Analysis of De-peaking Strategies Implemented by American Airlines: Causes and Effects

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Submission date: July, 2003
Word count: 4208 words (including 2 tables and 2 figures)
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ABSTRACT

The airline industry in the United States has been one of the hardest-hit (economic victims of the terrorist attacks on September 11, 2001. In an effort to reduce operating cost to better adapt to the decreasing demand, American Airlines (AA) has introduced de-peaking strategies at two of its major hubs: Chicago O'Hare and Dallas/Fort Worth International Airports. In this paper, American Airlines' market performance before de-peaking implementation is investigated. The results suggest that the differences between the market performance of the whole company and those services going through hubs might have triggered the implementation of de-peaking. Moreover, traffic directionality at ORD and DFW allowed American Airlines to implement de-peaking strategies without drastically increasing the transfer times.

However, as it is shown here, even these small increases in transfer time affected AA's market share. In the second part of this paper, market share ratios of American Airlines to its strongest competitor, United Airlines, are studied by using a logit market share model and weighted least squares method. The results revealed a decrease in American Airlines' market share. These findings emphasize the importance of banked scheduling strategies at the hub to keep low transfer times, and encourage the use of utility models of airline service in the planning and design of new policies.

1. INTRODUCTION

Since the 1980's most major US airlines have adopted the hub-and-spoke route structure, and selected one or more airports (hubs) that serve as connection points for the majority of their flights. At these connection points, passengers coming from different origins can transfer to the same destination flight, and passengers coming from the same origin can be reallocated into different destination flights. Airlines exploit the economies of scope and density associated with this approach: they offer frequent service on economically-sized aircraft in large numbers of low-density markets. However, in order to save transfer waiting time, airlines normally use banked scheduling strategies at their hub airports. Such strategies require high level of resources (e.g., employee, gates, etc.) for very short periods of time, which combined with all the idle time between the arrival batches, elevate the operation costs considerably.

The terrorist attacks on September 11, 2001 caused the most severe crisis faced by the airline industry ever. American Airlines, the world's largest airline, topped the charts for losses in the first quarter of 2002, with $575 million at the parent level, compared to $43 million for the same period in the previous year (*1*). In response to this crisis, the company "de-peaked" its schedule at two of its major hubs: Chicago O'Hare (ORD) and Dallas/Fort Worth (DFW), while retaining banks at Miami (MIA) and St. Louis (STL) Airports.

This study examines the possible causes and effects of these de-peaking strategies, focusing on the company's market share. Section 2 provides a brief background on the subject. Section 3 examines the possible causes for de-peaking, including the market share changes experienced by American Airlines after 9/11. Section 4 analyzes the market share changes experienced by the company after the strategies were implemented.

2. BACKGROUND

Over the last two decades, hubbing has allowed airlines to expand their market and serve small and medium-sized cities. Nevertheless, this type of structure has also become very expensive. Airlines usually apply banked scheduling strategies in hub airports to reduce the transfer time (time between connections). As a result, under adverse weather they often face peak-period congestion and excessive delays. In addition, the constraints of banked scheduling force carriers to make less efficient usage of aircraft, gates, ground crews, flight crews, and other resources. High demand, and the premium placed by business travelers on service quality, justified these costs two years ago, but the current economic crisis is forcing the airlines to reconsider their structure.

A de-peaked hub schedule features fairly constant rates of arrivals and departures throughout the whole day instead of the typical arrival and departure banks. Figures 1a and 1b show the cumulative scheduled arrival curve of American Airlines in Chicago O'Hare and Dallas/Fort Worth International Airports (January 10, 2001; January 10, 2002; and January 10, 2003) (*2*). Since de-peaking was implemented in 2002 the cumulative curve of 2003 is very smooth. The number of flights remained almost the same, but the new distribution allowed a better utilization of aircraft, staffing, and infrastructure. The results are considerable cost savings for the airline along with a small increase in transfer times for the passengers.

