Airlines Entry and Exit and Its Impact on Air Traffic Management: An Analytical Framework for Zero-Sum and Positive Sum Games

By

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ABSTRACT

Passenger airline service can have a significant impact on a metropolitan region's economy in terms of direct spending and employment, as well as on indirect spending related to industries such as tourism and the service sector. In the past decade passenger service levels have changed considerably in many markets due to a wide variety of events including increased competition, terrorism, and a downturn in the economy. Airlines have responded to these challenges in a variety of ways. Some of the traditional network carriers have been forced into bankruptcy in an attempt to reduce their costs and compete more effectively with the low cost carriers. In contrast, the low cost carriers have expanded service and enter new markets at a rapid pace.

This paper examines the economic evolutionary process whereby a dominant carrier competes intensely in one market against a similar airline and retreats in another where new, lower cost entrants expand service. The relevant literature is examined for evidence pertaining to the market's response to a network carrier's financial distress, its impact on airport service levels, and implications on local economies. A zero sum case is explained using a recent example. A positive sum case is explored, where the positive contributions of the entering carrier exceed those left behind by the resident carrier. In the process, depending on the types of gains and nature of evolving airlines network, the patterns of air traffic may also change. Using these experiences, an analytical framework is proposed that attempts to explain the emergent behavior of low cost carriers when they enter new markets. In addition, the impact of these changes on the air traffic management system is also examined.

JEL Classification: L93

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1. Introduction: *Airline Industry: House of Cards?*

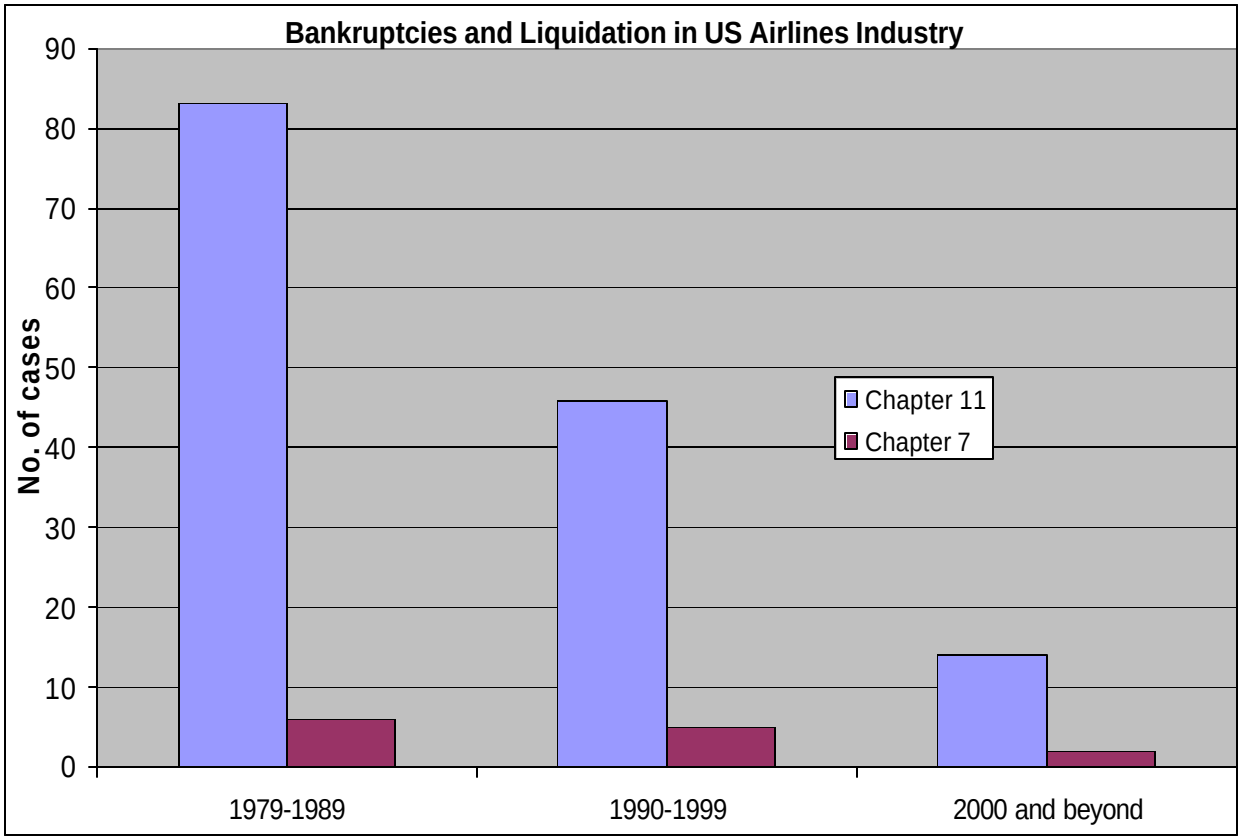
United Airline's bankruptcy declaration on December 9th, 2002 did not come as a surprise to many industry watchers and analysts. Speculation had been rampant in the months preceding the announcement. However, the fortune of then No.2 carrier (in terms of both capacity and passenger enplanements) was sealed on December 4th when the Air Transportation Stabilization Board (ATSB) rejected United's bid to secure a guarantee for US $1.8 billion of a US $2 billion loan. In its rejection letter to United, the ATSB indicated that the business plan of the carrier was faulty for several reasons: (a) revenue projections were out of line with what the future may actually hold, particularly against the backdrop of rapidly declining yields and a lack of enthusiasm in passengers for paying premiums on business class travel; (b) cost structure - even after proposed restructuring - was still at a significant disadvantage compared to that of the industry; and, (c) the potential effects of continued expansion by low-cost carriers had not been considered adequately in developing revenue projections [see http://www.ustreas.gov/press/releases/reports/unitedltr1.pdf for more details].

Prior to the ATSB's decision, there had been extensive reports of lobbying and counter-lobbying on Capitol Hill. While the House Speaker, J. Dennis Hastert aggressively supported United's bid for the loan guarantee, United's main competitors asked the ATSB to reject the guarantee. A loan guarantee to United, competitors argued, would be inappropriate aid for a mismanaged airline and a waste of taxpayers' money[ii] [see http://www.nytimes.com/2002/11/27/business/27AIR.html?todaysheadlines]. At the end, the ATSB seemed to have sided with the competitors' viewpoints. As the Chairman of the ATSB, Edward Gramlich put it, "the Loan Board has a responsibility to taxpayers, and to fostering the long-term health of the airline industry" [see http://www.ustreas.gov/press/releases/reports/unitedgramlich.pdf]. After spending the next year restructuring costs and realigning to emerging revenue scenarios, United has secured exit financing from private financiers as of December, 2003, provided that it can also secure loan guarantee from the ATSB. It is expected that the carrier will go back to the ATSB, sometimes in early spring 2004, with a loan appeal amounting to around $1.6 billion.

United's declaration of bankruptcy was the third among the network carriers since 2001. On July 10, 2002, the ATSB conditionally approved the application of US Airways for a Federal loan guarantee of US $980 million. On Aug. 11th, US Airways too sought bankruptcy protection. Hawaiian Airlines, the third network carrier, sought bankruptcy protection on March 21, 2003.

Bankruptcies (Chapter 11) and liquidation (Chapter 7) are not new to the US airlines industry. As the figure 1 below shows, the industry had experienced numerous bankruptcies and liquidations in the past; with 83 cases of chapter 11 in the decade following deregulation of the industry in 1978, of which 6 resulted in Chapter 7. The growth environment of the 1990s, especially those taking place in the latter part of decade, appears to have stabilized the economic environment of the airline industry and resulted in only 46 chapter 11 cases, of which 5 evolved into Chapter 7. The decade of 2000, which began with a slowdown of economic activities and the tragic events of Sept. 11, 2001, appears to have increased the bankruptcy and liquidation possibility. The industry had already witnessed 14 cases of bankruptcies, of which 2 resulted in liquidation, through October 2003.

Figure 1:



Source: ATA (2003); Based on data from Table 1 in Appendix A.

In addition to the direct impact on service to passengers, the bankruptcies have profound economic impact. Air carriers are an integral part of local economies, large or small. Through its direct and indirect effects on employment, tourism, and airport finance, air carriers can both stimulate and benefit from local economies. Bankruptcies and possible liquidation affects these local economies substantially. So much so, the trends in bankruptcies following Sept. 11, 2001 have caused an alarm among regulators and policy-makers alike. Since every bankrupt carrier is unique, both in terms of the role they play on their local economies and their role in the overall air transportation network, it would be impossible to draw generalized conclusions regarding the effects of these bankruptcies. Nonetheless, it is important to understand and perhaps quantify what roles these bankruptcies play on route networks and hence on air transportation, and local economies.

This paper is an attempt to examine this economic evolutionary process whereby a dominant carrier retreats from markets as new entrant/s gradually take on opportunities left behind. If the entering carrier/s is truly a substitute for the resident carrier, in terms of number of passengers and operations,[iii] the resulting outcome yields to zero-sum; positive if the contributions exceed those left behind by the resident carrier and *vice versa*. In the process, depending on the types of gains and nature of evolving airlines network, the patterns of air traffic may also change. The underlying fiscal relationships may undergo significant changes as well. In this paper, we examine two carriers, US Airways and Southwest Airlines in two markets, Baltimore-Washington International Airport (BWI) and Philadelphia International Airport (PHL). Using experience from the BWI market, we built an analytical framework that attempts to explain the emergent behavior

of Southwest in PHL. The paper is divided as follows: Section 2 briefly reviews the literature. In particular, we examine the evidence pertaining to the market response to a network carrier's financial distress, and its impact on airport service levels. Section 3 describes a situation where network carriers compete among each other yielding a zero sum outcome using Washington Dulles International Airport (IAD) as a case study. Section 4 describes the evolutionary process demonstrating a positive sum outcome that took place over the last 10 years in the BWI market. Section 5 describes the most recent market situations at PHL and develops an analytical framework to explain the emergent behavior of Southwest Airline[iv], drawing on experiences from the BWI market and elsewhere. Section 6 concludes the paper.

