DEREGULATION INDUCED VOLATILITY OF AIRPORT TRAFFIC

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Airline deregulation is spreading worldwide and has important consequences for the planning, design, and management of airports. One important effect is that the overall traffic at an airport -and by extension its revenues - is much more volatile in a liberal environment. This is demonstrated by analysis of the US experience over the last twenty-five years. The increased risk thus associated with airport projects emphasizes the need to discard traditional, static master planning in favor of dynamic strategic planning.

KEY WORDS: Airport design, traffic forecasting, deregulation, master plans, strategic planning

1. INTRODUCTION

Forecasting is basic to all planning and design. Typically, it is both the first and the crucial step in the process: the configuration and the size of the facilities are tied to quite specific and detailed estimates of long-term forecasts. This standard practice is embedded, for example, in the guidelines for master planning issued by both the US Federal Aviation Administration (US FAA, 1985) and the International Civil Aviation Organization (ICAO, 1987)

Unfortunately, forecasting is never accurate, as has been amply demonstrated by numerous retrospective studies comparing actual realisations with forecasts (see, for example, Ascher, 1978).

The disparity between prediction and reality has been extensively documented for aviation in particular (de Neufville, 1976; US Office of Technology Assessment, 1982; Maldonado, 1990).

Worse, our ability to forecast for airport planning appears to be getting weaker. Deregulation of the industry, by removing the constraints on companies to reorganize their routes and services, increases the volatility of the traffic. Projects will henceforth be based on shakier assumptions, and will be more risky.

This paper documents the increased volatility of airport traffic by analysis of the experience in the United States over the last 25 years. Section 3 describes the model of how airline deregulation induces the volatility of airport traffic, defined in Section 5; Section 4 describes the method of analysis; and Section 6 demonstrates the effects by statistical analysis.

The conclusion to be derived from these observations is that the standard process of airport planning needs to be adapted to account for the realities of a deregulated environment. Master plans for 20 years or more, based upon detailed forecasts for the period, do not make sense when the traffic is volatile.

What is required instead is a continuous planning process, one that consciously positions the airport owners to take advantage of new opportunities without overcommitting them to a preemptive

vision:

Dynamic Strategic Planning.

2. SPREAD OF DEREGULATION

As background to this analysis, it is important to recognize that economic deregulation of air transport is spreading and likely to continue to do so worldwide. The profound changes in United States airlines and airports since 1978 are largely going to be repeated. Indeed the rate at which this American innovation is spreading is truly remarkable.

Already, Canadian air transport has largely deregulated since 1985: government control over tariffs has virtually disappeared and the government-owned airline, Air Canada, has been privatised. Australia has experienced an even more extraordinary change: from being one of the world's most closely regulated environments for air travel, it has become one of the most liberal. As recently as 1986 the Australian Federal government owned both a major domestic carrier (Trans-Australian Airlines) and the international airline (Qantas), owned and operated the airport system, and strictly regulated the fares, routes, schedules and types of aircraft used. In about five years it has now privatised its domestic airline (renamed Australian); spun off the airports to a independent business, the Federal Airports Corporation; and as of November 1990, removed virtually all economic regulations on domestic air transport.

A parallel revolution has occurred in Britain: both the national airline, British Airways, and the British Airports Authority have been privatised.

Worldwide, similar drastic reductions in bureaucratic control are occurring so rapidly that it is difficult to keep up with them. Argentina is selling off its national airline, Taiwan is allowing competition, so are the Philippines, and so on. Meanwhile European air transport is in ferment.

Economic deregulation is spreading because it offers enormous economic advantages over the form of regulated air transport that evolved over the previous half century. First of all, the collection of routes accumulated by an airline over the years, by lengthy negotiation with disparate authorities, is difficult to operate coherently: there are so many constraints on when aircraft can fly and which passengers they can carry. Secondly, the inflexibility in fares makes it impossible for airlines to maximize their revenues from any flight and leads to unproductive use of capital and equipment. And bureaucratic sluggishness, of course, stifles the kind of experimentation and innovation that is key to developing effective new services.

