045)	(.0170)	(.0056)	(.0271)	(.0138)	(.0506)	(.0188)
[T+1,T+2]	-.0289***	.0006	.1075***	.0780***	-.4237***	.0365**	-.5186***	-.0671
	(.0069)	(.0036)	(.0301)	(.0118)	(.0364)	(.0147)	(.0607)	(.0469)
[T+3-]	-.0016	-.0312***	.0144	-.0108	-.5035***	.0456***	-.0783	.0070
	(.0085)	(.0042)	(.0184)	(.0097)	(.0394)	(.0173)	(.0568)	(.0321)
[T_{Exit}+1,T_{Exit}+2]		-.0230***		-.0182***		.0108		.0302
		(.0089)		(.0038)		(.0301)		(.0173)
[T_{Exit}+3-]		-.0262*		-.0224***		.0683**		.0665***
		(.0152)		(.0053)		(.0291)		(.0205)
LCCin	-.0825***				-.0275			
	(.0060)				(.0189)			
SWin	-.1011***				.0720**			
	(.0082)				(.0328)			
HHI	.0900***				-.4524***			
	(.0188)				(.0829)			
Codeshr	.1125***				-.5961***			
	(.0104)				(.0593)			
Net_origin	.4834							
	(.4537)							
Net_dest	.3463							
	(.4586)							
Network	.0413							
	(.0325)							
Direct	-.0307**							
	(.0107)							
Round	-.5408***							
	(.0169)							
Constant	5.34***				3.98***			
	(.0224)				(.0498)			
R-squared	0.1653				0.0570			
N	182,644				81,718			

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

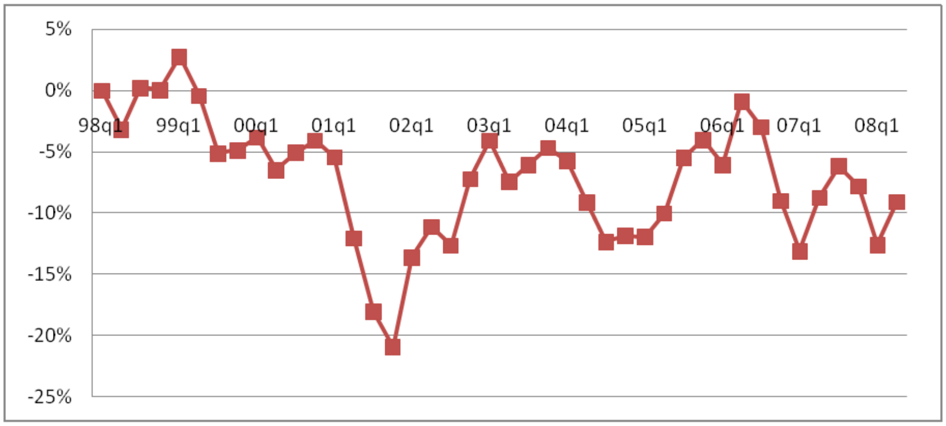

Figure 4: % Quarterly Median Fare Change by Carrier on the Same Route (base: 1998Q1)

Once a bankrupt airline emerges, the fare cut does not persist. For two quarters after emergence, legacy airlines' fare seems to be lower by 2.9% than before they are under financial distress. However, the fare level goes up to the original level in the later periods. Meanwhile other bankrupt airlines raise their fare by 10.8% right after emergence than before affected by financial distress but the big raise is only temporary. These fare increase after emergence may be due to huge capacity cut by bankrupt airlines that continues in post-bankruptcy periods as we can see in the second estimation result on capacity.

Capacity is measured by the number of seats available.[22] The estimation result suggests that bankrupt airlines, especially legacy airlines, are shrinking their operations even prior to actual filing. While in bankruptcy, the airlines keep their capacity level lower than before they experience financial distress and the magnitude of capacity cut gets larger over time (from 14% at the early stage to 29% in the later stage for legacy bankruptcies and 13 to 15% for other bankruptcies). This pattern goes beyond bankruptcy protection period, continuing even in post-bankruptcy periods so the capacity level is almost cut in half after emergence compared to the usual periods unaffected by bankruptcy. Other bankrupt airlines cut capacity significantly right after emergence but it does not seem to continue in later periods.

Interestingly, non-bankrupt rivals respond differently to legacy and non-legacy bankruptcies in terms of capacity change. When a legacy carrier goes bankrupt, their rivals not in bankruptcy expand capacity by about 4 to 7%. When other carrier goes bankrupt, on the other hand, the rivals not in bankruptcy also tend to cut capacity significantly. The reduction by non-bankrupt competitors may indicate either route-specific negative demand shocks that affect all carrier operating on the route negatively or aggressive new entries intended to fill the reduced capacity by bankrupt airlines.

Bankrupt airlines' capacity cut can be interpreted as an attempt to reduce total expenses quickly and regain proper liquidity level. This effort would not stop at only reducing services. Sometimes they will drop relatively unprofitable routes. The "After Exit ([T_{Exit}+1,T_{Exit}+2] and [T_{Exit}+3-])" effects are intended to see the responses of remaining airlines to bankrupt airline's exit. For two quarters after a bankrupt airline

[22] Usually, airline industry capacity is measure by available seat miles (number of seats times the distance between the two end points of a route: ASM). Here, we compare capacity change by the same carrier on the same route so the number of seats is sufficient to measure capacity.

withdraws services from the route altogether, the remaining airlines rather lower fare though their capacity level does not change significantly.

The estimated coefficients on other variables seem to make sense. First of all, in the fare equation, when low cost airlines are present in a route, airlines cut fare by 8.3%. If the low cost airline is Southwest, the fare cut is even larger by 10.1% so the total fare cut under the presence of Southwest is huge, about 18.4%. Concentration in a route is positively associated with fare. So airlines set price about 0.9% higher when Herfindahl Index (HHI) is higher by 100 (unit of HHI variable = 1/1000). When a ticket carrier and an operating carrier are different (codesharing), that is, an actual flight is operated by a different carrier from a carrier that sets fare and sells the ticket, the fare level is higher. The fare tends to be higher by 1.1% with 10 percentage point increase in the fraction of codeshring The number of routes from the origin (or to the destination) that an airline serves does not seem to have significant relationship with fare level. This may be because we count all the routes where an airline serves with at least 1%. If an airline has a small presence in a route, the route may not give the airline a power to command a premium. Though not reported, if we count only the route where an airline has at least 5% presence, the relationship become positive, and significant. The portion of direct flights and that of round trips are negatively related to fare level (0.3% lower if 10 percentage point more direct flights, 5.4% lower if 10 percentage point more round trip tickets).

In the capacity equation, the presence of Southwest is positively related to total capacity (about 4.5% (=-.0275+.0720) higher when Southwest is present). Concentration has negative relationship with total capacity (4.5% lower when HHI is higher by 100). When the fraction of codesharing increases, the supply of direct flights that they operate themselves decreases significantly. This seems to suggest the reason why the fare is higher with more codesharing.

So far we have seen carrier-level changes in the periods surrounding bankruptcy. When a legacy bankrupt airline cuts fare as well as capacity, non-bankrupt rivals cut fare but expand capacity when a legacy carrier is bankrupt. In other bankruptcy cases, on the other hand, both bankrupt and non-bankrupt rivals cut fare and capacity. Now, we will move on to the route level analysis to see how the total capacity level on the routes changes during the periods affected by bankruptcy. Table 7 reports the estimation results.

The total route capacity seems to decrease by about 3.5% in the later stage of bankruptcy when a legacy airline is bankrupt and 2% when other airline is bankrupt. Borenstein and Rose (2003) found that quarterly capacity adjustment is larger than the capacity change under bankruptcy. Similarly, we find that the capacity decrease in bankrupt route is comparable to average quarterly capacity adjustment, which is about 3% (see Figure 5). The standard deviation of quarterly capacity adjustment is about 1.9%. Aggregate demand shock such as September 11 (2002Q3) has a much larger impact on capacity level. Thus route capacity change due to bankruptcy does not seem to be large compared to other factors. Also, even when bankrupt airlines actually exit from the route, the total capacity does not decrease. Besides, the performed departures do not how any significant decrease during bankruptcy, which seems to suggest that smaller aircraft is serving the route on average during the period.