2. Review of Evidence: *Your Loss is My Gain*

Market Response to Bankruptcies: An Example

Bankruptcies at US Airways and United sent stocks of rival carriers surging around the time of those decisions, August 11th and Dec. 9th, 2002, respectively. This response was primarily guided by the anticipation, analysts argue, that rivals such as American, Delta, Northwest and Continental – all network carriers – are likely to gain in two different ways from the bankrupt airlines' woes. First, other network carriers are expected to pick up capacity from the restructuring of United and US Airways, as these carriers are expected to leave markets that are unsustainable under bankruptcy requirements. Second, rivals may gain significant cost savings by wringing out concessions from employees by wielding the bankruptcy hammer [see Herskovitz (12/5/2003), Reuters].

Impact of Bankruptcies on Airline services

The impact of bankruptcies on airline service levels, (i.e., the operations and number of destinations they serve – two important indicators) has been empirically studied by Borenstein and Rose [see Borenstein and Rose (2003)]. By examining data from 1984-2001, they estimate the impact of major airline bankruptcies on the level of flights and destinations served at US airports. These impacts have been made to depend on time lagged effects of bankruptcies.[v] Thus, the 2 quarters leading up to, and the 2 quarters after, and including the quarter at which bankruptcy took place have been considered as independent variables in addition to local employment and personal income. Finally, by incorporating a set of airport seasonal and time effects to control for systematic changes in service levels, they estimate the number of flights at airports and number of destinations they serve. Furthermore, sub-sampling data along three hubs, (large, medium, and small), allow them to capture the hub-specific impact of airline bankruptcies. Large hubs, for the purpose of empirical estimation, were defined as those averaging more than 400 flight operations a day during the 18-year sample period; and there were 26 airports in this category. Medium hubs (51 airports) were defined as those with 100-400 flight operations a day while small hubs (118 airports) were those with 8-100 flight operations a day.[vi]

The overall empirical findings support the general belief that bankruptcies hurt both the number of flights airlines operate and the number of destinations airlines serve. In particular, the number of flights declines by around 20% in the quarter an airline files for bankruptcy. The quarters leading up to a bankruptcy have a negative impact; the effect gradually peters out going forward. The cumulative impact of bankruptcies on flight operations, observed over 5 quarters, have been estimated to be around -8.7%. Thus, if an airline operator has a 50% share of the market, filing bankruptcy would result in an overall decline of 4.35% in flight operations at the airport. A similar effect has been also estimated in case of number of destinations. However, the cumulative impact is relatively lower, estimated at -5.4%.

The empirical work by Borenstein and Rose is an important contribution, especially at this juncture of time when so many airlines are either faced or facing grim prospects of bankruptcy and liquidation. Furthermore, the industry, academia and the policy-makers alike lack full understanding of the impact of airline bankruptcies despite numerous occurrences over the last two decades.[vii] Despite this, and somewhat mixed results, there are important financial implications arising from the findings of Borenstein and Rose (2003) which need careful consideration by airport operators.[viii]

However, the applications of these results for policy implications and airport finance, as the authors themselves point out, shall wait further and careful research. This is because the empirical study had several shortcomings: (i) the statistical significance of empirical point estimates does not appear to be consistent. For example, it is not clear why the bankruptcy during quarters prior to filing would have positive impact for smaller airports, but negative for other airports. (ii) Many of the estimated coefficients, especially those for the number of destinations served equation, have been found to be statistically insignificant. Bankruptcy appears to statistically significantly affect only ,the number of flights at the time (quarter) of filing, especially at medium and small airports; (iii) The speed at which airports adjust to the post-bankruptcy environment has not received any attention in the study. While there is some evidence that the effect of bankruptcy peters out going forward, the evidence is not definitive. The airlines industry is dynamic. It is expected that as bankrupt air carriers abandon markets, they may open up opportunities for rival carriers. The speedier those responses, the faster will be the adjustment for airports to return back to original levels of service[ix]. The present study does not consider these important aspects stemming from bankruptcy and adjustments; and, (iv) The impact of regional economies has not been given attention even though both local employment and personal income have been factored in both estimating equations. Conversely, given the causality embedded in the estimating equations, the impact of airline operations (or, lack thereof due to bankruptcies) on regional economies can not be understood either.

3. Zero-Sum Game: A Case Study of IAD

When carriers with similar business models compete head on, it tends to result in a zero-sum game. In the case of Washington Dulles International Airport (IAD), a network carrier, US Airways, attempted to establish itself at a secondary hub of another network carrier, United Airlines.

The scenario is a very familiar one. A competing airline comes in to another airlines' established "territory." The number of operations and passengers increase dramatically as both airlines lower fares and jockey for market position. Ultimately the carrier left standing is the one that is willing to sustain losses the longest, since neither airline has a low enough cost structure to sustain their position indefinitely. Typically the airline trying to move into the market is the casualty, since the existing airline has some home field advantage (e.g., a large base of frequent fliers, and more flight offerings). Once the challenging airline retreats, the market characteristics at the airport revert back to initial levels of activity. Thus, the competition yields a zero sum outcome in the long run.

In this scenario neither carrier can afford to charge fares that do not cover their operating costs for extended periods of time. While it is true that network carriers tend to focus on market share and market dominance as desired metrics, as opposed to individual segment profitability, thus leading them to serve some unprofitable routes. This modus operandi cannot be sustained for all destinations out of a hub airport.

The table below demonstrates the timeline well. Back in 1997, United accounted for close to half of the passengers departing out of Washington Dulles (48%). US Airways was among the other network carriers that had a presence at IAD in order to feed their hub and spoke network (i.e. Delta to Atlanta, Continental to Newark and Houston, Northwest to Detroit and Minneapolis, American to Dallas and Miami, and US Airways to Charlotte and Pittsburg).

Table 1: Aviation Activities at Washington Dulles (IAD) Airport

	All Carriers at IAD		United Airlines at IAD		US Airways at IAD	
	Departures	Passengers	Departures	Passengers	Departures	Passengers
Mar-97	4,511	376,344	32%	48%	12%	11%
Mar-00	6,881	555,075	43%	54%	27%	19%
Mar-02	4,775	401,260	40%	54%	5%	4%

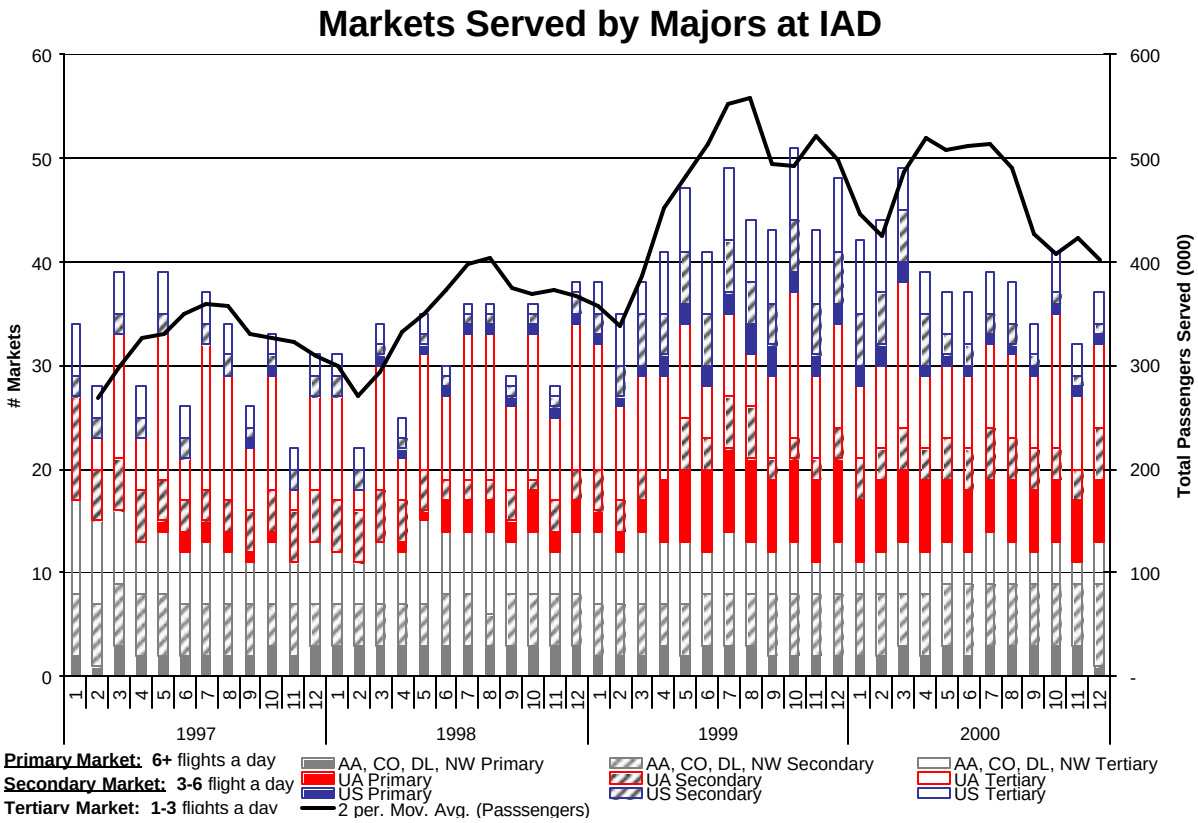
By March of 2000, US Airways and United were nearing the end of the market share battle at Dulles. Both passengers and departures had significantly increased from 1997 levels as United Airlines increased operations to match US Airway's play for the market. Eventually US Airways retreated, and by March of 2002, their presence at Dulles was minimal. By this time total operations and passengers had nearly reverted back to their 1997 levels. In other words, intense competition had not yielded any differentiable and long-term sustaining benefit to either carriers, and perhaps to the passengers as well.

The story becomes even more evident looking at Figure 2. Initially United served a little over 10 destinations between 1 and 6 times a day. US Airways served about half the number of destinations as United at this time. However by 1999 they began serving more destinations and adding frequency to existing destinations (increase in length of blue section). In response, United began serving its destinations much more intensively (increase in solid red section), giving passengers more frequent access to United's network. By the end of 2000 US Airways significantly reduced its operations (decrease in blue section).