By removing constraints on operations, deregulation permits airlines to construct efficient, economical systems. These turn out to be the hub-and-spoke networks that have grown to characterize airline operations in the United States in the last

decade. Hub-and-spoke operations allow airlines to aggregate passengers to and from many destinations, to place them on larger more economical aircraft, and thus to serve lower density routes with higher frequency and lower fares. (Note that these hub-and-spoke systems have little in common with the star-shaped networks typical of international and European airlines in particular: lack of sixth freedom rights make it impossible for those airlines to offer the kind of service between end-points of the network, crucial to efficient hub-and-spoke systems.)

By removing constraints on fares and services, deregulation encourages airlines to experiment. They respond by constantly changing their patterns of activity. They generally do so by surprise too, in order to gain a competitive advantage over other airlines. These moves are often quite substantial. Right after the 1978 deregulation in the United States, for example, United Air Lines decided to withdraw from short-haul markets, thus dropped many destinations in California and abandoned its plan to occupy its brand-new terminal in San Francisco. Around the same time, TWA shifted its base of operations from Kansas City to St. Louis, an airport some 400 miles away that is better for hubbing, thereby causing an approximately 30% drop in traffic for Kansas City between 1979-81 (Figure 1). Between 1979-86, conversely, Piedmont Airlines deliberately built up Charlotte as a hub for its system, and tripled its traffic within four years; more recently, American Airlines has been repeating this kind of performance at Raleigh-Durham (Figure 2).

Airlines that can respond aggressively to these new freedoms develop substantial competitive advantages over airlines that are either still regulated or incapable of responding. Whichever, those static airlines are marginalized fairly rapidly. This has certainly been the fate of both Pan American and Eastern Airlines in the United States: the position of these once dominant airlines has become desperate within a decade of deregulation. Both have sold assets in efforts to survive: Pan American disposed of its Pacific routes to United Airlines; Eastern sold its Latin American network to American Airlines, and yet still became bankrupt.

Deregulation spreads because nations recognize that it is the key to nurturing the competitive advantages achieved by deregulated competitors. The lessons from America, reinforced daily by practical experience in the competition for passengers and cargo, are being learned well (de Neufville, 1987).

Deregulation arguably has many disadvantages, economic or social as many have remarked (see Pavaux, 1984; and Sauvan, 1987 for example). The development of a few megacarriers in the United States, with the potential for oligopolistic practices, may ultimately need to be controlled. There may also be societal needs to insure that all regions of a country are adequately served by air transport.

The issue for airport owners and their funding agencies is that deregulation is contagious in any case, whether it is an overall benefit or a plague. Either way, they need to be concerned about its implications for airports.

3. EFFECTS OF DEREGULATION ON AIRPORTS

It is now clear that economic deregulation of the airlines has substantial effects on airports. Although early studies of deregulation focussed only on the airlines and their passengers (see Meyer et al, 1981; and Bailey et al, 1985, for example), later considerations clearly pointed out how various factors of production for this industry were affected by deregulation, specifically showing how the work force suffered (Pavaux, 1984).

Airports, as a key factor of production of air transport, are directly impacted by what happens to the industry. As airlines acquire the flexibility to enter and withdraw from markets, airports find that their traffic rises or falls. Figures 1 and 2 make the point.

Many airports are especially vulnerable because they are strategic hubs for a particular airline's hub-and-spoke network. These hubs are routinely dominated by a single airline. Table 1 illustrates

Table 1: Examples of Domination of Hub-and-Spoke Airports by a Single Airline

Airport	Dominant Airline	Market Share Estimates for 1987
Pittsburgh	US Air	83%
Minneapolis-St. Paul	Northwest	82%
St. Louis	TWA	82%
Houston/International	Continental	72%
Cincinnati	Delta	68%
Detroit	Northwest	65%

Source: New York Times/Solomon Brothers Inc.

this phenomenon. Note that since these data represent confidential marketing information, only estimates are available. Industry sources acknowledge them to be realistic, however.