Table 7. Estimation Results: Capacity Change in Route-Level

Dependent Var.	$ln(N\_seats\_all)$		$ln(N\_dprts\_all)$	
	Bankruptcy-affected route		Bankruptcy-affected route	
Variable	Legacy bankruptcies	Others	Legacy bankruptcies	Others
[T_B-2]	.0038	.0177***	-.0006	.0230***
	(.0063)	(.0067)	(.0062)	(.0068)
[T_B-1]	.0073	-.0036	.0040	.0145*
	(.0064)	(.0066)	(.0064)	(.0067)
[T_B]	-.0040	-.0045	.0010**	.0066
	(.0068)	(.0072)	(.0068)	(.0073)
[T_B+1]	-.0064	-.0199**	.0095	-.0037
	(.0064)	(.0085)	(.0070)	(.0082)
[T_B+2~T]	-.0353***	-.0188*	-.0122	-.0116
	(.0088)	(.0108)	(.0088)	(.0104)
[T+1,T+2]	-.0112	-.0595**	-.0010	-.0413*
	(.0070)	(.0258)	(.0067)	(.0261)
[T+3~]	.0159	.0532**	.0126	.0444**
	(.0119)	(.0239)	(.0122)	(.0222)
[T_{Exit}+1,T_{Exit}+2]	-.0034	-.0014	.0011**	.0072
	(.0157)	(.0089)	(.0157)	(.0087)
[T_{Exit}+3~]	.210	-.0128	-.0074	-.0197
	(.0177)	(.0126)	(.0235)	(.0121)
LCCin	.0608***		.0541***	
	(.0142)		(.0138)	
SWin	.1289***		.0994***	
	(.0220)		(.0197)	
HHI	-.3530***		-.5040***	
	(.0470)		(.0498)	
Constant	11.79***		2.32***	
	(.0342)		(.0353)	
R-squared	0.1294		0.1283	
N	41,993		41,993	

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size
* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

In sum, there is a sign of capacity decrease during bankruptcy which may indicate that bankrupt airlines add capacity that would otherwise been eliminated. But the size of the decrease is not large. Especially when a legacy airline is bankrupt, the bankrupt airline cut back on capacity and non-bankrupt rivals expand operations. Moreover, even when bankrupt airline actually cease operation in a route, the total route capacity does not show a sign of decrease. That is, overcapacity problem does not seem to get worse as a result of bankruptcy protection.

However, the composition of capacity has been changed because bankrupt airlines reduce capacity and other airlines fill the gap. This leads to our next question: what kind of non-bankrupt firms are replacing

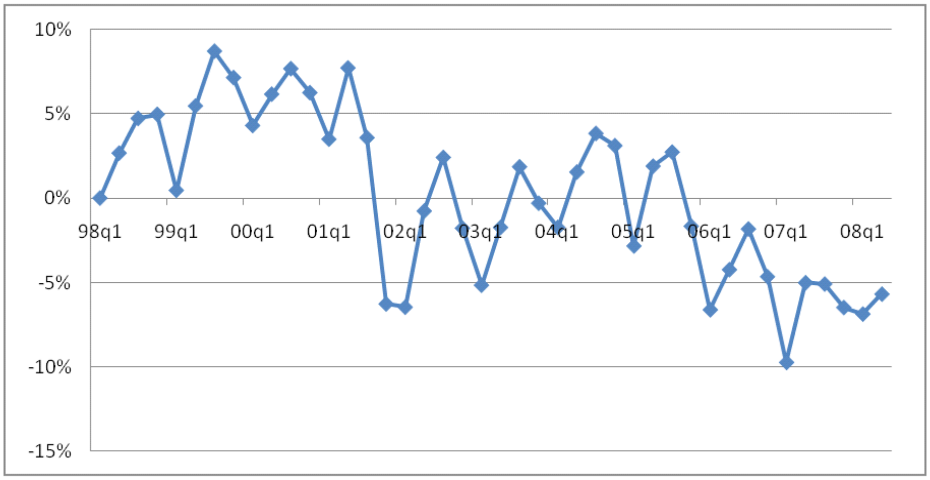

Figure 5: % Quarterly Roue Capacity Change (base: 1998Q1)

the bankrupt airlines' capacity? This question is important because, even with the same capacity level, if bankrupt airlines' capacity is replaced by more efficient airlines with lower cost, then the industry is improving in the sense that the average cost of the industry is lowered and efficiency increases.

3.2 Who Replaces Bankrupt Airlines' Capacity?

We have seen the replacement of bankrupt airlines' capacity by non-bankrupt rivals when a legacy carrier is bankrupt. For consumer's perspective, who provides flight services may not be important as long as there is some airlines that would. Although, the composition of capacity could be important in terms of allocative efficiency. If bankrupt airlines are relatively inefficient and they are forced to cut back on capacity, then relatively efficient airlines may take the openings as an opportunity to expand.

Given that the reduced capacity by the bankrupt legacy airlines is filled by non-bankrupt rivals, interesting question would be who replaces the bankrupt airlines' capacity. Figure 6 shows the significant difference in unit cost (per available seat mile: ASM) between legacy and low cost carriers. Figures 7 compares CASM excluding fuel costs between carrier groups since fuel cost may be affected more by external shock than by endogenous managerial or operational efficiency, which also shows a significant cost difference between carrier groups.

The answer to the question of who would replace bankrupt airlines' capacity is unclear in theory. When some large network carriers are bankrupt and reduce supply, other large network carriers may become more appealing to the travelers who used to choose the bankrupt carrier due to similar product characteristics. In that case, the replacement of capacity will be mostly done by similar large network carriers rather than low cost carriers with smaller network and no frills. However, similar network carriers may experience similar negative shocks that forced the other airlines to file for bankruptcy, which makes their expansion less likely. Or travelers simply may not care about network size or other qualities than price. Then low cost airlines will be able to take more share of the residual demand that all non-bankrupt rivals are facing through lower price.

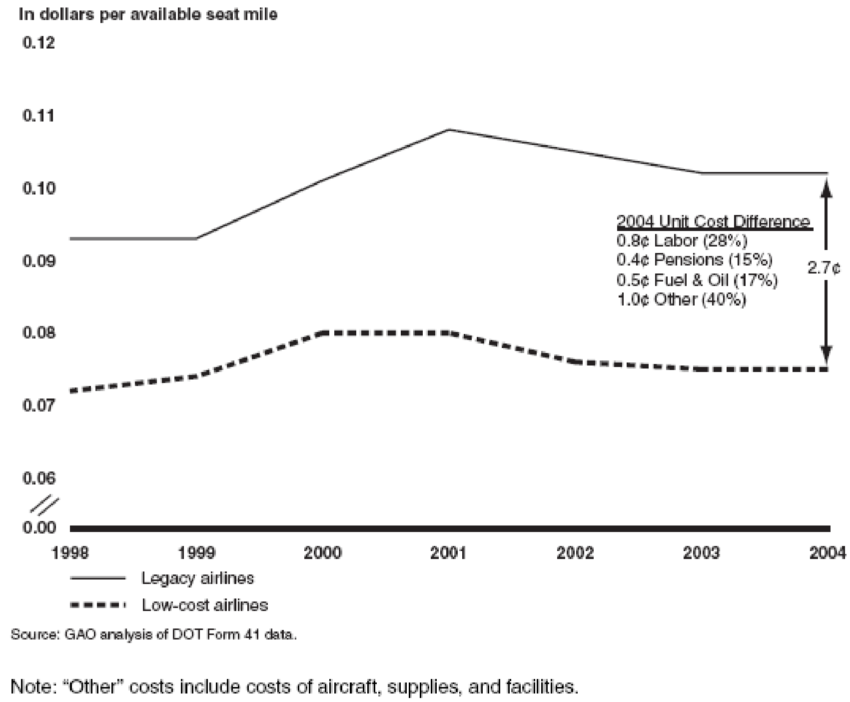

Figure 6: Figure 6: Difference in Unit Costs between Legacy and Low Cost Airlines, 1998-2004 (Source: GAO-05-945, Figure 3)

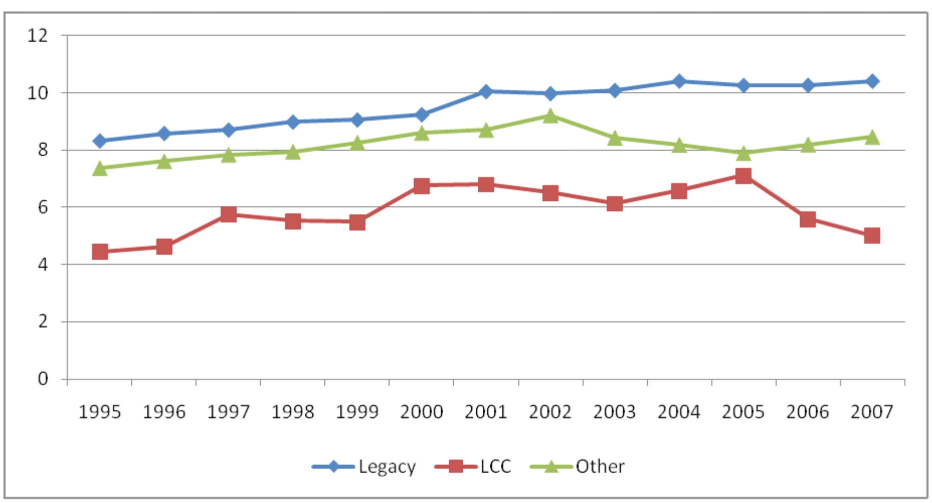

Figure 7: CASM excluding Fuel Costs (in Cents), by Carrier Group (Source: Author's Calculation based on Airline Data Project (ADP) established by the MIT Global Airline Industry Program)

In order to see how non-bankrupt low cost airlines respond to rivals' bankruptcy, we conduct more regressions on fare and capacity, respectively. Table 8 and 9 report regression results from the same econometric specification from Section 3.1 with capacity and market share as a dependent variable, respectively. The difference is, now we add one more category to non-bankrupt competitors ($NonB\_lcc$). The estimated coefficients on the variables under this new category ($NonB\_lcc$ column) are interpreted as the incremental effect of LCC among non-bankrupt competitors. So, the sum of estimates from $NonB$ column and $NonB\_lcc$ column is the total effect of being a non-bankrupt competitor. First, we will look at capacity change.