3. POSSIBLE CAUSES FOR DEPEAKING

The objective of this section is to identify the major causes for the implementation of de-peaking in two American Airlines' hubs. One reason for American's decision to de-peak at its hubs may be related to the performance of these hubs in the year prior to the schedule change. The analysis below compares market share trends at the three hubs during this period. Our market share calculations are based on revenue rather than passengers so that both price and traffic changes are taken into account. We consider all OD pairs (markets) in which American Airlines had traffic connecting through one of the three hubs (there are 3581 such OD pairs for DFW, 2152 OD pairs for ORD, and 252 OD pairs for MIA) in both the first quarter of 2001 and the first quarter of 2002. For simplification purposes the following notation will be used hereafter,

- AAH: Revenue generated on a single market by American Airlines flights connecting at the hub,
- AA: Total revenue generated by American Airlines on a single market, and
- Total: Total revenue generated by all the airlines on a single market.

Tables 1a and 1b compare the market share changes for Dallas/Fort Worth, Chicago O'Hare and Miami International Airports. The changes were computed by subtracting the market share during the first quarter of 2001 from that during the first quarter of 2002 (the values shown in the tables represent the average across all the markets for each hub). Therefore, positive changes mean an increase in market share, and negative changes a decrease.

The average market share of American Airlines (AA/Total) increased for the three hubs (see Table 1a). However, the increase in Miami was noticeably less than that in Dallas/Fort Worth and Chicago O'Hare. A two-sample t-test for unequal variances shows that the average increase in DFW and ORD was similar and different from that in MIA (see the t-statistics and the t-critical in Table 1a).

On the other hand, the revenues generated by American Airlines with flights connecting through the hubs decreased in reference to the total revenues generated by American Airlines on the same markets (AAH/AA) (see Table 1b). The reduction, meaning smaller profits from the hubs, was more noticeable in Dallas and Chicago.

According to Walter Aue, American Airlines VP-Capacity Planning, de-peaking strategies are applicable in Miami as well as in Chicago and Dallas because of the high share of flow traffic (*3*). (St. Louis (STL) Airport is not considered in this paper, because it became a major hub very recently with American Airlines' acquisition of TWA). Statistics show that 61.5% of the total American Airlines traffic going through Miami is made up of connecting (flow) passengers, compared to 59.9% and 68.8% in the cases of Chicago and Dallas, respectively (*4*). However, there is a major difference between the flow passengers in MIA and the flow passengers in DFW and ORD: directionality. Given the location of Dallas and Chicago, most of their flights are east-west. In contrast, Miami is a multi-directional hub, connecting U.S. cities in the north and west, to points throughout Latin America and the Carribean.

Directionality allowed American Airlines to implement de-peaking strategies without making the transfer times unbearably long. Despite de-peaking its aggregate schedules into Chicago O'Hare and Dallas/Fort Worth, American was able to keep directional banks. Eastbound flights depart during a small time window a short period after a batch of flights coming from the west and carrying most of the connecting passengers arrive (see Figure 2)(*5*). Banks from the east are alternated with those from the west for a smoothed overall arrival schedule (see Figure 1a and 1b). The drop in revenues at ORD and DFW, combined with the directionality of most of their flights, might have triggered the implementation of the de-peaking policies.

3. POSSIBLE EFFECTS OF DEPEAKING

After a massive planning effort, American Airlines decided in 2002 to completely de-peak its schedules at Chicago O'Hare and Dallas/Fort Worth International Airports. In April of 2002, with the exception of an hourly flight from Chicago to New York La Guardia, American Airlines rescheduled virtually all of 333 mainline and 180 Eagle flights at ORD. Similarly, in November of 2002, American changed 477 mainline flights and 214 Eagle flights at DFW (*3*). Considering that these values are daily, the task was definitely a major one.