The home court advantage can easily be seen in the percentages above. As United rose to meet the challenge by US Airway's, a 9% increase in departure market share led to a 6% increase in passenger market share (a ratio of 2/3). However US Airways had to work a lot harder to get similar results. For US Airways a 15% increase in departure market share only led to an 8% increase in passenger market shares (a ratio of almost 1/2).

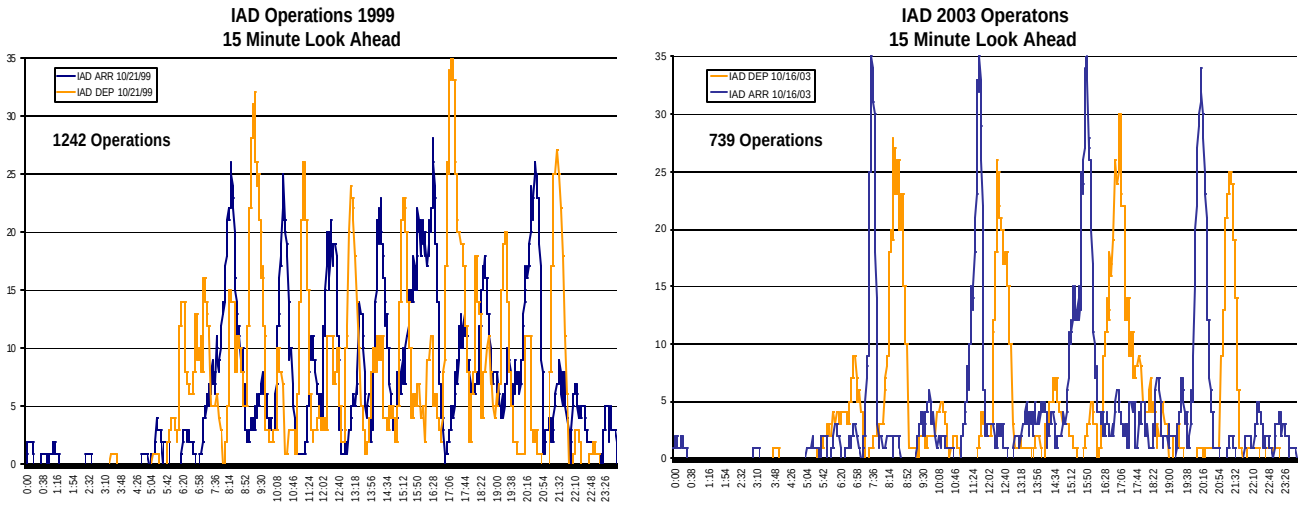
It should be noted that United may have been even more eager to curb the growth of US Airways at Dulles because of their experience at Chicago. United's main hub of operations, Chicago O'Hare International (ORD) was already shared with another airline, American Airlines. In the past, the duopoly at Chicago has made it difficult for United to pursue favorable airport improvements and use airport capacity efficiently.[x]

Figure 2:



When network carriers compete against each other, it also has implications on air traffic management (ATM). Since the network carriers tend have similar operational characteristics, they make operations at the airport more complex when they compete with each other. Network carriers tend to operate banks of flights, where many incoming or outgoing operations occur in a short period of time. This operational characteristic cuts down on passenger connect times, but uses resources very intensely. As can be seen from the graphs [Figure 3], when US Airways and United were competing head on in 1999, there were multiple bursts of activity throughout the day, with little time for operations to recover if the system was disrupted. In 2003, with United as the lone dominant carrier at Dulles, the schedule becomes even more intense. However there is now room for "schedule recovery" should operations become disrupted due to weather or other causes. From an ATM perspective these short but intensive bursts of operations take a toll on the en-route environment, since adjacent sectors can only handle so many aircraft in a given period of time.

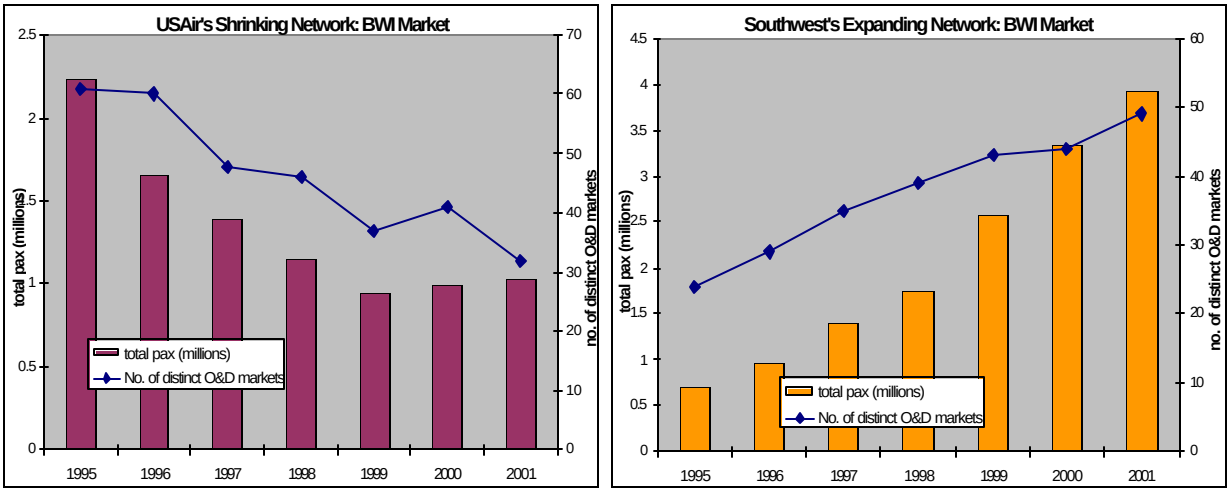
Figure 3: Banking operations[xi] before and after competitive responses



4. Positive-Sum Game: A Case Study of BWI

In 1992, US Airways had a strong presence at BWI. With more than 1,300 weekly departures heading to 63 domestic and international destinations, US Airways was serving more than 4.5 million annual passengers [UNISYS (2002)]. With an 80:20 split between local and connecting passengers, respectively, BWI was an important hub for US Airways. Southwest Airlines entered the market in October, 1993. Although the impact was felt the following year dramatically, with a staggering 42% annual growth, Southwest's expansion has been persistent over the years. On average, BWI has experienced an annual growth rate of 13.7% in total passengers. By 2000, the airport was serving almost 9 million passengers and Southwest was the dominant carrier.

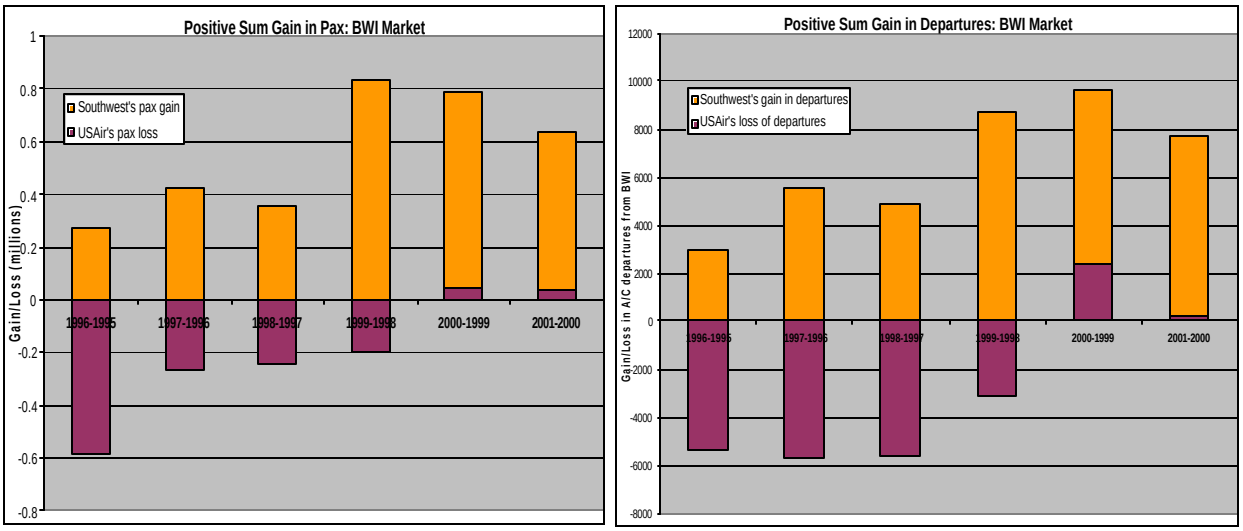
Figure 4: US Airways Contracts while Southwest Expands



While Southwest expanded its base and developed BWI as a major east coast operations base, US Airways contracted gradually. As the figure below demonstrates, US Airways served less than a million passengers in 2001 compared with more than 2 million passengers in 1995. By 2001, the number of total destinations served by US Airways was less than 30. In contrast, Southwest, as shown in figure 4, expanded and served more than 4 million passengers and 50 destinations from BWI in 2001. This transition has come about gradually; as US Airways has become marginalized at BWI, Southwest has become an important player, not only at BWI but throughout the East Coast.