Table 8. Estimation Results: Non-bankrupt LCC Responses to Rivals' Bankruptcy in Capacity

Dependent Var.	$ln(N\_seats)$					
	Legacy Bankruptcies			Others		
Variable	Bankrupt	NonB	NonB_lcc	Bankrupt	NonB	NonB_lcc
[T_B-2]	-.1541***	.0383**	-.0038	.0748***	-.0172	-.0079
	(.0310)	(.0171)	(.0214)	(.0219)	(.0176)	(.0348)
[T_B-1]	-.2491***	.0364**	-.0103	-.0884**	-.0243	-.0477
	(.0358)	(.0182)	(.0252)	(.0356)	(.0205)	(.0324)
[T_B]	-.1444**	.0302*	.0865***	.0435	-.1007***	.2684***
	(.0357)	(.0183)	(.0246)	(.0438)	(.0222)	(.0506)
[T_B+1]	-.1973***	.0110	.0991***	-.1312***	-.1041***	.0631**
	(.0373)	(.0194)	(.0244)	(.0433)	(.0231)	(.0441)
[T_B+2~T]	-.2879***	.0418***	.1494***	-.1425***	-.0632***	.0778*
	(.0271)	(.0158)	(.0249)	(.0508)	(.0217)	(.0425)
[T+1,T+2]	-.3383***	.0122	.0991***	-.5133***	-.0960*	.3113***
	(.0367)	(.0173)	(.0205)	(.0611)	(.0519)	(.1114)
[T+2~]	-.4583***	-.0435**	.2391***	-.0406	-.0009	.1343*
	(.0389)	(.0206)	(.0268)	(.0568)	(.0243)	(.0753)
[T_{Exit}+1,T_{Exit}+2]		.0065	.0478		.0132	.0463
		(.0385)	(.0594)		(.0270)	(.0430)
[T_{Exit}+3~]		.0083	.1763***		.0342	.1641***
		(.0416)	(.0533)		(.0216)	(.0422)
LCCin	-.0206					
	(.0189)					
SWin	.0658**					
	(.0328)					
HHI	-.4051***					
	(.0827)					
Codeshr	-.5795***					
	(.0591)					
Constant	3.95***					
	(.0499)					
R-squared	0.0630					
N	84,092					

NonB_lcc (=LCC×NonB) Non-bankrupt LCC dummy

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

Table 9. Estimation Results: Market Share Change

Dependent Var.	$ln(Mkt\_share)$					
	Legacy Bankruptcies			Others		
Variable	Bankrupt	NonB	NonB_lcc	Bankrupt	NonB	NonB_lcc
[T_B-2]	-.1406***	-.0161*	.0366***	.0503***	-.0524***	-.0333
	(.0127)	(.0084)	(.0118)	(.0157)	(.0081)	(.0160)
[T_B-1]	-.1644***	-.0309***	.0310**	-.0315**	-.0509***	.0356***
	(.0139)	(.0096)	(.0132)	(.0163)	(.0083)	(.0152)
[T_B]	-.1792***	.0067	.0476***	-.0610***	-.0796***	.1661***
	(.0159)	(.0098)	(.0166)	(.0212)	(.0097)	(.0185)
[T_B+1]	-.2483***	-.0237***	.0455***	-.1877***	-.0356***	.0972***
	(.0166)	(.0090)	(.0163)	(.0261)	(.0110)	(.0191)
[T_B+2~T]	-.1911***	.0171*	.1613***	-.2407***	-.0008	.0052
	(.0155)	(.0100)	(.0135)	(.0286)	(.0120)	(.0198)
[T+1,T+2]	-.2617***	-.0109	.0631***	-.5372***	.0537	.2717***
	(.0177)	(.0090)	(.0113)	(.0653)	(.0383)	(.0668)
[T+2~]	-.2521***	-.0569***	.1108***	-.0570	-.0780***	.2240***
	(.0213)	(.0122)	(.0190)	(.0444)	(.0257)	(.0541)
[T_{Exit}+1,T_{Exit}+2]		.0006	.0422		.0472***	.0041***
		(.0245)	(.0307)		(.0115)	(.0181)
[T_{Exit}+3~]		.0485*	.2045***		-.0016	.1549***
		(.0257)	(.0412)		(.0118)	(.0249)
Constant	-2.34***					
	(.0079)					
R-squared	0.0474					
N	182,644					

NonB_lcc (=LCC×NonB) Non-bankrupt LCC dummy

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

The estimation result on capacity is interesting since it shows that capacity expansion by non-bankrupt competitors are mostly done by low cost airlines. A bankrupt legacy (other) airline cuts their capacity even before actual filing and the size of cut is about 25% (9%) right before the filing (see $[T_B - 1]$ row). Average non-bankrupt airlines increase their capacity then by 4% and low cost airlines are not different from other airlines not in bankruptcy. The capacity cut by a bankrupt legacy (other) airlines is smaller at first but get larger under bankrupt protection (see $[T_B]$, $[T_{B+1}]$, and $[T_{B+2}]$ rows) from 14% to 29% (from insignificant number to 14%). While a legacy airline is bankruptcy, average non-bankrupt airlines expand by 4.2% at most and low cost airlines expand their capacity much more than average non-bankrupt airlines by about 8.7 to 15%. When other airline is bankrupt, average non-bankrupt airlines also reduce capacity but low cost airlines' capacity level show little change except for the temporary increase upon rival's bankruptcy. After a bankrupt airline withdraws their operations from a route, then other airlines, especially low cost airlines seem to increase capacity in later periods.

In Table 9, the analysis on market share shows market share change in the periods surrounding bankruptcy. The loss in market share of bankrupt airlines is significant even before the actual bankruptcy filing. The loss is larger during bankruptcy. Then, who are the bankrupt airlines losing their market share to? Average non-bankrupt airlines seems to lose market shares or remain virtually the same as before during the same period. If we look at low cost airlines in particular, they are actually increasing their presence in the bankrupt route. Once a bankrupt airline exits from a route, other airlines, especially low cost carriers, seem to win market share at least in later periods. So low cost airlines take an opportunity to expand and increase their market share at the expense of bankrupt airlines or other non-bankrupt airlines.

Then are low cost carriers changing their fare along with expansion? Table 10 shows that the average fare cut by non-bankrupt competitors in each period surrounding bankruptcy almost doubles the previous estimates. While a legacy (other) airline is under bankruptcy (see $[T_B]$, $[T_{B+1}]$, and $[T_{B+2}]$ rows), for instance, a non-bankrupt rival' fare cut was estimated to be around 5.4% (insignificant number) at first and 3.9% (5.2%) later. More importantly, although average non-bankrupt rivals maintain lower fare than the usual periods unaffected by bankruptcy, low cost airlines maintain higher fare than usual. For example, when a rival files for bankruptcy (see $[T_B]$ row), non-bankrupt low cost carrier raises fare by about 3.5% (=-0.0537+0.0892; the summation of the two estimates are significant) in legacy bankruptcies. So, aggressive pricing by bankrupt airlines seems to affect only non-LCCs among non-bankrupt airlines.

Although low cost airlines increases its fare, it would be still lower than other carriers' fares. Thus, the capacity expansion by low cost airlines to fill the reduced capacity by bankrupt airlines could pose a significant price competitive pressure on other non-bankrupt airlines. These results imply that non-bankrupt competitors may look like they are hurt by bankrupt airlines' aggressive pricing since they tend to lower fares on bankrupt routes, but that low cost airlines take an opportunity to expand capacity and increase their presence may have more impact on price competitive pressure rather than bankrupt firms' low price. That is, bankrupt carrier may have triggered fare cut in the beginning, it could be their capacity cut that increases price competition by allowing low cost airlines to expand. Thus bankruptcy protection per se do not seem to harm average non-bankrupt airlines. Moreover, efficient airlines with low cost structure are benefited by bankrupt airlines' capacity cut. That is, the industry transition in favor of more efficient players may have been facilitated by bankruptcy filings and capacity cut that followed.