What was American Airlines expecting from these de-peaking strategies? By restricting itself to no more than one arrival and one departure per minute throughout the day, the company increased minimum aircraft turn times (e.g., Boeing757s' by 2 minutes, Boeing737s and MD-80s' by 6 minutes, F100s' by 5 minutes, and ERJs' by 4 minutes). Similarly, American decreased by 5 minutes the mean aircraft ground time at Chicago, and by 8 minutes at spoke airports. Schedule reliability increased and time spent in queue at runways decreased. Labor efficiency also went up. Furthermore, the company is now using five fewer aircraft (three mainline jets and two RJs) and four fewer gates at Chicago; and nine less mainline jets, two less RJs, and at least four fewer gates at Dallas (*3*).

However, average passenger transfer time at Chicago O'Hare went up by 10.7 minutes, while median transfer time increased by 7 minutes (*3*). Are these changes considered negligible by travelers when choosing their flight? Or do they affect American Airlines' market share and decrease its revenue so as to offset the benefits of de-peaking?

The objective of this section is to analyze the changes in market share resulting from the implementation of de-peaking. The market performance of American Airlines and its strongest competitor, United Airlines, at their hub in Chicago O'Hare are compared. Airfare and service frequency are the two most important factors influencing customers' selection of an airline. Therefore, they should be controlled for if one wants to calculate the market share changes resulting solely from de-peaking. .

To do so, we estimated a market share model with a logit form, so the ratio of the market shares of the two companies is given by Equation 1a.

$$\frac{S_i^{mq}}{S_j^{mq}} = \frac{N_i^{mq}/n^{mq}}{N_j^{mq}/n^{mq}} = \frac{N_i^{mq}}{N_j^{mq}} = \frac{\exp(V_i^{mq})}{\exp(V_j^{mq})} \tag{1a}$$

Equation 1b is the linear form of Equation 1a, and it will be used throughout the paper.

$$\ln\left(\frac{S_i^{mq}}{S_j^{mq}}\right) = \ln\left(\frac{N_i^{mq}}{N_j^{mq}}\right) = V_i^{mq} - V_j^{mq} \tag{1b}$$

where S_i^{mq} is the market share of airline *i* in market *m* during quarter *q*, given by the ratio of passengers using airline *i* to the total number of passengers in market *m* during quarter *q*, or equivalently the probability of a passenger selecting airline *i*; N_i^{mq} is the number of passengers in market *m* using airline *i* during quarter *q*; n^{mq} is the total passengers in market *m* during quarter *q*; and V_i^{mq} is the utility of a hubbed service provided by airline *i* in market *m* during quarter *q*.

To calculate V_i^{mq}, the on-line connecting service utility model developed by Hansen in 1989 is used. The model is a function of the average fare, the airline's frequencies on both segments of the itinerary, and the circuity of the service. Circuity is "the sum of the great circle distances from the hub to the cities constituting the market minus the great circle distance between these cities" (*6*). However, in our case, only one hub, ORD, is considered and we assume that for the same market, the circuity is equal for all the airlines so that it can be excluded from the function. The log of the frequency is used because of the "diminishing returns with respect to the gain in service attractiveness from adding additional flights" (*6*). Thus, the deterministic utility function of a hubbed service is,

$$V_k^{mq} = \alpha_k + \beta F_k^{mq} + \gamma_1 \ln(v^{\max})_k^{mq} + \gamma_2 \ln(v^{\min})_k^{mq} + \gamma_3 D_q \qquad (k=i, j) \tag{2}$$

where V_k^{mq} is the deterministic utility of a hubbed service for airline *k* in market *m* during quarter *q*; F_k^{mq} is the average fare of the service; $\left(v^{\max}\right)_k^{mq}$ is the flight frequency on the maximum frequency link; $\left(v^{\min}\right)_k^{mq}$ is the flight frequency on the minimum frequency link; and D_q is a dummy variable set to 1 for quarters after depeaking.