Has this process left the Baltimore-Washington metro economy better or worst off? In order to understand this, we should weigh the relative gain against relative losses. Since US Airways and Southwest are the two major players at BWI, we have decided to keep this weighing between these two carriers only. The overall magnitude of this net gain may change if we expanded our analysis to account for other carriers, but the overall conclusions would not change. Figure 5 below demonstrates that, overall, Southwest's gains (represented by orange) far exceed US Airways's losses, both in terms of passengers (panel 1) and number of departures (panel 2). In particular, Southwest began to pull ahead, as time went by, in much larger volumes than passenger losses of US Airways.. While US Airways lost a little more than 1.24 million passengers during the period 1996-2000, Southwest gained almost 2.63 million passengers. In other words, more than 1.38 million new passengers were added to the system assuming that passengers (lost and gained) are perfect substitute for each other. During the same period, while the number of US Airways departures declined by more than 17,000, Southwest added a little more than 29,000 departures.[xii]

Figure 5: Positive Sum Gain for BWI and Baltimore-Washington Metro economy

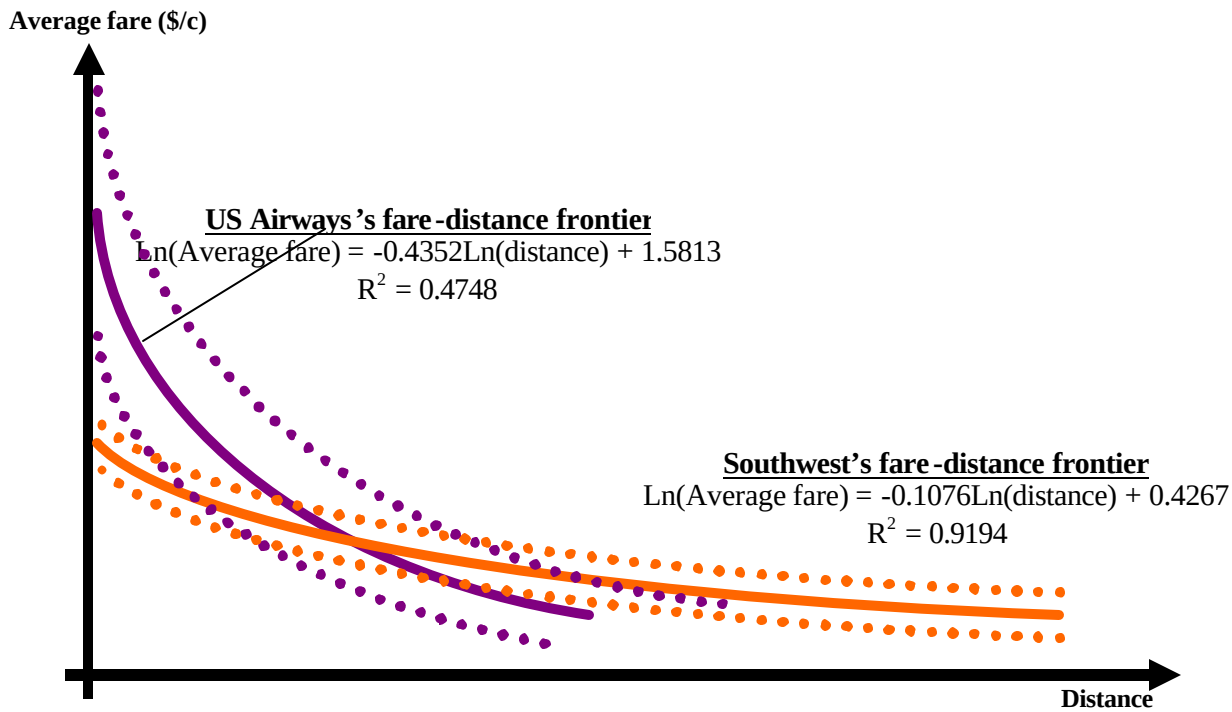


Clearly, these findings have important implications for the Baltimore-Washington metro economy. Assuming that Brueckner's 10:1 ratio[xiii] applies to this context and can be maintained over time in the Baltimore-Washington metro area, this would imply that Southwest's entrance has added almost 140,000 new jobs in the metro area. Furthermore, the 1.38 million net additional passengers have added more than $7 million in revenue to BWI airport from passenger facility charges alone. Notice, however, that this net gain in employment has taken more than 5 years and the adjustment process may not have been smooth for many people

involved, particularly those who lost employment with US Airways or were transferred elsewhere.

The primary vehicle through which Southwest has attracted passengers to BWI is via offering competitive fares. Southwest's relatively low fares forced US Airways into an uncompetitive position. In order to maintain its revenue position at BWI, US Airways, attempted to raise fares in some markets, short-hauls in particular, that led passengers into either choosing Southwest (wherever these alternatives were available) or leave the market altogether [see UNISYS (2002) for this discussion]. On the one hand, lower fares induced many motorists to choose Southwest over driving. Thus, substitutability between carriers, and the demand inducement through competitive fares (i.e., complimentarity effect) sit at the core of BWI's rapid traffic growth in recent times.[xiv]

Figure 6: Fare Distance Frontier for Two Carriers at BWI Market



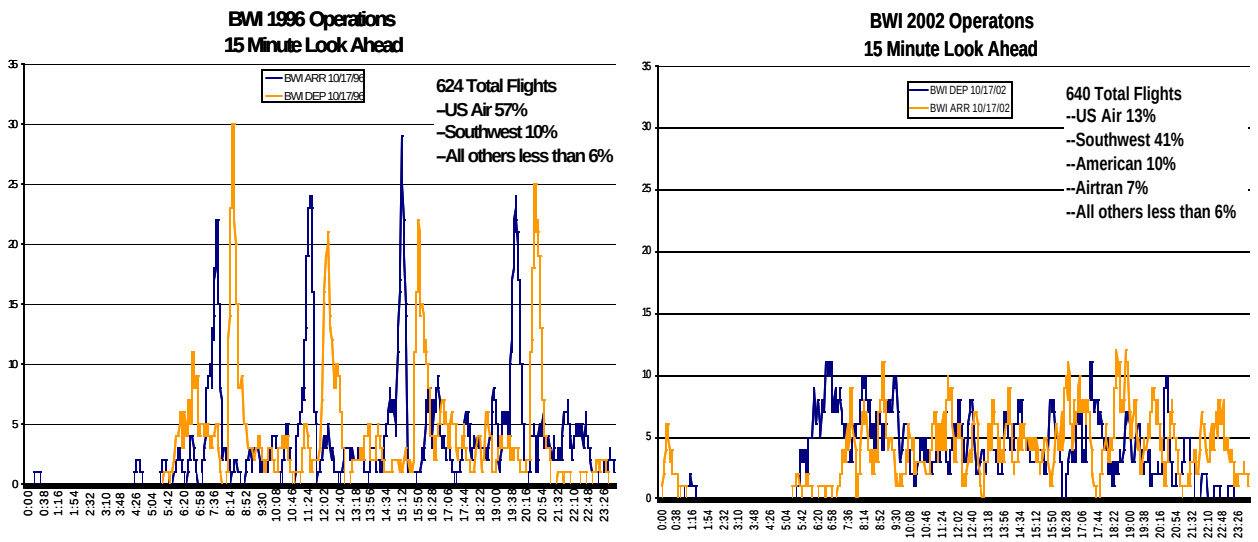
The dynamics underlying fare competition is also shown in figure 6, drawn notionally based on estimated relationships. We estimate the fare-distance relationship for the two carriers in the BWI market using data for the second quarter of 2003. As the figure shows, average fare tends to decline for both carriers with distance; although relatively faster for US Airways than Southwest. Second, US Airways still tends to enjoy a relatively higher entry or reservation fare, as captured by the higher vertical intercept. Finally, the variance of this relationship is far higher for US Airways than it is for Southwest. In other words, US Airways tends to charge higher variants on its base price than does Southwest. These three characteristics together also form the foundation of Southwest's fare policy. Competitive fares (as reflected by lower intercepts) across many destinations (as captured by distances) with lower variations on base prices (i.e., maximum walk-in fares of $299/one-way) has led Southwest to attract new passengers and retain them over time [see also UNISYS (2002) for market-to-market competition between the

two carriers]. Pursuing a policy counter to this has led US Airways, to retreat from the BWI market.

The changes in airline market share and increases in activity levels also have implications for air traffic management at BWI and the surrounding airspace.[xv] Complexities in air traffic management will likely increase, *ceteris paribus*, as the operational intensity increases. However, the complexity arising from higher operations can be offset by airline scheduling practices. In other words, airlines can dampen the intensity of air traffic complexities by distributing their operations throughout the day, resulting in a less "peaky" banking structure.[xvi] The figure below demonstrates this effect.

The left hand panel of the Figure 7 shows the number of operations at BWI in 15 minute increments in 1996. US Airways was still the dominant carrier, and accounted for 57% of all operations at the airport. The four traditional hub and spoke connecting banks US Airways operated at BWI are clearly evident, with a peak of 30 departures during the 8:30 am bank. In contrast, the right hand panel shows BWI operations on a typical day in 2002, when Southwest had become the dominant carrier with 41% of the market, and US Airways had declined to 13%. Even though the total number of flights had gone up (640 versus 624) the peak period activity had declined by nearly a third, with a peak of only 12 flights. This flattening of the curve reflects the "rolling hub" technique employed by Southwest. Rather than offering a limited number of connecting opportunities to a wide number of destinations (as shown in the left hand panel), Southwest provides very frequent service to a limited number of destinations. This greatly increases their operating efficiencies by ensuring that Southwest gate and ramp staff, ground equipment and gates are fully utilized throughout the day. From an Air Traffic Management perspective, the rolling hub allows for more aircraft to operate at an airport per day compared to a traditional connecting bank structure. Smoothing out the peaks allows for a more efficient operation and allows for the ATC system to recovery more easily from adverse weather and other events which may limit the capacity of an airport or surrounding airspace. .

Figure 7: Banking operations at BWI before and after Southwest became the dominant carrier



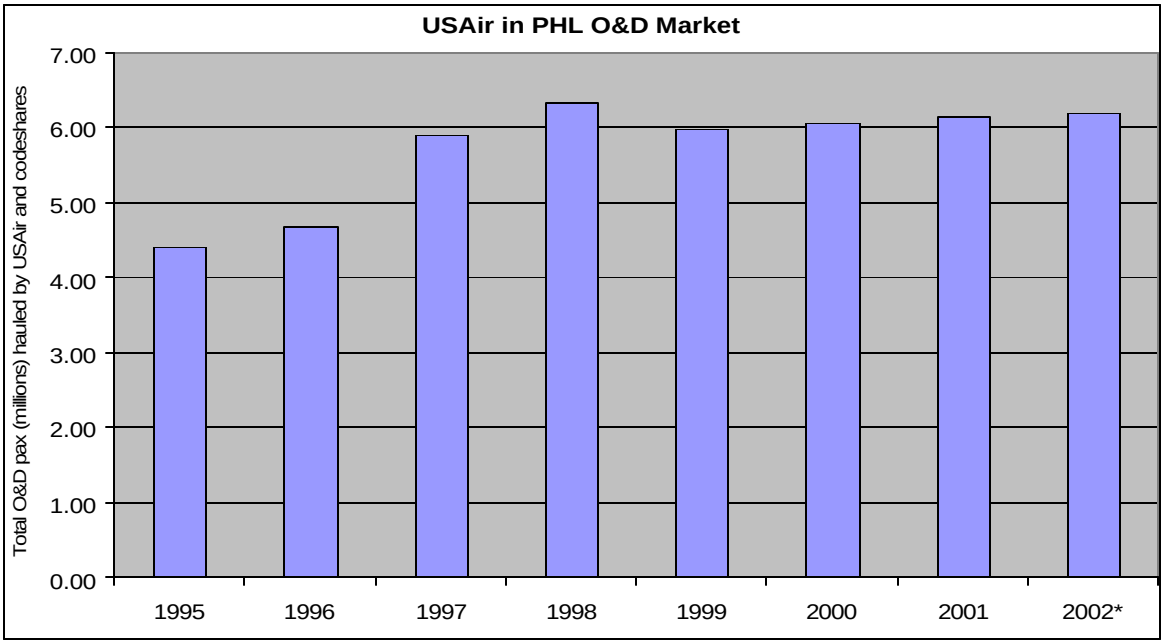
5. Southwest Airlines in PHL market: Taking the cue from BWI