Table 10. Estimation Results: Non-bankrupt LCC Responses to Rivals' Bankruptcy in Price

Dependent Var.	$ln(Med\_fare)$					
	Legacy Bankruptcies			Others		
Variable	Bankrupt	NonB	NonB_lcc	Bankrupt	NonB	NonB_lcc
[T_B-2]	-.0246***	.0055	-.0063	.0141**	-.0108***	.0396***
	(.0055)	(.0042)	(.0050)	(.0065)	(.0037)	(.0072)
[T_B-1]	-.0517***	-.0154***	.0141***	-.0104	-.0016	.0264***
	(.0056)	(.0040)	(.0050)	(.0073)	(.0036)	(.0062)
[T_B]	-.1091***	-.0537***	.0892***	-.0290***	-.0062	.0112
	(.0077)	(.0043)	(.0051)	(.0091)	(.0048)	(.0083)
[T_B+1]	-.1029***	-.0421***	.0701***	-.0188	-.0172***	.0860***
	(.0082)	(.0043)	(.0050)	(.0119)	(.0056)	(.0100)
[T_B+2~T]	-.0820***	-.0388***	.0604***	-.0241	-.0516***	.1168***
	(.0080)	(.0050)	(.0060)	(.0166)	(.0064)	(.0110)
[T+1,T+2]	-.0185***	.0018	.0041	.1136***	.0879***	-.0231
	(.0070)	(.0041)	(.0047)	(.0314)	(.0134)	(.0254)
[T+2~]	.0023	-.0390***	.0334***	.0245	-.0024	-.0268
	(.0085)	(.0051)	(.0075)	(.0190)	(.0098)	(.0227)
[T_{Exit}+1,T_{Exit}+2]		-.0294***	.0265		-.0472	.1434***
		(.0107)	(.0185)		(.0057)	(.0091)
[T_{Exit}+3~]		-.0507***	.0841***		-.0274	.0216**
		(.0196)	(.0294)		(.0049)	(.0093)
LCCin	-.0781***					
	(.0061)					
SWin	-.1018***					
	(.0082)					
HHI	.0930***					
	(.0186)					
Codeshr	.1199***					
	(.0105)					
Net_origin	.2522					
	(.4520)					
Net_dest	.0856					
	(.4587)					
Network	.0374					
	(.0331)					
Direct	-.0328***					
	(.0107)					
Round	-.5467***					
	(.0168)					
Constant	5.35***					
	(.0225)					
R-squared	0.1705					
N	182,644					

NonB_lcc (=LCC×NonB) Non-bankrupt LCC dummy

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

3.3 How Much Fraction of LCC Growth is Explained by Rivals' Bankruptcy?

[Incomplete]

Given the long history of the airline industry since deregulation in 1978, the low cost carrier, even with a significantly large cost efficiency relative to legacy carriers, have not expanded that much (see Figure 8). Also, most of the growth has occurred only after 1990 (low cost carriers' passenger share is less than 5% in 1990). This raises a question. What does it take for efficient airlines to take markets from less efficient incumbents? Incumbent legacy airlines can be very adverse to reducing capacity for various reasons. For one, capacity reduction is not reversible so it may be hard to get terminals or other airport facilities back once they lose them to other airlines. Or, since they have extra aircraft anyway, they can add capacity at a very low marginal costs. These reasons may be holding back the incumbent airlines from reducing capacity in normal times when they do not need any dramatic change immediately.

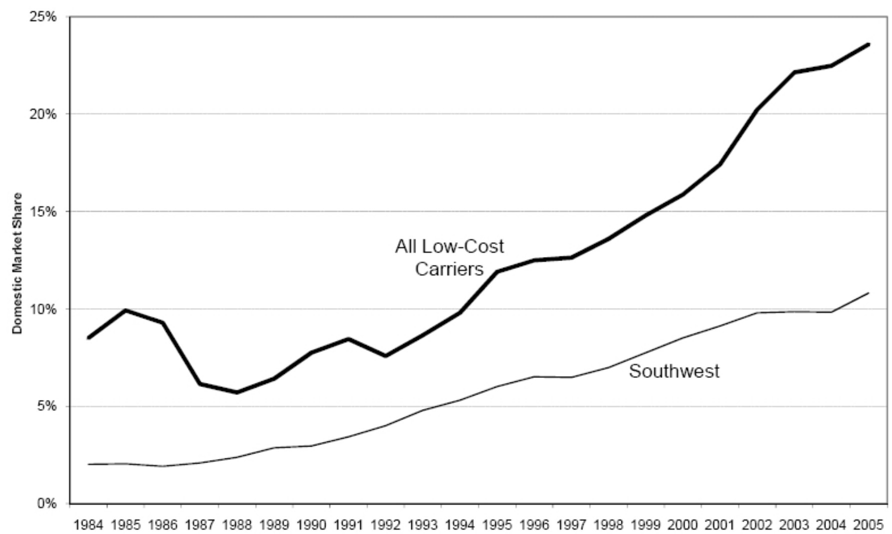

Figure 8: Domestic Market Share of Southwest and LCC, 1984-2005 (Source: Borenstein and Rose (2007) "How Airline Markets Work… Or Do They?" Figure 7)

The previous empirical analysis suggests that rivals' bankruptcy seems to be one factor that spur low cost carrier expansion. Figure 9 shows the quarterly capacity change by carrier group compared to the first quarter of 1998 on the same route (among quarterly 1000 most travelled routes). It is clear that legacy airlines are reducing capacity on average and low cost airlines are increasing capacity. The correlation of the quarterly changes between legacy and low cost airlines is -0.88. The correlation is 0.71 between legacy and other airlines and -0.53 between low cost and other airlines. The highly negative correlation between legacy and low cost airlines shows the possibility that at least part of legacy airlines' capacity is being replaced by low cost airlines.

Some argue that the price competitive pressure from low cost carrier pushes legacy carriers to file for bankruptcy. In that sense, LCC expansion itself would have affected legacy airlines' bankruptcies. However, whatever the reason for the bankruptcy is, low cost airlines seem to take the openings from bankrupt airlines'

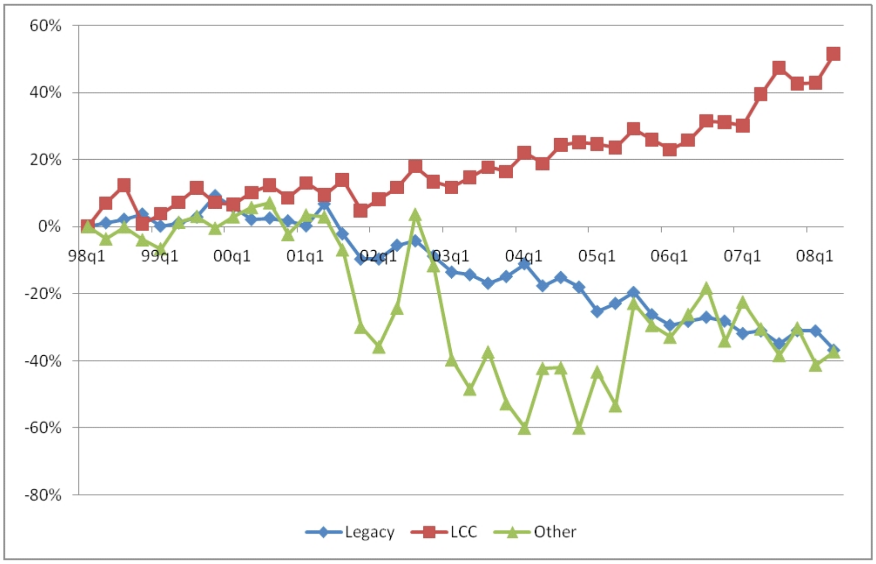

Figure 9: % Capacity Change on the Same Route, by Carrier Group (base: 1998Q1)

capacity cut for recovery as an opportunity to expand. Then how large is this effect? How much fraction of LCC growth is explained by LCC's expansion while a bankrupt rival is cutting back on capacity by reducing supplies of seats on a route or even dropping some relatively unprofitable routes. Based on the estimation results, we can calculate the fraction from the following formula:

$$\text{Bankruptcy effect} = \sum_{r\in\{Bankrupt\ routes\}} \sum_{i\in\{LCC\}} \sum_{t\in\{Bankrutcy\ periods\}} \frac{\widehat{\Delta\%}_t}{1+\widehat{\Delta\%}_t} \cdot \text{Capacity}_{i,r,t}$$

while $r \in \{Bankrupt\ routes\}$ is a route where some airlines serving the route are in bankruptcy, $i \in \{LCC\}$is a low cost airline serving bankrupt routes, $t \in \{Bankrutcy\ periods\}$ is the period while some airlines serving the route are bankrupt and "Bankrupt periods" are $\{[T_B], [T_B + 1], [T_B + 2\tilde{}T], [T_{Exit} + 1, T_{Exit} + 2], [T_{Exit} + 3\tilde{}]\}$ in the empirical section, $\text{Capacity}_{i,r,t}$ is the the capacity level of the low cost airline i on route r at time t "but for" rival's bankruptcy, and $\widehat{\Delta\%}_t$ is a set of the summation of the two estimated coefficients on non-bankrupt airlines and non-bankrupt LCC for each bankruptcy period (except for pre- and post-bankruptcy periods) that are significant in Table 8 (regression results on log-transformed number of seats available). From Table 8,