After substituting the utility function into Equation 1b, we get:

$$\ln\left(\frac{S_i^{mq}}{S_j^{mq}}\right) =$$

$$\left(\alpha_i - \alpha_j\right) + \beta\left(F_i^{mq} - F_j^{mq}\right) + \gamma_1\left[\ln\left(v^{\max}\right)_i^{mq} - \ln\left(v^{\max}\right)_j^{mq}\right] + \gamma_2\left[\ln\left(v^{\min}\right)_i^{mq} - \ln\left(v^{\min}\right)_j^{mq}\right] + \varepsilon^{mq} \tag{3}$$

where $\varepsilon^{mq} = \ln\left(\frac{S_i^{mq}}{S_j^{mq}}\right) - \ln\left(\frac{\hat{S}_i^{mq}}{\hat{S}_j^{mq}}\right)$ is a stochastic error term that includes both measurement error and unobserved attributes of the two service alternatives in market *m*. The error term is heteroscedastic because the measurement error depends on the magnitudes of N_i^{mq} and N_j^{mq}. To correct the heteroscedasticity we adapted a method documented in Maddala 1983 (*7*). The method consists of applying weights that are estimates of the standard error of the stochastic error. The estimate is given by:

$$\hat{\sigma}^{mq} = \sqrt{\frac{N_i^{mq} + N_j^{mq}}{N_i^{mq} N_j^{mq}}} \tag{4}$$

We then estimate Equation 3 using weighted least squares where the weight w^{mq} is the inverse of these estimated standard errors. Therefore, the final form is described as follows:

$$\frac{\ln\left(\frac{N_i^{mq}}{N_j^{mq}}\right)}{w^{mq}} = (\alpha_i - \alpha_j)\frac{1}{w^{mq}} + \beta\frac{(F_i^{mq} - F_j^{mq})}{w^{mq}} + \gamma_1\frac{\left[\ln(v^{\max})_i^{mq} - \ln(v^{\max})_i^{mq}\right]}{w^{mq}}$$
$$+ \gamma_2\frac{\left[\ln(v^{\min})_i^{mq} - \ln(v^{\min})_j^{mq}\right]}{w^{mq}} + \eta\frac{D_q}{w^{mq}} \tag{5}$$

where Dq is a dummy variable for de-peaking (0 for the first quarter of 2002, 1 for the third and fourth quarters of 2002).

The processed data from HUB and ONBOARD T100 of Data Base Products, based on the DOT ten percent flight coupon survey, were used in our analysis, which include the number of passengers, average fare, and scheduled maximum and minimum frequencies. All the data are quarter based and only domestic and round trips with one stop at ORD were considered. In addition, markets with a minimum service frequency of less than 90 were not included in the data set, because that frequency would be too low to be considered a regularly scheduled service. The de-peaking strategy was implemented at ORD in April 2002. Hence, data from the first, third and fourth quarter of 2002 are used.

The regression results are presented in Table 2. All the independent variables are significant to the dependent one, i.e. the market share ratio of airline *i* (AA) to airline *j* (UA). The unit of average airfare is $100, so that the negative estimated parameter (-0.44) means that if the difference of average airfare between AA and UA for a particular market increases $100, the ratio of AA's market share to UA's market share for that market will drop 44 percent.

In addition, the coefficients of logarithmic maximum and minimum frequency are large; both of them are close to 1. This reveals that service frequency is a critical factor in market competition.

Finally, the negative estimated parameter for the de-peaking dummy variable represents a decrease in AA's market share between the first quarter of 2002 and the third and fourth quarters of 2002. The estimated magnitude of the reduction is about 4 percent, with a standard error of 2 percent. In other words, controlling for fare and frequency, it appears that American lost about 4 percent in market share versus United for traffic connecting through ORD between the period before de-peaking was implemented and the period after de-peaking. While it is possible that this change is the result of some other factor than de-peaking itself, our results point to the possibility that American's cost savings from de-peaking have come at the expense of traffic and revenue. They also challenge the widely held view that service does not matter in the era of Internet flight booking and declining business travel.