Description of PHL Market

Philadelphia, it is generally agreed upon, is an underserved market [see UNISYS (2003) for some evidence]. The size of the origin-destination (O&D) market is relatively low compared with similar sized cities and airports. For example, while the ratio of O&D passengers per capita is around 1 for the Philadelphia economic area, it is 2.42 for San Francisco, 2.2 for the Baltimore-Washington metro, 1.9 for Chicago, 1.85 for Boston, 1.6 for Houston, and 1.24 for New York[xvii]. This has been primarily due to US Airways's failure to grow the market to its full potential as Figure 8 below demonstrates. With US Airways as its dominant air carrier, PHL's total O&D traffic was a little over 7 million in 2000.

One of the ways that air carriers grow market, as we have seen from the BWI case study, is through offering competitive fares. In almost all the markets that Southwest serves through BWI, lower air fares have induced powerful responses from travelers. This has been possible as Southwest honed in on the comparative cost advantage over US Airways at BWI, and elsewhere. In comparison, US Airways had little or no opportunity to offer competitive fares, either at BWI or PHL, faced with increasing per unit cost (i.e., cost per available seat miles) throughout the 1990s. Consequently, the markets originating and ending at PHL did not grow, especially between 1997-2002. [xviii].

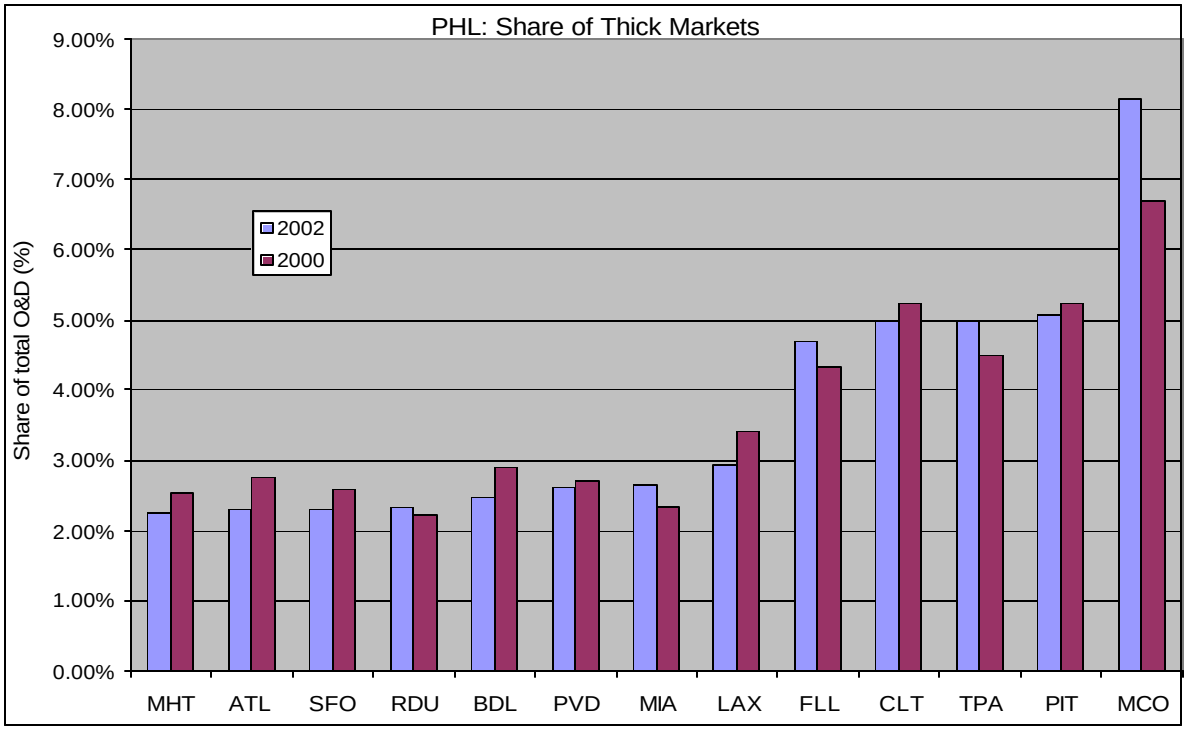
Figure 8:



'*': Estimated 2002 based on data for 6 months.

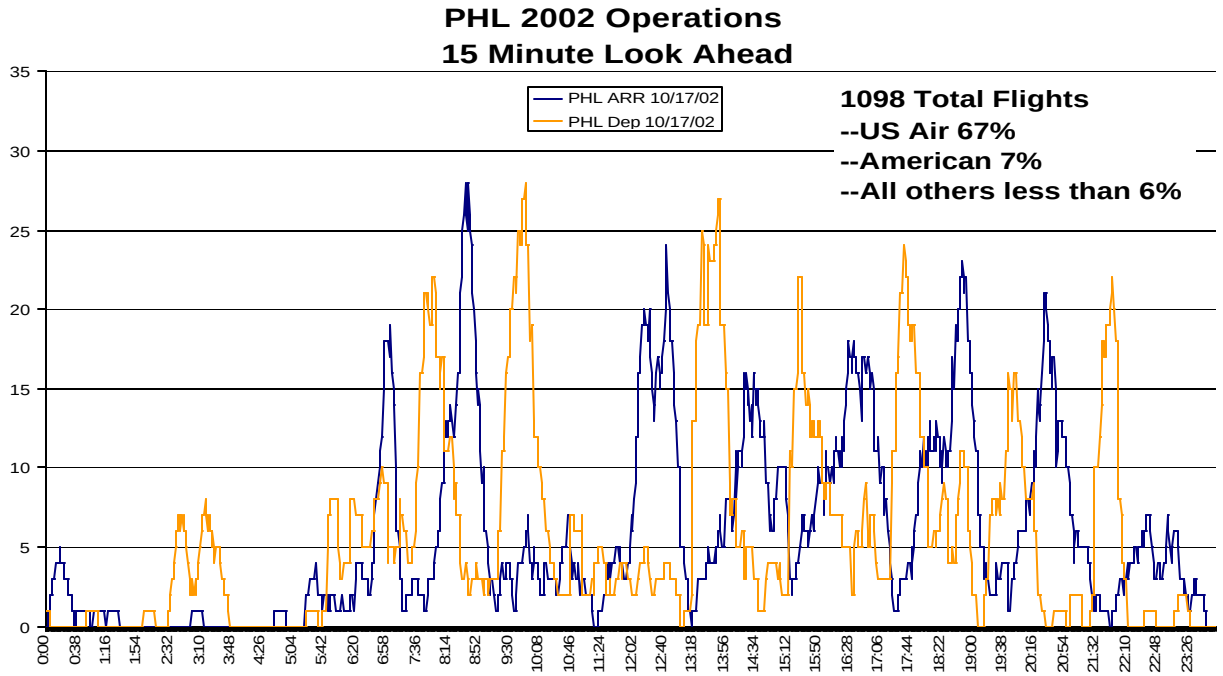
The market share of individual cities (i.e., number of passengers in a market relative to the total passenger counts of US Airways in PHL), as a result, have not grown either [see figure 9]. A closer look at 13 of the top 15 markets[xix] of US Airways from PHL reveals that, despite demand reductions in periods following the events of 2001, the top markets (or, "thick" markets) have managed to maintain their relative strengths fairly well. The relative strength of these markets also demonstrates that these are stable O&D markets.

Figure 9:



Finally, as at BWI under US Airways dominance, PHL too has a very peaky banking structure at present. The peaky banking structure, together with relatively higher volumes in operations, also increases the likelihood of delays at PHL.

Figure 10:



Choice of Markets

We present a simple framework below to analyze Southwest's choice of markets as it enters into PHL. Much of the choice rationale is based on Southwest's demonstrated behavior at BWI, and what is likely given the uniqueness of PHL. There are two primary reasons for which predicting the right markets for Southwest at PHL may have important implications, especially for understanding air traffic management. First, market choices by Southwest will have tremendous impact, as we have seen in BWI and elsewhere, on airline traffic and the entire metro economy. This, in turn, will have implications for infrastructure development at the airport and in the metro economy. If Southwest induces air transportation demand, half of the magnitude of it has generated in BWI, we may witness tremendous pressure on all aspects of aviation infrastructure in the very near future.[xx]

Second, increased operations resulting from higher demand will increase both the volume and complexities of air traffic management. The major difference between BWI and PHL is that the airspace above PHL is already crowded due to high volumes of enroute traffic destined for or departing from New York City metro area airports. Hence, any increase in operations at PHL will further complicate the airspace congestion problems currently present in the Northeast. As we have seen from our earlier analysis, it is expected that traffic at the terminals, immediate airspace (i.e. TRACON) and en route will increase gradually even if US Airways departs the PHL market quickly. Hence, the FAA along with the PHL airport authority and/or the local government may require a fresh look at the New York-Philadelphia airspace soon in light of changing industry conditions.