Much of the traffic through these transfer points, easily about 50% and sometimes as high as 70%, only uses the airport as a way station for changing aircraft. This interchange traffic has no real need to be at a particular airport, and would be elsewhere if served by a different airline. For example, a passenger between Boston and San Francisco normally goes through Minneapolis-St. Paul if flying Northwestern; Chicago if going by TWA; or Dallas/Ft. Worth if going by American. Thus if TWA is on strike (or is otherwise uncompetitive) passengers will divert in large numbers from St. Louis; only a fraction of the traffic will remain, the small portion that actually wants to be in St. Louis. Traffic at transfer airports thus depends on the fate of its dominant airline.

The vulnerability of hub airports is illustrated by the example of New York/Newark. Its traffic grew rapidly after deregulation, tracking the extraordinary growth of Peoples Express. This traffic then collapsed almost as abruptly, when that airline failed. Figure 3 shows the fever chart.

Simply put, deregulation induces volatility in airport traffic by removing the dampening effects of the controls. In a regulated environment, yearly variations in traffic are small and major

changes occur slowly. With regulation removed, the yearly variations are much larger and major changes occur rapidly.

Major shifts of traffic also occur in the transition between the regulated and deregulated regimes. Airlines profit from the new freedom to make major, previously impossible, adjustments to their system. This is what United Airlines did when it took advantage of deregulation to withdraw from its traditional but less profitable short-haul routes.

The effect of deregulation on airport traffic is comparable to the effect of removing shock absorbers on an automobile: there is an immediate readjustment to a new equilibrium level, and then the system responds extravagantly to every bump in the road.

4. ANALYSIS METHODOLOGY

The basic scheme of analysis is simple: do regression analyses of traffic data on US airports before and after deregulation, and then compare the results. The comparison of trends and variability of the data before and after deregulation identifies the degree of deregulation induced volatility.

The effect is, in fact, quite obvious when one looks for it. Plots of the data show the often striking result (Figure 4). Note that this pattern occurs not only at the airports with the lower levels of traffic, which might a priori to be more

sensitive to changes, but also at the airports with the highest levels of traffic. Specifically, Chicago/O'Hare was affected both by American Airlines shifting a major part of its hub-and-spoke traffic to its new base at Dallas/Ft. Worth, and by parallel, unsynchronized movements by other airlines.

To obtain a fair picture of the situation, the analysis needs to consider a substantial period both before and after the deregulation. The "before" period for the analysis extended back as far as 1968, the decade before deregulation. The "after" period includes ten years of data, through the latest comparable report (US FAA, 1990).

In retrospect, ten years of post-deregulation data was probably not necessary. The results obtained from analyzing this period are not substantially different from those obtained from our earlier study of the six years following deregulation (Barber, 1986; de Neufville and Barber, 1986). If anything, the extended data amplify the conclusions, by including later effects such as the collapse of traffic at New York/Newark (Figure 3) and the buildups at Charlotte and Raleigh-Durham (Figure 2). Deregulation induced volatility of airport traffic is not a problem which goes away with time.

A subtle part of the analysis involved the collection of comparable data. Simply put, the official statistics one can look up do not represent comparable situations. The most obvious

example of this fact is that, during the 1970's, major airlines developed within the States of California and Texas (e.g., PSA and Southwest Airlines) that did not report their traffic to the federal authorities. National data on airports such as Hollywood/Burbank, Oakland and San Jose thus seriously under-represent the real situation during that period. Moreover the two major series of national data, from the Civil Aeronautics Board's sample of one out of every ten tickets (US CAB, yearly) and the federal data on airport emplanements (US CAB/FAA, yearly) always disagreed with each other, often by a wide margin. Furthermore, neither one of these ever seemed to coincide with the data reported by individual airports.

To avoid inconsistencies in the data, the analysis thus used the FAA statistics, which are uniform over the country and reasonably consistent over the years, for airports which had no obvious errors or unreported traffic. To avoid the possibility of apparently large percentage changes due to the small overall level of traffic, we also focussed attention on the larger airports, those with over 2 million emplanements in 1988 (and thus around 1 million at the time of deregulation). The resulting data set comprised 38 airports.