4. CONCLUSION

This paper has methodically examined the conditions that might have triggered American Airlines structural changes in the year 2002. The results revealed that the drop of AA's revenue generated by flights going through the hubs, combined with the increase of AA's total revenue for the same markets, as well as the directionality of the majority of the flights in Chicago O'Hare and Dallas/Fort Worth International Airports, played an important role in American Airlines' decision of implementing de-peaking strategies.

A further investigation was carried out in order to understand the consequences of the new policy. Airfare and service frequency, the two most important factors influencing customers' selection of an airline, were controlled in our calculation. The results indicated that the ratio of AA's market share to UA's decreased by more than four percent after de-peaking. A plausible, if not yet confirmed, hypothesis is that this loss in market share derives from increases in layover times for connecting services-flip-side of the widely touted cost savings generated by de-peaking. If future research confirms this finding, then it will be necessary for airlines to balance these cost savings against revenue losses. More generally it would confirm the view that in an industry as mature as the airlines, there are few if any pain-free ways to save large amounts of dollars.

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LIST OF FIGURES AND TABLES

TABLE 1a AA/Total changes between first quarter of 2001 and first quarter of 2002

	DFW	ORD	DFW	MIA	ORD	MIA
Mean	0.06	0.05	0.06	0.02	0.05	0.02
Variance	0.04	0.02	0.04	0.01	0.02	0.01
T-statistics	0.50		5.01		4.72	
T-critical	1.96		1.97		1.97	

TABLE 1b AAH/AA changes between first quarter of 2001 and first quarter of 2002

	DFW	ORD	DFW	MIA	ORD	MIA
Mean	-0.12	-0.10	-0.12	-0.06	-0.10	-0.06
Variance	0.07	0.07	0.07	0.03	0.07	0.03
T-statistics	-2.83		-5.15		-3.37	
T-critical	1.96		1.97		1.97	

Data from the “Origin and Destination Survey of Airline Passenger Traffic” (O&D Plus+) or “Ten-percent Survey”

TABLE 2 Market share ratio model regression results

Variable	Estimated parameter	Standard error
Intercept	-0.08	0.02
Average fare difference	-0.44	0.02
Maximum frequency difference	0.94	0.03
Minimum frequency difference	0.68	0.03
Time dummy variable	-0.04	0.02