	Legacy Bankruptcies				
	During Bankruptcy			After Exit	
$t =$	$[T_B]$	$[T_B+1]$	$[T_B+2\tilde{}T]$	$[T_{Exit}+1, T_{Exit}+2]$	$[T_{Exit}+3\tilde{}]$
NonB	.0302*	.0110	.0418***	.0065	.0083
NonB_lcc	.0865***	.0991***	.1494***	.0478***	.1763***
SUM	0.1167***	0.1101***	0.1912***	0.0543	0.1846***
$\widehat{\Delta\%}_t$	0.1167	0.1101	0.1912	0	0.1846

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

	Other Bankruptcies				
	During Bankruptcy			After Exit	
$t =$	$[T_B]$	$[T_B+1]$	$[T_B+2\tilde{}T]$	$[T_{Exit}+1, T_{Exit}+2]$	$[T_{Exit}+3\tilde{}]$
NonB	-.1007***	-.1041***	-.0632***	.0132	.0342
NonB_lcc	.2684***	.0631***	.0778*	.0463	.1641***
SUM	0.1677***	-0.041	0.0146	0.0595*	0.1983***
$\widehat{\Delta\%}_t$	0.1677	0	0	0.0595	0.1983

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

For now, we estimated the effect with a easier (in terms of calculation) version of the formula:

$$\text{Bankruptcy effect} = \sum_{r\in\{Bankrupt\ routes\}} \sum_{i\in\{LCC\}} \sum_{t\in\{Bankrutcy\ periods\}} \widehat{\Delta\#}_t$$

Here $\widehat{\Delta\#}_t$ is the estimated average difference in capacity compared to the usual periods unaffected by bankruptcy. That is, $\widehat{\Delta\#}_t$ is a set of the summation of the two estimated coefficients on non-bankrupt airlines and non-bankrupt LCC for each bankruptcy period (except for pre- and post-bankruptcy periods) that are significant in Table 11 in the next section (robust regression results on raw number of seats available). This number will give us a rough idea of the size of the fraction.

	Legacy Bankruptcies				
	During Bankruptcy			After Exit	
$t =$	$[T_B]$	$[T_B+1]$	$[T_B+2\tilde{}T]$	$[T_{Exit}+1, T_{Exit}+2]$	$[T_{Exit}+3\tilde{}]$
NonB	0.473	0.384	1.102	0.213	0.672
NonB_lcc	4.474***	5.648***	6.656***	3.333*	10.568***
SUM	4.948***	6.033***	7.758***	3.546***	11.241***
$\widehat{\Delta\#}_t$	4.948	6.033	7.758	3.546	11.241

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, Unit: 1000 seats

	Other Bankruptcies				
	During Bankruptcy			After Exit	
$t =$	$[T_B]$	$[T_B+1]$	$[T_B+2\tilde{}T]$	$[T_{Exit}+1, T_{Exit}+2]$	$[T_{Exit}+3\tilde{}]$
NonB	-3.860***	-4.537***	-3.544***	-0.558	0.805
NonB_lcc	7.712***	6.109***	7.345***	5.059***	4.384***
SUM	3.852***	1.571	3.800***	4.500***	5.189***
$\widehat{\Delta\#}_t$	3.852	0	3.800	4.500	5.189

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, Unit: 1000 seats

As a result, the fraction of LCC growth explained by responses to rivals' bankruptcy is about 10.22% of the growth from the first quarter of 1998 to the second quarter of 2008 in the quarterly 1000 most travelled routes. If we only look at the growth from 2002Q1 to 2008Q2 on the top 1000 popular routes, then the fraction is estimated to be 14.69%.

If bankruptcy is one factor that spurs low cost airlines' expansion as we have seen so far, then what else would be there? How much fraction of the low cost airlines' growth is explained by rivals' bankruptcy relative to other factors? Some candidates are mergers, external demand shocks such as September 11, 2001, or supply shocks such as soaring fuel costs. We will investigate such factors that affect low cost expansion discretely and compare the size of effects to bankruptcy effects.

4 Robustness Checks

[Incomplete]

This section checks whether the results are robust over different samples and econometric specifications. We will begin with a different form of dependent variable. We then discuss the balanced sub-panel data with route selectivity under bankruptcy issue. Finally, upper and lower quartile fare will be analyzed.

4.1 Raw Number of Capacity Change

So far we have used log-transformed capacity. The choice between raw value of log-transformed value of dependent variable would depend on what we would like to look at. Using raw number will give us the difference whereas using the log-transformed value will give us ratio (percentage change). Log-transformation also has advantage of being less vulnerable to outliers in dependent variables. If we regress on the raw number, the sign of the estimates are largely unaffected but the size of effect is different.

4.2 Balanced Sub-Panel

This section uses only carrier-route pairs that exist for all quarters throughout the data periods. So, the carriers have not entered into a new route or exited from current routes in this subsample. The estimates then measure only the change in incumbents' fare or capacity. The original sample is unbalanced panel data as a carrier that is observed on a route at some point may disappear at another time or a new carrier shows up on a route.

The route selection in normal times (unaffected by bankruptcy) can be captured by individual fixed effects so the estimates would be consistent. However, the route selection may occur more actively or differently in the periods surrounding bankruptcy either because bankrupt carriers have to change their strategies discretely or because demand changes more significantly (enough to push some airlines to file for bankruptcy) in those periods. As airlines enter into profitable routes where they have comparative advantage and exit from unprofitable routes that they cannot set high price, the non-random route selection can bias the estimated bankruptcy effect on fare and capacity to zero. The selectivity bias, if present, may lead to smaller estimates for bankruptcy effects than the actual effects. The balanced sub-panel have only carriers that are present on a route throughout the data periods so the potential selectivity bias may be reduced by using this subsample, though the balanced sub-panel have drawbacks that we do not use all the information available (the sample size shrinks significantly, from 182,644 to 93,525 (84,092 to 54,015) for the fare (capacity) regression.)

Table 12 repeats the same econometric specifications in Table 8 (on capacity) and 10 (on fare) with the balanced sub-panel. The estimation results show that the direction of bankrupt effects do not change overall but the size of the estimated coefficients is larger for bankrupt firms and average non-bankrupt competitors, with balanced sub-panel. This may suggest a potential selectivity bias. Without building up a structural model of entry and exit decision, it is hard to fix the potential selectivity bias. We will work on improving the estimates in this aspect also.

4.3 Upper and Lower Quartile Price Change

In the main empirical results, we look at median fares. This section looks at upper and lower quartile fares if there is any meaningful difference over the range of fares. Table 13 reports the estimation results that repeat the same regressions in Table 10 using 25th (panel 1) and 75th (panel 2) percentile fares instead of median fare. The fare cut in the periods surrounding bankruptcy seems to be a bit larger for the upper quartile fare, though the difference does not seem big. This result may imply that airlines on bankrupt routes become to have weaker market power that allows them to price-discriminate.

Table 11. Estimation Results: Raw Number

Dependent Var.	N_seats					
	Legacy Bankruptcies			Others		
Variable	Bankrupt	NonB	NonB_lcc	Bankrupt	NonB	NonB_lcc
[T_B-2]	-4.476***	.709	1.628***	-.248	-1.471***	1.493*
	(.863)	(.491)	(.569)	(1.102)	(.481)	(.855)
[T_B-1]	-4.158***	.855	2.315***	-1.263	-2.391***	1.963**
	(.854)	(.535)	(.621)	(1.185)	(.487)	(.834)
[T_B]	-5.956***	.473	4.474***	3.093*	-3.860***	7.71***
	(1.129)	(.563)	(.687)	(1.614)	(.618)	(.992)
[T_B+1]	-8.576***	.384	5.648***	-4.256***	-4.537***	6.109***
	(1.274)	(.586)	(.662)	(1.630)	(.640)	(1.048)
[T_B+2~T]	-12.660***	1.102*	6.656***	-5.615**	-3.544***	7.345***
	(1.269)	(.665)	(.835)	(2.508)	(.922)	(1.481)
[T+1,T+2]	-13.830***	1.395**	4.414***	-17.199***	-1.786	14.904***
	(1.200)	(.556)	(.596)	(2.179)	(1.440)	(3.530)
[T+2~]	-16.755***	.104	9.038***	-4.695**	-1.450	11.651***
	(1.477)	(.818)	(.965)	(2.363)	(1.270)	(2.715)
[T_{Exit}+1,T_{Exit}+2]		.213	3.333*		-.558	5.058***
		(1.281)	(1.823)		(.737)	(1.130)
[T_{Exit}+3~]		.672	10.568***		.805	4.384***
		(2.054)	(2.757)		(.758)	(1.616)
LCCin	3.788***					
	(.710)					
SWin	4.539***					
	(1.021)					
HHI	20.365***					
	(2.975)					
Codeshr	-19.173***					
	(1.881)					
Constant	54.612***					
	(1.783)					
R-squared	0.1488					
N	84,121					