5. VOLATILITY OF TRAFFIC

By volatility we mean the capacity for rapid change. In general terms, it is the average year-to-year variation in traffic. The more variable the traffic, the higher the volatility.

To make this concept as practical as possible, volatility is defined in ordinary terms that require no experience in statistics. Thus the volatility for any year, t, is the percent difference between the actual traffic and the trend of traffic:

$$\text{Volatility, } vt = 100\ [(\text{actual}-\text{trend})/\text{trend}]$$

The volatility index for a period is simply the average of the absolute values of the volatility over that period (the absolute value focusses attention on the yearly range of the variation):

$$\text{Volatility Index} = |(v\ t)|/\ (\text{years})$$

Finally, the relative volatility of traffic between any two periods, such as before and after deregulation, is the ratio of their volatility indexes:

$$\text{Volatility Ratio} = \text{Volatility After}/\text{Volatility Before}$$

Volatility is similar to the concept of standard deviation in statistics, but is more appropriate for both theoretical and practical reasons. Formally, it must be expected that as traffic grows so does its variance: the data are heteroscedastic and, strictly speaking, it does not make sense to speak of a simple standard deviation. In practice, it is much easier to measure

volatility since it can be calculated directly from the data for any single year.

The data on volatility of airport traffic before and after deregulation were thus calculated by comparing the actual data with the trends established by regression analysis.

6. RESULTS OF ANALYSIS

The main result is that deregulation does indeed induce volatility in airport traffic. The supporting data are in Table 2.

The average volatility of airport traffic before deregulation was 4.15, for the airports in the data set. This indicates that traffic in any year was about +/- 4% off from the long term trend.

Note that this volatility is measured around an established trend. It does not measure discrepancies with respect to the forecast, which are only estimates of the trends, themselves in error. Those differences are generally very much larger than the year-to-year volatility. The discrepancies between actual traffic and forecasts are typically on the order of +20% in five years (de Neufville, 1976). They also increase for longer-term forecasts. In a recent study of experience at 22 airports in the New England Region of the United States, Maldonado (1990) observed average errors of +/- 23%, 34% and 76% respectively for

5, 10 and 15 year forecasts.

Table 2: Volatility at 38 Major US Airports

Airport	Domestic Passengers Millions, 1988	Volatility Before Dereg	Index After		Volatility Ratio	
			Old	New	Old	New
Chicago/O'Hare	26.6	2.99	7.11	11.56	2.38	3.87
Atlanta	21.8	3.59	6.38	5.94	1.78	1.66
Los Angeles/Intl.	18.6	4.58	5.79	7.80	1.27	1.70
Denver	14.4	3.38	5.27	3.58	1.56	1.06
San Francisco	13.3	2.57	5.58	7.01	2.17	2.73
New York/Laguardia	11.3	3.74	3.59	4.24	0.96	1.13
New York/Newark	10.8	4.67	27.42	18.66	5.87	3.99
Boston	10.1	3.15	7.66	3.82	2.43	1.21
St. Louis	9.6	3.13	12.35	8.20	3.94	2.62
Miami	9.5	5.25	6.47	8.34	1.23	1.59
Phoenix	9.5	2.97	16.26	11.79	5.48	3.97
Detroit/Metro	9.2	3.76	13.89	14.08	3.69	3.74
Honolulu	8.4	6.94	6.26	7.92	0.90	1.14
Pittsburgh	8.4	2.86	8.53	10.49	2.98	3.67
Minneapolis-St.Paul	8.2	5.82	10.17	6.42	1.75	1.10
Orlando	7.5	12.47	12.65	14.88	1.01	1.19
Washington/Natl.	7.3	2.94	3.52	3.76	1.20	1.28
Las Vegas	6.9	2.64	6.32	10.59	2.39	4.01
Seattle	6.8	6.03	6.28	7.25	1.04	1.20
Philadelphia	6.6	2.89	9.38	12.31	3.24	4.26
Charlotte	6.0	3.43	22.19	10.96	6.47	3.19
Salt Lake City	4.7	2.85	14.19	8.54	4.98	2.99
Memphis	4.5	3.38	15.00	19.58	4.43	5.79
Tampa	4.5	6.48	4.36	6.61	0.67	1.02
Kansas City	4.5	5.31	10.59	13.78	1.99	2.59
Houston/Intercont.	4.4	5.46	33.49	74.76	6.13	13.69
Baltimore/Wash.	4.4	3.69	23.36	13.07	6.34	3.55
Fort Lauderdale	3.9	6.75	7.84	10.72	1.16	1.59
Cleveland	3.5	3.33	6.45	8.68	1.94	2.61
Cincinnati	3.5	2.41	12.51	17.71	5.20	7.35
Raleigh-Durham	3.5	3.37	14.35	29.93	4.26	8.89
Nashville	3.2	3.81	17.94	29.51	4.71	7.74
New Orleans	3.2	4.97	3.48	4.58	0.70	0.92
Portland, OR	2.8	3.74	5.59	8.09	1.50	2.17
Indianapolis	2.4	2.88	9.26	14.99	3.22	5.20
Hartford	2.3	3.23	8.84	14.22	2.74	4.47
Dayton	2.1	2.95	20.31	19.33	6.89	6.55
Albuquerque	2.1	3.28	10.89	9.10	3.32	2.77
Average		4.15	11.09	12.97	3.00	3.42