The optimal choice of markets for Southwest, as we postulate it, results from identifying the best metro markets that US Airways is presently serving first, and then constraining them by factors that are unique to Southwest. Given that established US Airways markets[xxi] are already proven and tested destinations, they are the most likely candidates for picking (i.e., also known as "cherrypicking")[xxii]. However, these choices are constrained by some Southwest-specific factors. For example, Southwest's network is very different than US Airways.[xxiii] In choosing new markets, Southwest will likely try to optimize its own network's capacity. Thus, the Boston metro area (i.e., Providence, Rhode Island and Manchester, New Hampshire since Southwest does not fly to Boston Logan International Airport) is expected to receive special consideration since a Philadelphia-Boston operation would consolidates Southwest's eastern seaboard operations. Similarly, flying to West Coast destinations directly and/or via some other markets, distributed across different locations, strengthens the carrier's national network.

Second, Southwest possess only one broad type of aircraft; short (737 300/500) and long-haul narrowbodies (737 700/800)[xxiv]. Optimal use of these aircraft imposes constraints on minimal distances. Hence, it is likely that Southwest will choose markets that are medium to longer-haul distance in order to optimize the efficient use of its aircraft inventory. Third, Southwest does not codeshare. Lack of code-sharing partnerships also restricts Southwest's market choices into medium to long-haul distances. Choice of medium to longer-haul distance markets is further enhanced by Southwest's stringent turn-around requirements.

Finally, Southwest has been very careful in picking its markets. In choosing all previous 59 markets, PHL being the 60th, Southwest has carefully avoided markets and airports that already have a dominant carrier. In many instances, these airports are crowded. Furthermore, Southwest's entrance has triggered a fare war in numerous occasions. Although, the carrier has a tremendous cost advantage over all its competitors, Southwest has used this advantage in developing markets at secondary airports via offering lower fares[xxv], rather than plunging into direct competition at the primary airport. The result, as we have seen in the case of BWI, has

been spectacular. The gradual substitution away from other carriers, and even other modes has resulted in an enormous gain in market share for Southwest. Hence, we postulate that Southwest would, most likely, avoid those airports where a dominant carrier already runs a hub.[xxvi]

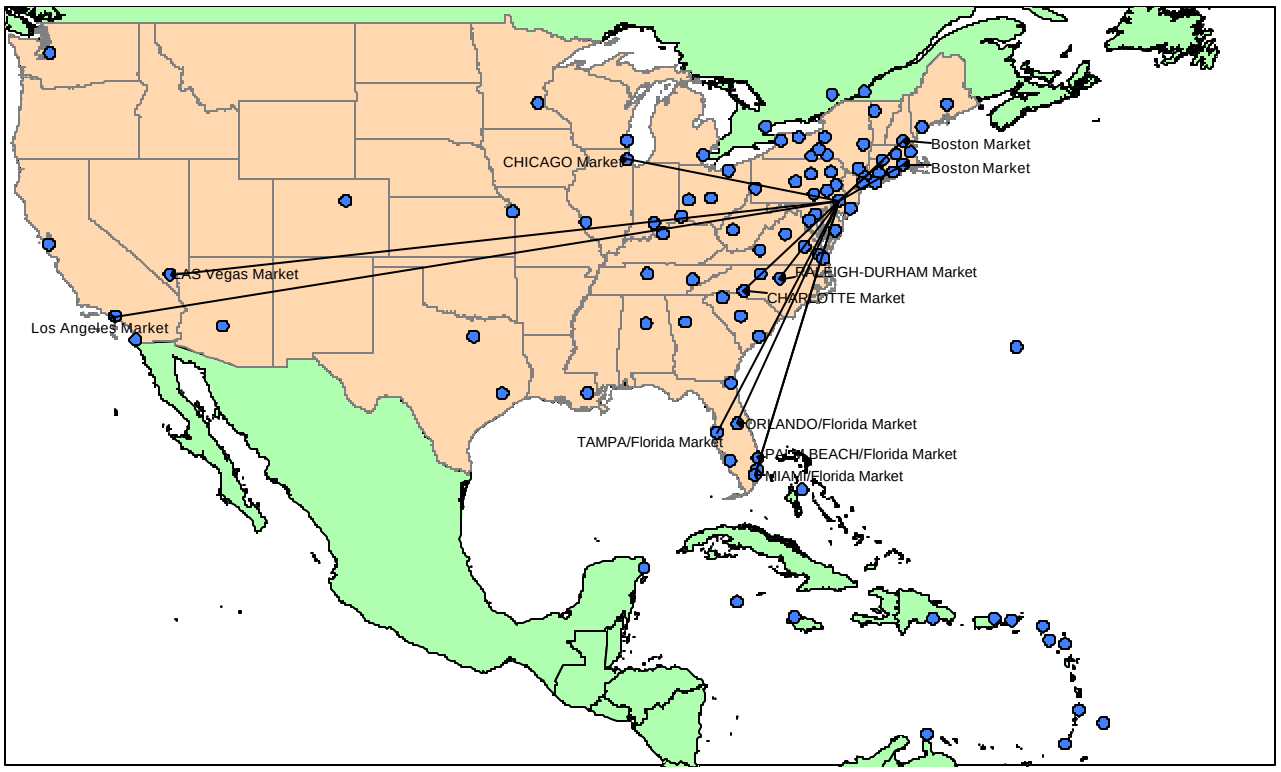
The market choice framework for Southwest in PHL, therefore, can be summarized as follows[xxvii]:

Choose best markets served by US Airways (i.e., "Cherrypick" US Airways's markets)[xxviii] : subject to:

- Optimize efficient use of 737 fleet inventory and turn around time requirements.
- Optimize the maximum capacity gain for the entire network. This would imply choosing airports that have relatively high O&D potentials and can also be used, as needed, as transfer points for distributing O&D passengers between the farthest points; and finally,
- Minimize the possible competitive responses. Simply put, stay away from competitor's large hub market, e.g., Atlanta Hartsfield Jackson International Airport[xxix].

Result of this exercise is best presented in terms of the following map:

Figure 11: Picking the Optimal Markets for Southwest Airlines from PHL



Given the data we have, we could choose any number of markets and sort them in terms of optimal choices. However, we believe that these market choices are results of a sequential process. As Southwest carves out market niches gradually and has more and more gates become available at PHL,[xxx] it is likely that the carrier will add new markets. Therefore, we chose 6 market areas initially: Boston, Raleigh Durham/Charlotte, Florida, Chicago, Las Vegas,

and Los Angeles. Following our earlier discussion, Manchester and/or Providence will be likely candidates for Boston, Raleigh Durham or Charlotte airports or a secondary airport nearby are likely candidates for Raleigh Durham/Charlotte, Orlando, Miami or Tampa airports representing Florida, Chicago Midway Airport representing Chicago, Las Vegas McCarren Airport representing Las Vegas, and Burbank Glendale Pasadena Airport representing Los Angeles market. Given that US Airways runs a relatively strong operational hub in Charlotte, we decided that market may be picked at some later date, if at all. Thus, our choices were narrowed down to 8 airports representing 5 markets: Manchester or Providence, Orlando, Mami or Tampa; Chicago Midway, Las Vegas McCarren, and Burbank Glendale Pasadena

On December 11, Southwest announced its first picks for scheduled operations from PHL. These are: Providence, Orlando, Tampa; Chicago Midway, Phoenix Sky Harbor, and Las Vegas McCarren Airport . Our picks, made prior to Southwest's announcement, came fairly close. We correctly predicted 5 of the destinations. However, we strongly believe that other markets, e.g., Los Angeles in particular, will be served via Phoenix Sky Harbor, and/or Las Vegas McCarren Airport. Direct flights to Burbank Glendale Pasadena will likely be added later as Southwest consolidates its position at PHL.

Finally, airlines industry is a dynamic sector. Responding to the recent tragic events of 9/11, recession, severe acute respiratory syndrome (SARS), and the war in Iraq, the airlines industry has restructured itself into an entity that appears to be very different than before. Low-cost and regional carriers have become a very potent force, and appears increasingly likely for competition amongst themselves. As competition between low-cost carriers and network carriers nears saturation, it is likely that low-cost carriers would look at each other's markets more closely. Some such signs are already visible. For example, in very recent past, Jet Blue tried to expand its operations at Atlanta (ATL) airport. The stiff competition they faced there were more from Air Tran, a low-cost carrier, than its network counterpart, Delta. Similarly, Frontier has announced recently that it would add schedule flights between its primary airport at Denver (DEN) to PHL, perhaps a preemptive move to thwart any future Southwest ambition. As fares, market destinations, and other characteristics of competition near equality, quality of commodity (i.e., air transportation) is also nearing equality. For example, Southwest has been seriously thinking about changing its long-term no-frill approaches by adding some in-flight entertainment, leather seat, etc [see Wall Street Journal, December 23, 2003; New York Times, January 7, 2004].

6. Conclusions

In this paper, we have examined the economic evolutionary process in aviation using three markets as the focus of our discussion. Examining IAD markets more closely, we have demonstrated that when network carriers compete amongst themselves, outcome is likely to be a zero sum game. Similar business models and cost similarities do not allow themselves to offer competitive fares that are required for long-term and sustainable market shares. In the BWI market, on the other hand, we have demonstrated that the dominant carrier retreated from markets as new, lower cost entrants expanded service. This has resulted in a positive sum game for the BWI market. The review of relevant literature pertaining to the market's response to a network carrier's financial distress, its impact on airport service levels, and implications on local economies provides the backdrop within which we study the evolutionary process.

Using BWI as the guidepost and employing the comparative fare advantage of Southwest Airlines, we speculate that a similar evolution may await Philadelphia market as well. A positive sum case is explored, where the positive contributions of the entering carrier exceed those left

behind by the resident carrier. In the process, depending on the types of gains and nature of evolving airlines network, the patterns of air traffic may also change. Using these experiences, we propose an analytical framework that attempts to explain the emergent behavior of low cost carriers when they enter new markets. In addition, the impact of these changes on the air traffic management system is also examined.

Using this analytical framework, we find that Southwest is likely to offer initial services to six markets. Against Southwest's recent announcement of initial markets, our choices appear to have matched fairly well. These choices and Southwest's expected dominance at PHL may have an impact on air traffic management. While we expect to observe increasing volumes of air traffic, the peakiness of the schedule resulting in severe stress in the infrastructure, including that of the airspace, may be limited by Southwest's distributed schedules. Furthermore, we anticipate that spatial growth northeast corridor may spark competition between Southwest and JetBlue. The recent announcement of JetBlue seeking entry into La Guardia airport indicates that this competition may intensify as Southwest begins its operations in May, 2004.