NonB_lcc (=LCC×NonB) Non-bankrupt LCC dummy

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

Table 12. Robustness Check: Balanced Sub-Panel

Panel 1: Capacity

Dependent Var.	$ln(N\_seats)$					
	Legacy Bankruptcies			Others		
Variable	Bankrupt	NonB	NonB_lcc	Bankrupt	NonB	NonB_lcc
[T_B-2]	-.1247***	.0323*	.0512**	-.0264	-.0018	-.0153
	(.0340)	(.0184)	(.0214)	(.0435)	(.0193)	(.0453)
[T_B-1]	-.1756***	.0270	.0044	.0660	-.0234	-.0135
	(.0377)	(.0197)	(.0339)	(.0516)	(.0208)	(.0426)
[T_B]	-.1031***	.0185	.0653*	.2145***	-.0769***	.1224**
	(.0383)	(.0192)	(.0340)	(.0750)	(.0239)	(.0571)
[T_B+1]	-.1713***	-.0005	.1164***	-.0682	-.1037***	.1179**
	(.0416)	(.0215)	(.0327)	(.0515)	(.0249)	(.0501)
[T_B+2~T]	-.2289***	.0298*	.2210***	-.1855**	-.0986***	.0493
	(.0280)	(.0165)	(.0309)	(.0948)	(.0216)	(.0768)
[T+1,T+2]	-.2850***	.0209	.1611***	-.1849***	.0389	.3424***
	(.0392)	(.0200)	(.0275)	(.0410)	(.0405)	(.1089)
[T+2~]	-.3892***	-.0245	.2538***	-.1766**	.0088	.1572*
	(.0418)	(.0231)	(.0328)	(.0801)	(.0268)	(.0808)
[T_{Exit}+1,T_{Exit}+2]		.0207	.1202**		-.0309	.0910*
		(.0422)	(.0524)		(.0272)	(.0540)
[T_{Exit}+3~]		.0406	.1363**		.0292	.1143**
		(.0442)	(.0540)		(.0223)	(.0508)
LCCin	.0126					
	(.0210)					
SWin	.0957**					
	(.0408)					
HHI	-.1507*					
	(.0915)					
Codeshr	-.8068***					
	(.0831)					
Constant	4.03***					
	(.0547)					
R-squared	0.0795					
N	54,015					

NonB_lcc (=LCC×NonB) Non-bankrupt LCC dummy

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

Panel 1: Fare

Dependent Var.	$ln(Med\_fare)$					
	Legacy Bankruptcies			Others		
Variable	Bankrupt	NonB	NonB_lcc	Bankrupt	NonB	NonB_lcc
[T_B-2]	-.0321***	.0031	.0109	.0410	-.0106***	.0268**
	(.0071)	(.0051)	(.0078)	(.0323)	(.0048)	(.0109)
[T_B-1]	-.0589***	-.0179***	.0293***	.0061	-.0080**	.0682***
	(.0070)	(.0050)	(.0074)	(.0290)	(.0046)	(.0110)
[T_B]	-.1138***	-.0591***	.0910***	-.0339	-.0142*	-.0187
	(.0102)	(.0056)	(.0077)	(.0316)	(.0061)	(.0152)
[T_B+1]	-.1283***	-.0478***	.0806***	.3166***	-.0240***	.0799***
	(.0103)	(.0053)	(.0072)	(.0334)	(.0070)	(.0152)
[T_B+2~T]	-.1089***	-.0573***	.0672***	.3123***	-.0539***	.0795***
	(.0100)	(.0063)	(.0076)	(.0490)	(.0087)	(.0168)
[T+1,T+2]	-.0174**	-.0139***	.0109	.3297***	.0964***	-.0552
	(.0087)	(.0051)	(.0077)	(.0426)	(.0161)	(.0355)
[T+2~]	-.0146	-.0669***	.0659***	.1375***	.0086	-.0804***
	(.0108)	(.0065)	(.0114)	(.0258)	(.0115)	(.0294)
[T_{Exit}+1,T_{Exit}+2]		-.0399***	.0817***		-.0429***	.1197***
		(.0131)	(.0242)		(.0067)	(.0123)
[T_{Exit}+3~]		-.0613***	.1564***		-.0305***	.0185
		(.0233)	(.0333)		(.0067)	(.0157)
LCCin	-.0877***					
	(.0078)					
SWin	-.1199***					
	(.0116)					
HHI	.0578**					
	(.0262)					
Codeshr	.1084***					
	(.0167)					
Net_origin	.7693					
	(.6007)					
Net_dest	.5418					
	(.6081)					
Network	-.0402					
	(.0430)					
Direct	-.0304**					
	(.0153)					
Round	-.4549***					
	(.0240)					
Constant	5.35***					
	(.0311)					
R-squared	0.1690					
N	93,525					

NonB_lcc (=LCC×NonB) Non-bankrupt LCC dummy

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

Table 13. Robustness Check: Upper/Lower Quartile Fare Change

Panel 1: Effect on 25^{th} Percentile Fare

Dependent Var.	$ln(Q1\_fare)$					
	Legacy Bankruptcies			Others		
Variable	Bankrupt	NonB	NonB_lcc	Bankrupt	NonB	NonB_lcc
[T_B-2]	-.0218***	-.0149***	.0200***	.0253***	-.0074**	.0293***
	(.0046)	(.0035)	(.0045)	(.0057)	(.0033)	(.0058)
[T_B-1]	-.0402***	-.0174***	.0202***	-.0205***	-.0088***	.0320***
	(.0050)	(.0036)	(.0043)	(.0067)	(.0033)	(.0056)
[T_B]	-.1115***	-.0446***	.0820***	-.0395***	-.0185***	.0301***
	(.0069)	(.0038)	(.0047)	(.0079)	(.0042)	(.0068)
[T_B+1]	-.0932***	-.0321***	.0671***	-.0320***	-.0202***	.0840***
	(.0071)	(.0038)	(.0048)	(.0099)	(.0051)	(.0081)
[T_B+2~T]	-.0760***	-.0361***	.0696***	-.0201	-.0530***	.1109***
	(.0069)	(.0045)	(.0058)	(.0138)	(.0058)	(.0095)
[T+1,T+2]	.0035	.0049	.0015	.0239	.0770***	-.0303
	(.0062)	(.0037)	(.0045)	(.0276)	(.0134)	(.0233)
[T+3~]	.0047	-.0319***	.0142**	-.0024	-.0160	-.0009
	(.0072)	(.0048)	(.0069)	(.0157)	(.0101)	(.0215)
[T_{Exit}+1,T_{Exit}+2]		-.0096	-.0006		-.0383***	.1341***
		(.0109)	(.0191)		(.0048)	(.0076)
[T_{Exit}+3~]		-.0478***	.0453		-.0286***	.0233***
		(.0200)	(.0300)		(.0044)	(.0087)
LCCin	-.0599***					
	(.0049)					
SWin	-.1066***					
	(.0073)					
HHI	.0479***					
	(.0061)					
Codeshr	.1152***					
	(.0090)					
Net_origin	.5966					
	(.4064)					
Net_dest	.5191					
	(.4235)					
Network	-.0019					
	(.0289)					
Direct	-.0366***					
	(.0108)					
Round	-.3931***					
	(.0134)					
Constant	4.99***					
	(.0193)					
R-squared	0.1631					
N	182,644					

NonB_lcc (=LCC×NonB) Non-bankrupt LCC dummy

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

Panel 2: Effect on 75^{th} Percentile Fare

Dependent Var.	$ln(Q3\_fare)$					
	Legacy Bankruptcies			Others		
Variable	Bankrupt	NonB	NonB_lcc	Bankrupt	NonB	NonB_lcc
[T_B-2]	-.0437***	.0076	-.0160***	.0007	-.0008	.0331***
	(.0066)	(.0048)	(.0057)	(.0084)	(.0045)	(.0086)
[T_B-1]	-.0622***	-.0067	.0021	-.0101	.0012	.0189**
	(.0070)	(.0049)	(.0061)	(.0089)	(.0043)	(.0079)
[T_B]	-.1285***	-.0531***	.0699***	-.0433***	.0093	-.0118
	(.0087)	(.0053)	(.0062)	(.0107)	(.0058)	(.0099)
[T_B+1]	-.1136***	-.0365***	.0546***	-.0059	-.0017	.0609***
	(.0092)	(.0049)	(.0060)	(.0145)	(.0073)	(.0119)
[T_B+2~T]	-.1053***	-.0423***	.0404***	.0240	-.0641***	.1200***
	(.0091)	(.0056)	(.0074)	(.0188)	(.0080)	(.0132)
[T+1,T+2]	-.0471***	-.0059	.0062	.2134***	.1088***	-.0325
	(.0087)	(.0048)	(.0050)	(.0371)	(.0155)	(.0244)
[T+3~]	-.0346***	-.0573***	.0530***	.0951***	.0412***	-.0879***
	(.0103)	(.0061)	(.0085)	(.0262)	(.0144)	(.0259)
[T_{Exit}+1,T_{Exit}+2]		-.0498***	.0355*		-.0448***	.1213***
		(.0122)	(.0199)		(.0066)	(.0105)
[T_{Exit}+3~]		-.0496***	.0838***		-.0410***	.0197*
		(.0187)	(.0263)		(.0058)	(.0104)
LCCin	-.0996***					
	(.0074)					
SWin	-.0984***					
	(.0093)					
HHI	.0854***					
	(.0220)					
Codeshr	.0888***					
	(.0121)					
Net_origin	.1510					
	(.5523)					
Net_dest	-.1913					
	(.5550)					
Network	-.0673*					
	(.0397)					
Direct	-.0013					
	(.0126)					
Round	-.7415***					
	(.0200)					
Constant	5.93***					
	(.0278)					
R-squared	0.2018					
N	182,644					