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The volatility of the traffic does not depend on the size of the airport, as Figure 5 indicates. The data may also be considered homoscedastic, with a standard deviation of 1.84.

The volatility after deregulation depends on which trend is taken as the reference. This can either be the trend prevailing before deregulation (old trend) or the one established afterwards (new trend). Which is preferable depends on the point of view of the airport owner: prospectively considering what to do about deregulation, or retrospectively, thinking about the risk of projects once deregulation is established.

The volatility after deregulation is in either case greater than that before. On average it is around 12, either 11.09 (old trend) or 12.97 (new trend). The corresponding volatility ratios are 3.00 and 3.42. These differences are statistically significant, as Table 3 indicates.

Table 3: Test of Deregulation Induced Volatility

Element of Analysis	Old Trend	New Trend
Volatility Before Deregulation	4.15	4.15
Standard Deviation	1.84	1.84
Volatility After Deregulation	11.09	12.97
t-Statistic	23.25	33.26
Significance	< 0.001	<0.001

7. IMPLICATIONS FOR AIRPORT OWNERS

Greater volatility of traffic means greater risk. If the clientele for an airport is uncertain, so are the revenues. The exact relationship between traffic and revenues depends, of course, on the current agreements with airlines and other users. The overall effect is nevertheless clear.

Greater risk means higher costs of capital, higher interest charges. In general terms, the volatility is comparable to the beta factor of finance, the common measure of risk for bonds and shares (see for example Copeland and Weston, 1988). Lenders factor in this risk in determining their terms for financing projects. This is bad news for airport owners. What can they do about it?

Since the problem is risk, the solution must incorporate steps to reduce risk. The essential rules must be:

a) to plan for shorter term horizons, so as to minimise the extent of the risk, and

b) to design facilities to serve a range of future needs, to minimise the risk of rapid obsolescence.

Minimising risk thus implies that airport owners should back away from standard Master Planning, which generates a single solution for a long term future. Master plans are demonstrably ineffective in this regard in any case. Their proposals do not correspond to what happens. In the United States, for example, Maldonado (1990) demonstrated that the master plans correctly anticipated only half or less of the future projects.

What is desirable instead is some form of dynamic strategic planning (de Neufville, 1990). It should be strategic in that it consciously positions the airport owners in favorable positions allowing them to respond to new needs and opportunities as they arise. It should also be dynamic, a plan that is continuously adjusted to the real situation so as to minimize risks.

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List of Figures