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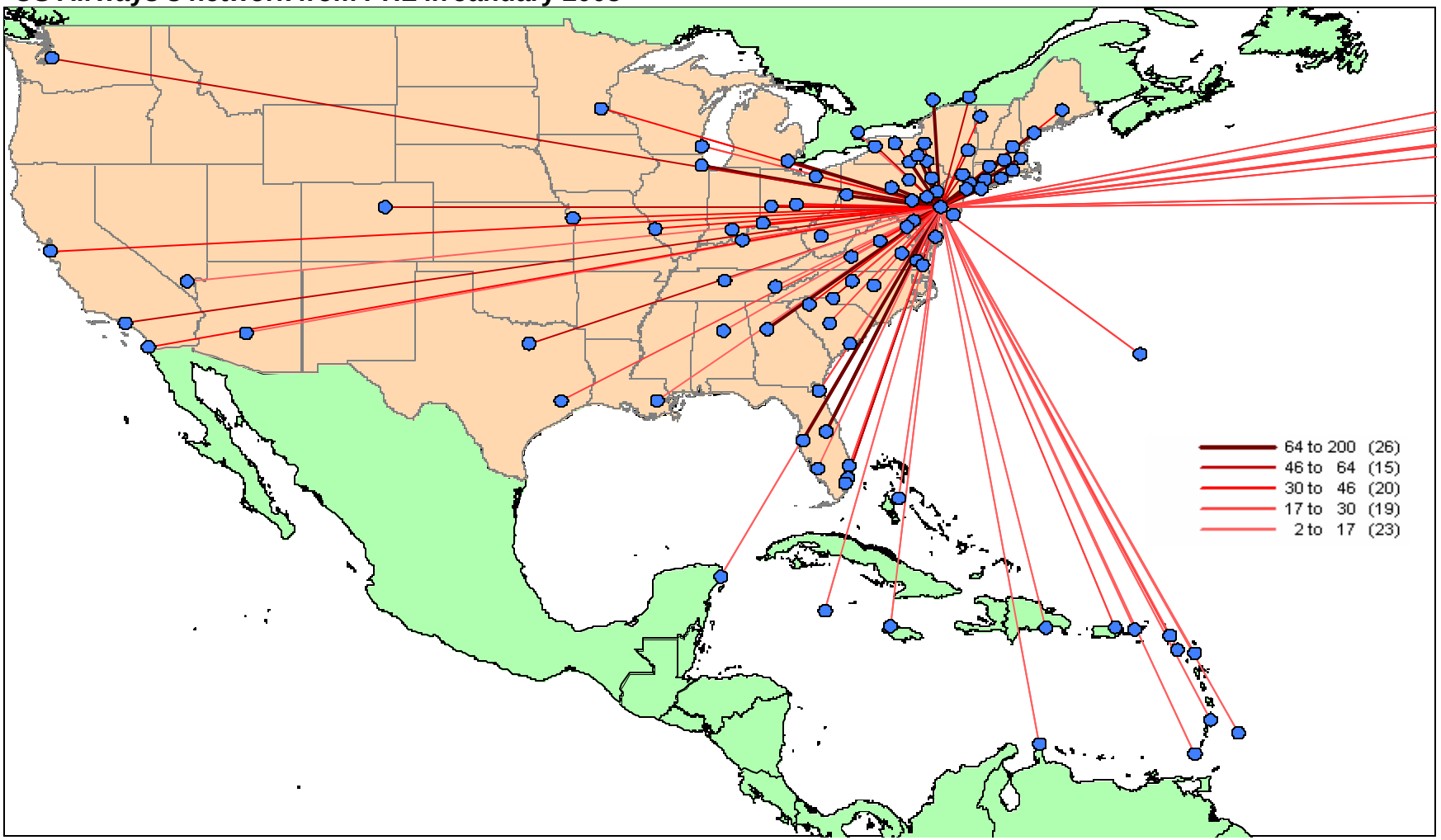
Appendix A: Airline Bankruptcies and Liquidation

DATE	Carrier	Chapter	DATE	Carrier	Chapter	DATE	Carrier	Chapter
5/18/1979	New York Airways	11	3/19/1985	Sun West Airlines	11	3/25/1991	Midway Airlines	11
11/19/1979	Aeroamerica	11	5/1/1985	Wise Airlines	11	3/26/1991	Grand Airways	11
1/24/1980	Florida Airlines	11	8/19/1985	Cascade Airways	11	4/1/1991	Metro Airlines	11
3/3/1980	Indiana Airlines	11	10/7/1985	Wheeler Airlines	11	5/20/1991	Jet Express	11
12/15/1980	Air Bahia	11	12/2/1985	Pride Air	11	5/30/1991	Metro Airlines Northeast	11
12/31/1980	Tejas Airlines	11	1/21/1986	Southern Express	11	6/27/1991	America West Airlines	11
3/6/1981	Mountain West	11	1/30/1986	Imperial Airlines	11	8/12/1991	Mohawk Airlines	11
3/16/1981	LANICA	11	2/11/1986	Arrow Airways	11	11/27/1991	Midway Airlines	7
7/13/1981	Coral Air	11	4/9/1986	Sea Airmotive	11	12/31/1991	Flagship Express	11
9/11/1981	Pacific Coast	11	8/19/1986	Trans Air	11	1/31/1992	Trans World Airlines	11
9/18/1981	Swift Air Line	11	8/28/1986	Frontier Airlines	11	2/28/1992	L'Express	7
10/9/1981	Golden Gate	11	2/19/1987	Chicago Airlines	11	6/8/1992	Markair	11
1/26/1982	Pinehurst Airlines	11	2/23/1987	McClain Airlines	11	6/8/1992	Hermans/Markair Express	11
3/3/1982	Silver State Airlines	11	2/27/1987	Rio Airways	11	12/15/1992	States West Airlines	11
3/26/1982	Air Pennsylvania	11	3/6/1987	Air Puerto Rico	11	9/20/1993	Evergreen International Aviation	11
4/2/1982	Air South	11	3/10/1987	Gull Air	11	9/21/1993	Hawaiian Airlines	11
4/16/1982	Cochise Airlines	11	3/12/1987	Royal West Airlines	11	1993	Key Airlines	11
5/13/1982	Braniff International	11	4/3/1987	Air Atlanta	11	3/21/1994	Resorts International	11
7/8/1982	Astec Air East	11	6/17/1987	Air South	11	10/11/1994	Florida West Airlines	11
8/19/1982	Will's Air	11	9/9/1987	Royale Airlines	11	2/3/1995	Crescent Airways	11
10/5/1982	Aero Sun International	11	1/5/1988	Sun Coast Airlines	11	4/14/1995	Markair	11
10/19/1982	Aero Virgin Islands	11	1/14/1988	Air New Orleans	11	6/30/1995	Trans World Airlines	11
11/9/1982	Altair	11	1/15/1988	Air Virginia	11	12/15/1995	The Krystal Company	11
12/9/1982	North American	11	1/20/1988	Mid Pacific Airlines	11	11/28/1995	Grand Airways	11
2/1/1983	Inland Empire	11	3/4/1988	Exec Express	11	1/10/1996	GP Express	11
2/14/1983	State Airlines	11	5/6/1988	Caribbean Express	11	1/22/1996	Business Express	11
4/22/1983	Golden West	11	5/25/1988	Pocono Airlines	11	1/23/1996	Conquest Airlines	11
9/24/1983	Continental Airlines	11	6/20/1988	Virgin Island Seaplane	11	9/30/1996	Kiwi International Airlines	11
12/2/1983	National Florida	7	8/11/1988	Princeton Air Link	7	7/25/1997	Mahalo	11
1/30/1984	Air Vermont	11	9/14/1988	Qwest Air	11	8/28/1997	Air South	11
2/2/1984	Pacific Express	11	9/27/1988	Southern Jersey Airways	11	10/5/1997	Western Pacific Airlines	11
2/8/1984	Dolphin	11	3/9/1989	Eastern Air Lines	11	11/6/1997	Mountain Air Express	11
4/9/1984	Combs Airways	11	3/14/1989	Big Sky Airlines	11	2/26/1998	Pan American World Airways	11
7/3/1984	Air Florida	11	7/19/1989	Air Kentucky	7	7/29/1998	Euram Flight Centre	11
7/17/1984	Excellair	7	9/28/1989	Braniff International	11	3/23/1999	Kiwi International Airlines	11
7/19/1984	American International	11	10/26/1989	Presidential Airways	11	6/25/1999	Sunjet International/Myrtle Beach J	11
8/21/1984	Emerald	11	11/12/1989	Resorts International	11	9/30/1999	Eastwind Airlines	7
8/29/1984	Hammonds Commuter	11	11/17/1989	Resort Commuter	11	11/29/1999	Access Air	11
9/4/1984	Air North	11	1/23/1990	Pocono Airlines	11	2/29/2000	Tower Air	11
9/27/1984	Wright Air Lines	11	5/10/1990	SMB Stage Lines	11	5/1/2000	Kitty Hawk	11
10/2/1984	Oceanaire Lines	7	7/5/1990	CCAir	11	9/19/2000	Pro Air	11
10/10/1984	Atlantic Gulf	11	12/3/1990	Continental Airlines	11	9/27/2000	Fine Air Services	11
10/10/1984	Connectaire	7	12/3/1990	Britt Airways	11	12/3/2000	Legend Airlines	11
10/26/1984	Air One	11	12/3/1990	Rocky Mountain Airways	11	12/6/2000	National Airlines	11
11/23/1984	Capitol Air	11	1/8/1991	Pan Am World Airways	11	1/10/2001	Trans World Airlines	11
11/28/1984	Wren Air Alaska	11	1/8/1991	Pan Am Express	11	8/13/2001	Midway Airlines	11
1/8/1985	Northeastern International	11	1/9/1991	L'Express	11	1/2/2002	Sun Country Airlines	7
1/22/1985	Pompano Airways	11	1/18/1991	Eastern Air Lines	7	7/30/2002	Vanguard Airlines	11
2/22/1985	Far West Airlines	11	1/20/1991	Bar Harbor Airlines	11	8/11/2002	US Airways	11
3/8/1985	American Central	11	1/22/1991	Virgin Island Seaplane	11	12/9/2002	United Airlines	11
3/13/1985	Provincetown Boston	11	1/29/1991	Northcoast Executive	7	3/21/2003	Hawaiian Airlines	11
						10/30/2003	Midway Airlines	7

Source: http://www.air-transport.org/econ/d.aspx?nid=6207; retrieved on Dec. 29, 2003

Appendix B:
US Airways's network from PHL in January 2003



Source: Official Airline Guide. Note: Solider the lines, heavily trafficked (i.e., enplanement and number of departures) destinations are.