NonB_lcc (=LCC×NonB) Non-bankrupt LCC dummy

Robust Cluster SE reported in parentheses. Time specific dummies included. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

5 Conclusion

The paper investigates a potential mechanism by which bankruptcy filings affect non-bankrupt firms and the industry as a whole. We found little evidence that bankruptcy protection harms the non-bankrupt efficient firms and the industry since bankrupt airlines underprice other airlines not in bankruptcy and they are holing on to capacity that would otherwise been liquidated. Bankrupt airlines cut fares but also cut capacity, non-bankrupt rivals cut fares a little but expand capacity, and low cost airlines among non-bankrupt rivals do not cut fare and increase capacity. So efficient airlines with lower cost are not negatively affected by bankrupt airlines' pricing and increase their presence. They replace the bankrupt airlines' inefficient capacity and possibly improve industry efficiency. So bankruptcy protection does not harm the industry in the sense that bankrupt airlines do not harm industry profitability and financial health of efficient rivals. However, if the bankrupt airlines were liquidated immediately and low cost carriers can expand at low cost, then the efficient carriers' growth might have been bigger. Thus the answer to the question if bankrupt protection harms the industry would be yes and no. It is "no" in the sense that bankrupt protection does not worsen the situation but it is "yes" in the sense that efficient airlines could have expanded even more and the industry could have been better off without bankrupt airlines. Thus, the answer would depend on the capability of bankrupt airlines to cut costs down to the level comparable to low cost carriers.

Besides, bankruptcy filing seems to make distressed airlines change their strategies in a more profitable way and the capacity cut triggered by the filing allows more efficient firms to expand. This raises an interesting question about low cost airline growth. What does it take for firms to expand in addition to efficiency? Bankruptcy seems to be one factor. The fraction of LCC growth from 1998 to 2008 in the quarterly 1000 most travelled routes is estimated to be about 10%. As for other factors, external demand/supply shocks, or an immediate structural changes such as bankruptcy or merger would be potential candidates for factors that spur efficient firms' growth. Future works would be on examining each factor and compare the fraction explained by each factor to bankrupt effect.

References

Borenstein, Severin. 1989. "Hubs and High Fares: Dominance and Market Power in the US Airline Industry." *RAND Journal of Economics.* 20: 344-365.

Borenstein, Severin and Joseph Farrell. 1998. "Competition and Productive Efficiency." *Working Paper.* University of California, Berkeley.

Borenstein, Severin and Nancy L. Rose. 1995. "Bankruptcy and Pricing in U.S. Airline Markets." *American Economic Review.* 85(2): 397-402.

Borenstein, Severin and Nancy L. Rose. 2003. "Do Airline Bankruptcies Reduce Service?" *NBER Working Paper* 9636.

Busse, Meghan. 2002. "Firm Financial Condition and Airline Price Wars" *RAND Journal of Economics*. 33(2): 298-318.

Chevalier, Judith. 1995. " Capital Structure and Product Market Competition: Empirical Evidence from the Supermarket Industry." *American Economic Review*. 85(3): 415-435.

Ciliberto, Federico and Carola Schenone. 2008. "Bankruptcy and Product-Market Competition: Evidence from the Airline Industry." *Working Paper*. University of Virginia.

Farrell, Joseph and Carl Shapiro. 1990. "Horizontal Mergers: An Equilibrium Analysis." *American Economic Review* 80(1): 107-126.

Hofer, Christian, Martin E. Dresner b, and Robert J. Windle. "The Impact of Airline Financial Distress on US Air Fares: A Contingency Approach." *Transportation Research Part E*

Kennedy, Robert E. 2000. "The Effect of Bankruptcy Filings on Rivals' Operating Performance: Evidence from 51 Large Bankruptcies." *International Journal of the Economics of Business*. 7(1): 5-26.

United States Government Accountability Office. 2004. "Commercial Aviation: Legacy Airlines Must Further Reduce Costs to Restore Profitability." GAO-04-836.

United States Government Accountability Office. 2005. "Commercial Aviation: Bankruptcy and Pension Problems Are Symptoms of Underlying Structural Issues." GAO-05-945.

Verbeek, Marno and Theo Nijman. 1992. "Testing for Selectivity Bias in Panel Data Models." *International Economic Review*. 33(3): 681-703.

Wolfers, Justin. 2006. "Did Unilateral Divorce Laws Raise Divorce Rates? A Reconciliation and New Results." *American Economic Review*. 96(5): 1802-1820.

Wooldridge Jeffrey M. 2001. "Econometric Analysis of Cross Section and Panel Data." MIT Press. Cambridge, MA.

Appendix A: Tables

Table A1. Variable List: Carrier-Level Bankruptcy-Related Variables

	Period	Bankrupt	NonB
Pre B	[T$_B$-2]	" " $\_Bankrupt[T_B-2]_{irt}$ =1 if a carrier i files for B at $t+2$ 0 otherwise	" " $\_NonB[T_B-2]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t & other carrier on r files for "B" at $t+2$,0 otherwise
	[T$_B$-1]	" " $\_Bankrupt[T_B-1]_{irt}$ =1 if a carrier i files for B at $t+1$ 0 otherwise	" " $\_NonB[T_B-1]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t & other carrier on r files for B at $t+1$,0 otherwise
During B	[T$_B$]	" " $\_Bankrupt[T_B]_{irt}$ =1 if a carrier i files for B at t 0 otherwise	" " $\_NonB[T_B]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t & other carrier on r files for B at t,0 otherwise
	[T$_B$+1]	" " $\_Bankrupt[T_B+1]_{irt}$ =1 if a carrier i filed for B at $t-1$ 0 otherwise	" " $\_NonB[T_B+1]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t & other carrier on r filed for B at $t-1$,0 otherwise
	[T$_B$+2~T]	" " $\_Bankrupt[T_B+2\sim T]_{irt}$ =1 if a carrier i filed for B at $t-2$ or before and is still bankrupt 0 otherwise	" " $\_NonB[T_B+2\sim T]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t and other carrier on r filed for B at $t-2$ or before and is still bankrupt, 0 otherwise
Post B	[T+1,T+2]	" " $\_Bankrupt[T+1,T+2]_{irt}$ =1 if a carrier i emerged from B at $t-1$ or $t-2$, 0 otherwise	" " $\_NonB[T+1,T+2]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t and other carrier on r emerged from B at $t-1$ or $t-2$, 0 otherwise
	[T+3~]	" " $\_Bankrupt[T+3\sim]_{irt}$ =1 if a carrier i emerged from B at $t-3$ or before, 0 otherwise	" " $\_NonB[T+3\sim]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t and other carrier on r emerged from B at $t-3$ or before, 0 otherwise
After Exit	[T$_{Exit}$+1, T$_{Exit}$+2]		" " $\_NonB[T_{Exit}+1,T_{Exit}+2]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t where a bankrupt carrier exited from at $t-1$ or $t-2$, 0 otherwise
	[T$_{Exit}$+3~]		" " $\_NonB[T_{Exit}+1,T_{Exit}+2]_{irt}$ =1 if a non-bankrupt carrier i serves route r at t where a bankrupt carrier exited from at $t-3$ or before, otherwise

Bankruptcy is abbreviated as B, " " = Legacy if legacy bankruptcies, Oth if others.

T$_B$: Quarter of bankruptcy filing, T: Last quarter in bankruptcy, T$_{Exit}$: Quarter of a bankrupt airline's exit from a route

Table A2. Variable List: Bankruptcy-Affected Routes

	Period	Bankruptcy-affected routes
Pre B	[T_B-2]	" " $\_B\_route[T_B-2]_{rt}$
		=1 if some carriers on r files for B at $t+2$, 0 otherwise
	[T_B-1]	" " $\_B\_route[T_B-1]_{irt}$
		=1 if some carriers on r files for B at $t+1$, 0 otherwise
During B	[T_B]	" " $\_B\_route[T_B]_{irt}$
		=1 if some carriers on r files for B at t, 0 otherwise
	[T_B+1]	" " $\_B\_route[T_B+1]_{irt}$
		=1 if some carriers on r files for B at $t-1$, 0 otherwise
	[T_B+2~T]	" " $\_B\_route[T_B+2\tilde{}T]_{irt}$
		=1 if some bankrupt carriers on r filed for B two or more quarters ago, 0 otherwise
Post B	[T+1,T+2]	" " $\_B\_route[T+1,T+2]_{irt}$
		=1 if some carriers on r emerged from B at $t-1$ or $t-2$, 0 otherwise
	[T+3~]	" " $\_B\_route[T+3\tilde{}]_{irt}$
		=1 if some carriers on r emerged from B at $t-3$ or before, 0 otherwise
After Exit	[T_{Exit}+1, T_{Exit}+2]	" " $\_B\_route[T_{Exit}+1,T_{Exit}+2]_{irt}$
		=1 if a bankrupt carrier exited from route r at $t-1$ or $t-2$, 0 otherwise
	[T_{Exit}+3~]	" " $\_B\_route[T_{Exit}+3\tilde{}]_{irt}$
		=1 if a bankrupt carrier exited from route r at $t-2$ or before, 0 otherwise

Bankruptcy is abbreviated as B, " " = Legacy if legacy bankruptcies, Oth if others.

T_B: Quarter of bankruptcy filing, T: Last quarter in bankruptcy, T_{Exit}: Quarter of a bankrupt airline's exit from a route

Table A3. Summary Statistics

Panel 1: Carrier-Level Sample

Variable (Unit)	Mean	Std. Dev.	Min	Median	Max
Med_fare (2000$)	131.69	50.80	20.76	123.20	1,384
$Q1fare$ (2000$)	102.21	35.12	20.07	99	1,384
$Q3fare$ (2000$)	192.37	98.09	20.76	168.93	1,889
$Network$ (1/1000)	.443	.195	.001	.438	.747
Net_origin (1/1000)	.016	.013	.001	.013	.069
Net_dest (1/1000)	.016	.013	.001	.014	.069
N_seats (1/1000)	64.289	49.842	0	54.898	390.793
N_dprts (1/100)	4.69	3.52	0	4.21	31.86
$Mktshare$ (1)	.22	.27	.01	.08	1
LCC	.22	.42	0	0	1
$LCCin$	.71	.44	0	1	1
$SWin$	.25	.43	0	0	1
HHI (1/1000)	.467	.180	.151	.426	1
$Codeshr$ (1)	.07	.21	0	0	1
$Direct$ (1)	.51	.41	0	.36	1
$Round$ (1)	.77	.13	0	.80	1
N	182,644				
N_sgmt	84,121				

Panel 2: Route-Level Sample

Variable (Unit)	Mean	Std. Dev.	Min	Median	Max
N_seats_all (1/1000)	133.880	77.059	.272	111.115	788.992
N_dprts_all (1/100)	9.99	5.83	.02	8.43	55.49
$LCCin$	.66	.47	0	0	1
$SWin$	.28	.45	0	0	1
HHI (1/1000)	.544	.218	.151	.493	1
$\#Carriers$ (1)	4.35	2.19	1	4	11
$Distance$ $(mile)$	853.28	608.98	67	692	4502
N	42,000				
N_sgmt	41,993				

N: Sample size, N_sgmt: Segment sample size (single stage flight only)

N_seats, N_dprts only avilable for the segment sample

Appendix B: Econometric Specification

$$Y_{irt} = Legacy\_Bankrupt'_{irt} \cdot \alpha + Legacy\_NonB'_{irt} \cdot \beta + Oth\_Bankrupt'_{irt} \cdot \gamma + Oth\_NonB'_{irt} \cdot \lambda$$
$$+ X_{irt} \cdot \phi + Time_t \cdot \theta + u_{irt}$$

where

an observation unit is a carrier i $(= 1, 2, \cdots, 51)$ on a route r $(= 1, 2, \cdots, 1447)$ at time t (= $1998Q1$, $1998Q2$,$\cdots$, $2008Q2$),

Y_{irt} is a dependent variable, $\ln(Med\_fare_{irt})$ or $\ln(N\_seats_{irt})$,
$\ln(Med\_fare_{irt})$: log-transformed median fare of a carrier i on a route r at time t,
$\ln(N\_seats_{irt})$: log-transformed number of seats available by a carrier i on a route r at time t,

$Legacy\_Bankrupt_{irt}$ is a 7×1 vector of bankrupt-carrier dummies of a carrier i on a route r at time t in legacy bankruptcies, for each time period from two quarters before bankruptcy filing to post-bankruptcy periods,
i.e. $Legacy\_Bankrupt_{irt} = (Legacy\_Bankrupt[T_B - 2],\ Legacy\_Bankrupt[T_B - 1],$
$Legacy\_Bankrupt[T_B],\ Legacy\_Bankrupt[T_B + 1],\ Legacy\_Bankrupt[T_B + 2\tilde{\ }T],$
$Legacy\_Bankrupt[T + 1, T + 2],\ Legacy\_Bankrupt[T + 3\tilde{\ }])'$,[23]

α is a 7×1 vector of coefficients conformable to $Legacy\_Bankrupt_{irt}$,
i.e. $\alpha = (\alpha_{preB2}, \alpha_{preB1}, \alpha_{B0}, \alpha_{B1}, \alpha_{B2+}, \alpha_{postB1,2}, \alpha_{postB3+})'$,

$Legacy\_NonB_{irt}$ is a 9×1 vector of non-bankrupt competitor dummies in the same period in legacy (other) bankruptcies for each period from two quarters before bankruptcy filing to post-bankrupt periods plus the periods after bankrupt legacy airline exited from a route,
i.e. $Legacy\_NonB_{irt} = (Legacy\_NonB[T_B - 2],\ Legacy\_NonB[T_B - 1],\ Legacy\_NonB[T_B],$
$Legacy\_NonB[T_B + 1], Legacy\_NonB[T_B + 2\tilde{\ }T],\ Legacy\_NonB[T + 1, T + 2],$
$Legacy\_NonB[T_{Exit} + 1, T_{Exit} + 2],\ Legacy\_NonB[T_{Exit} + 3\tilde{\ }])'$,

β is a 9×1 vector of coefficients conformable to $Legacy\_NonB_{irt}$,
i.e. $\beta = (\beta_{preB2}, \beta_{preB1}, \beta_{B0}, \beta_{B1}, \beta_{B2+}, \beta_{postB1,2}, \beta_{postB3+}, \beta_{exit1,2}, \beta_{exit3+})'$,

$Oth\_Bankrupt_{irt}$ is 7×1 vector of bankrupt-carrier dummies of a carrier i on a route r at time t in other bankruptcies, for each time period from two quarters before bankruptcy filing to post-bankruptcy periods,
i.e. $Oth\_Bankrupt_{irt} = (Oth\_Bankrupt[T_B - 2],\ Oth\_Bankrupt[T_B - 1],$
$Oth\_Bankrupt[T_B],\ Oth\_Bankrupt[T_B + 1],\ Oth\_Bankrupt[T_B + 2\tilde{\ }T],$
$Oth\_Bankrupt[T + 1, T + 2],\ Oth\_Bankrupt[T + 3\tilde{\ }])'$,

γ is a 7×1 vector of coefficients conformable to $Oth\_Bankrupt_{irt}$,
i.e. $\gamma = (\gamma_{preB2}, \gamma_{preB1}, \gamma_{B0}, \gamma_{B1}, \gamma_{B2+}, , \gamma_{postB1,2}, \gamma_{postB3+})'$,

[23] See Table 3 or Table A1 for details.

Oth_NonB_{irt} is a 9×1 vector of non-bankrupt competitor dummies in the same period in legacy (other) bankruptcies for each period from two quarters before bankruptcy filing to post-bankrupt periods plus the periods after bankrupt legacy airline exited from a route,

i.e. $Oth\_NonB_{irt} = (Oth\_NonB[T_B - 2],\ Oth\_NonB[T_B - 1],\ Oth\_NonB[T_B],$
$Oth\_NonB[T_B + 1], Oth\_NonB[T_B + 2\tilde{\ }T],\ Oth\_NonB[T + 1, T + 2],$
$Oth\_NonB[T_{Exit} + 1, T_{Exit} + 2],\ Oth\_NonB[T_{Exit} + 3\tilde{\ }])',$

λ is a 9×1 vector of coefficients conformable to Oth_NonB_{irt},

i.e. $\lambda = (\lambda_{preB2}, \lambda_{preB1}, \lambda_{B0}, \lambda_{B1}, \lambda_{B2+}, \lambda_{postB0}, \lambda_{postB3+}, \lambda_{exit1,2}, \lambda_{exit3+}),$

X_{irt} is a set of constant and control variables such as $LCC\ in$, $SW\ in$, HHI, Net_origin, Net_dest, $Network$, $direct$, $Round$, and $Codeshr$ if a dependent variable is $ln(Med\_fare)$ and $LCC\ in$, $SW\ in$, HHI, and $Codeshr$ if a dependent variable is $ln(N\_seats)$,

$Time_t$ is a set of time-specific dummies for each year, quarter pair and quarter dummies for Florida route, and

u_{irt} is the combination of time-invariant route-carrier fixed effect (δ_{ir}) and random shock to a carrier's fare on a route at specific time (δ_{irt}), i.e. $u_{irt} = \delta_{ir} + \delta_{irt}$.