ENDNOTES

[i] An earlier version of this paper was presented at the 83rd Annual Transportation Research Board (TRB) meeting during January 11-15, 2004 in Washington, D.C. Authors would like to thank the attendees and Katherine Harback of the University of Delaware for their comments and suggestions. Authors are with the Center for Advanced Aviation System Development (CAASD) of the MITRE Corporation [www.mitre-caasd.org]; 7515 Colshire Avenue, McLean, VA 22102; Correspondence can be made to: dbhadra@mitre.org

[ii] So aggressive this call has been that the media reported as Continental's Gordon Bethune saying in CNBC "taxpayers should not subsidize this loser" [see http://www.nytimes.com/2002/11/27/business/27AIR.html?todaysheadlines].

[iii] One can also use the number of markets served. However, the number of markets is somewhat secondary, primarily built to serve total number of passengers given the fleet structure and hence aircraft operations.

[iv] Southwest is set to begin its schedule operations from PHL on May 4, 2004.

[v] Bankruptcy variable - lagged positively and negatively by 2 quarters with the center on the quarter filing took place - is a product of time when filing took place and the share of total nonstop flights at airport j accounted for by filing carrier i.

[vi] Notice here that this operational definition has some semblance with FAA/DOT definition of hubs. The arbitrary cut-off at number of flights, however, may or may not correspond exactly to FAA definition of hubs based on enplanement.

[vii] This is demonstrated in the notice put out by the FAA/DOT in Federal Registrar, noted earlier.

[viii] It is apparent that based on the empirical findings discussed in Borenstein and Rose, market share of the airline that has either faced or contemplating bankruptcies, and few other assumptions, such as load factors, airport share of revenues can be easily calculated.

[ix] It is not obvious though that the airport will return back to its original service levels; nor it is necessary. Given the severe financial distress facing the resident carrier, it is likely that pre-bankruptcy service levels were perhaps inefficiently high, as acknowledged by Borenstein and Rose. If, on the other hand, entering carriers cannot replace otherwise socially-efficient markets rapidly, due to costly entry and/or preference and cost structure, the resultant outcomes may very well be socially inefficient.

[x] When new runway placement plan are discussed, neither airline, American nor United, want the runway to be placed near the other's terminal, thus giving them an advantage. This has led to a substantial amount of gridlock in terms of airport planning.

[xi] Banking operations are created by flows of arrivals and departures that result from airlines scheduling of incoming and outgoing traffic. Banking operations is the primary factor in intensifying air traffic management complexities at an airport.

[xii] Notice the implications of this calculation. Per capita passenger for each departure from these additions, therefore, is calculated to be 117. Under the assumption of 80% load factor, the per capita passenger would thus yield an aircraft size with 146 seats, typical for 737-400/500, an aircraft flown frequently by Southwest. Therefore, it is likely that these additional flights and passengers have been, by and large, served by Southwest Airlines.

[xiii] Despite the importance of the issue, the empirical link between airline service levels and urban economic development had not been studied [see Brueckner (2003a) for a discussion on the existing empirical literature] until 2003 when Brueckner (2003a) offered an empirical framework to fill this void. Using a well specified econometric framework, Brueckner specifies metro area employment as a function of airline traffic, measured as total enplanements, and a host of metro-specific exogenous factors. Using well chosen instruments from a list of exogenous variables to determine airline traffic at the first stage, and metro employment at the second stage in a two-stage least squares framework, Brueckner finds that airline traffic exerts a significantly positive effect on total employment in a metro area. The point estimate demonstrates that a 10% increase in airline traffic, i.e., enplanements, raises metro area service employment by 0.9%. In other words, there is a 10:1 ratio in enplanements to service employment in metro areas [see Brueckner (2003a, b) for more details].

[xiv] These two effects together form the basis for what has become known as *Southwest effect*. Morrison (2001) estimates that Southwest's low fares were directly responsible for $3.4 billion of savings to air passengers in 1998. In addition, $9.5 billion was saved due to the effect that actual, adjacent, and potential competition from Southwest had on other carriers' fares. The author finds that these savings ($12.9 billion in total) amount to 20 per cent of the domestic scheduled passengers' revenue in 1998.

[xv] For the sake of simplicity, issues relating to management of air traffic pertain to, in this context, as those managed by terminal towers, terminal radar approach control facilities (or, TRACONs), and en route traffic control centers (ARTCCs or, en route centers). Towers are located at airports and direct airport traffic on the ground and within approximately 5 nautical miles of the airport to altitudes of about 3000 feet. TRACON facilities sequence and separate aircraft as they approach and leave airports beginning approximately

5 nautical miles and ending approximately 50 nautical miles from the airport and at altitudes up to about 10,000 feet. En route centers control aircraft in transit and during approaches to TRACONs. The airspace that most en route centers control extends above 18,000 feet for commercial aircraft.

[xvi] This is rather simplified approach to a more complex problem. Here, we are assuming that flows of arrivals and departures, forming what is commonly known as airport bank structure, is the primary factor in intensifying air traffic management complexities. Weather, types of aircraft, runway conditions, and host of other factors also influence the intensity of air traffic management, factors, that are held constant for the present discussion.

[xvii] Furthermore, Bureckner (2003) has found that a 1% increase in metro area population raises metro area enplanement by 1%, i.e., unitary elastic relationship. Hence, the observed relationship between population and O&D travel is expected to be maintained over time as metro areas experience differential population growth rates.

[xviii] Following on our earlier discussion on relationship between population and O&D passengers, PHL may have a potential of, as much as, 16 million O&D passengers a year. We arrive at this number by multiplying O&D per capita quotient for Baltimore-Washington metro (2.2) to that of Philadelphia's population (7.32 million) in 2000 [see UNISYS (2003) for data].

[xix] We analyzed share compositions of all markets that US Airways has been serving from PHL, ranging around 65-80 destinations over the years. Here we report the top markets, 15 altogether. We report only 13 in the figure in order to maintain the consistency. Ranking of BOS has changed quite drastically between 2000 and 2002; it has moved from 45th ranking (in terms of share of US Airways's total O&D passengers in and out of PHL) in 2000 to no. 2 in 2002. ORD, on the other hand, has moved from no. 12th in 2000 to 16th in 2002. All other 13 have maintained their top (15) rankings in both 2000 and 2002 and hence reported here.

[xx] The State of Maryland had to undertake investment amounting to $1.8 billion in order to accommodate the increased demand arising from Southwest's increasing operations at BWI. Even though there have been difficulties in the process, the State has done fairly well to address the capacity issues in light of Southwest's requirements at BWI. The Philadelphia city council, as well as the state of Pennsylvania, should review the planning, and allocations on future infrastructure including that of the airport, in light of Southwest's decision to enter PHL.

[xxi] Market and airport choice needs some clarification. Metro areas where there is a unique airport which is served by the US Airways that presents itself as good candidate for being picked by Southwest, market and airport choice is identical. PHX and LAS are examples of this type of areas. However, markets where there is more than one airport (Boston metro market is an example), market and airport choices would be different. In the latter case, however, we anticipate that Southwest is likely to pick secondary airport (i.e. PVD, MHT in case of Boston metro) for reasons which would be soon evident.

[xxii] Appendix B provides the map of the entire network for US Airways from PHL. In line with our discussion here, we identify and rank markets according to frequencies and passengers served. Therefore, solider lines represent greater traffic activities and hence can be identified as cherry markets.

[xxiii] While US Airways's is a typical example of hub-and-spoke network, Southwest's represents, what has commonly known as, distributed network. Distributed network optimizes the network capacity by efficiently using sets of equal-sized airports rather than intensely utilizing economies of scale in a hub-and-spoke network [see Berry (2004) for more details].

[xxiv] The carrier has recently announced that it will consider acquiring RJs in the future. However, those operations may not mature until 2007-2008.

[xxv] Southwest's entrance has reduced average fare by almost one-third in BWI market. Similar fare reduction is likely in PHL market as well.

[xxvi] However, there is one exception. We anticipate that Southwest would move in to markets if it anticipates that the dominant market carrier is financially weakening (US Airways in PHL is an example), O&D market potential is large, and it optimizes the total network capacity. While we do not anticipate that Southwest will move to markets just to stop competitors to move in, as many have suggested [see UNISYS (2003)], decision to enter a particular market may be slowly influenced by emerging competition from other low-cost carriers as well. We address this issue in the section below.

[xxvii] This can be done by undertaking a gradient search method subject to those constraints. For now, however, we have worked out the results of this optimizing exercise long hand. That is, first we analyze the share of different markets in US Airways's PHL hub over the last eight years (1995-2002). This allows us to identify markets that can be called *cherry markets* (via an arbitrary cut-off, such as 1-2% of total) and determine their stability over time. Then, we identify locations around these cherry markets where Southwest may fly. Once those unconstrained choices have been identified, we then impose three restrictions, i.e., distance, network capacity maximization, and no primary hub in presence of established carrier. The result is a sub-set of US Airways's cherry markets that satisfy those restrictions.

[xxviii] This would imply, using our map description of US Airways's network of choosing solid lines first, followed by less solider lines.

[xxix] Threat of a broad scale fare war has always proved to be a strong deterrent for entry into established markets. Recently, Jet Blue found that out by entering into ATL market. This entry caused far stronger and wider responses than Jet Blue originally anticipated. By bringing in leased aircrafts quickly into the system and offering competitive fares, Air Tran, another low-cost carrier from ATL, matched Jet Blue's service and fare offerings. This happened, interestingly enough, without bringing Delta intensely into competition. For now, Jet Blue retreated and left ATL for Delta and Air Tran.

[xxx] To begin with, the carrier will have 4 gates in May, 2004.