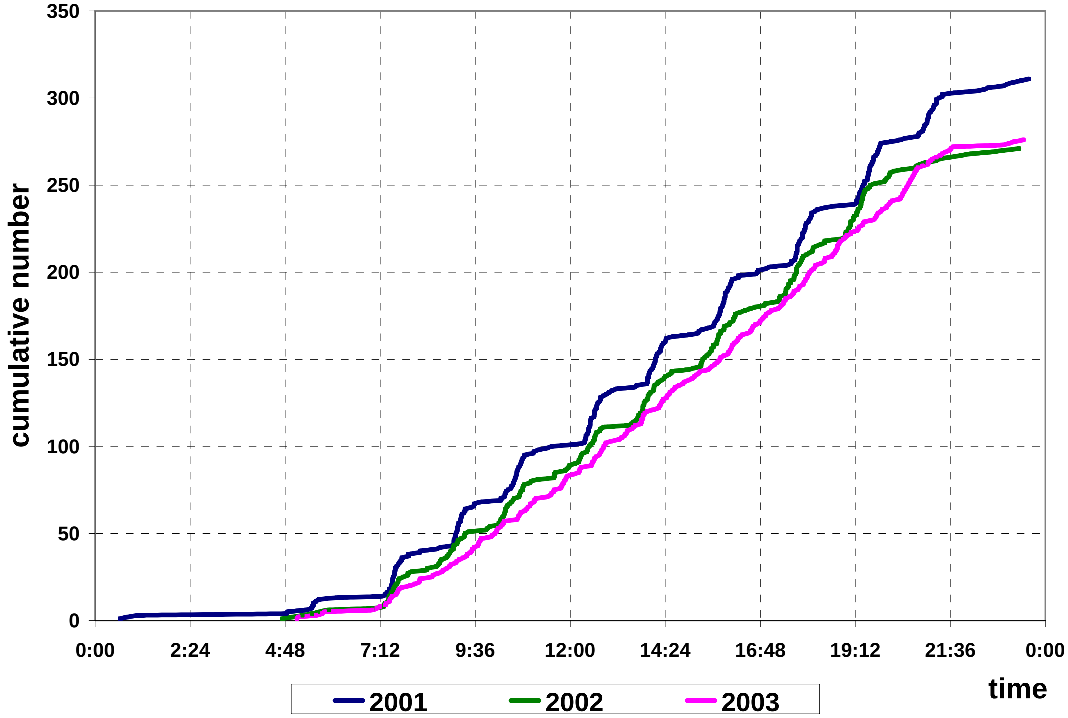

FIGURE 1a Cumulative number of arrivals of American Airlines to Chicago O'Hare International Airport.

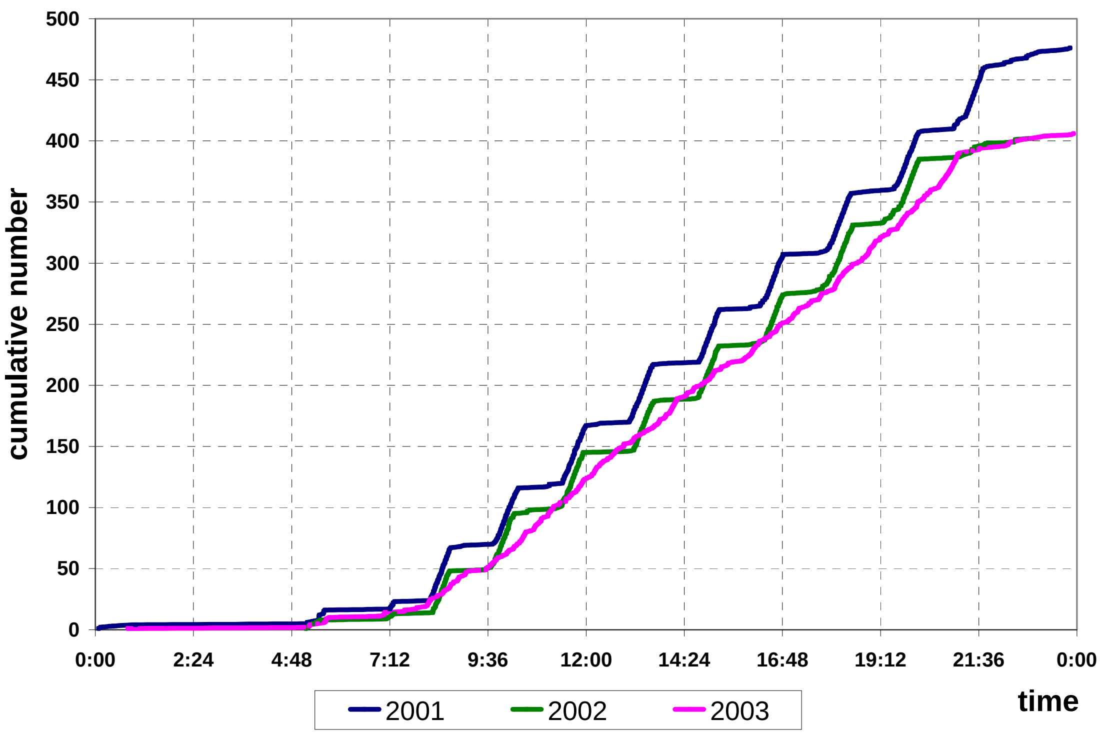

FIGURE 1b Cumulative number of arrivals of American Airlines to Dallas/Fort Worth International Airport.

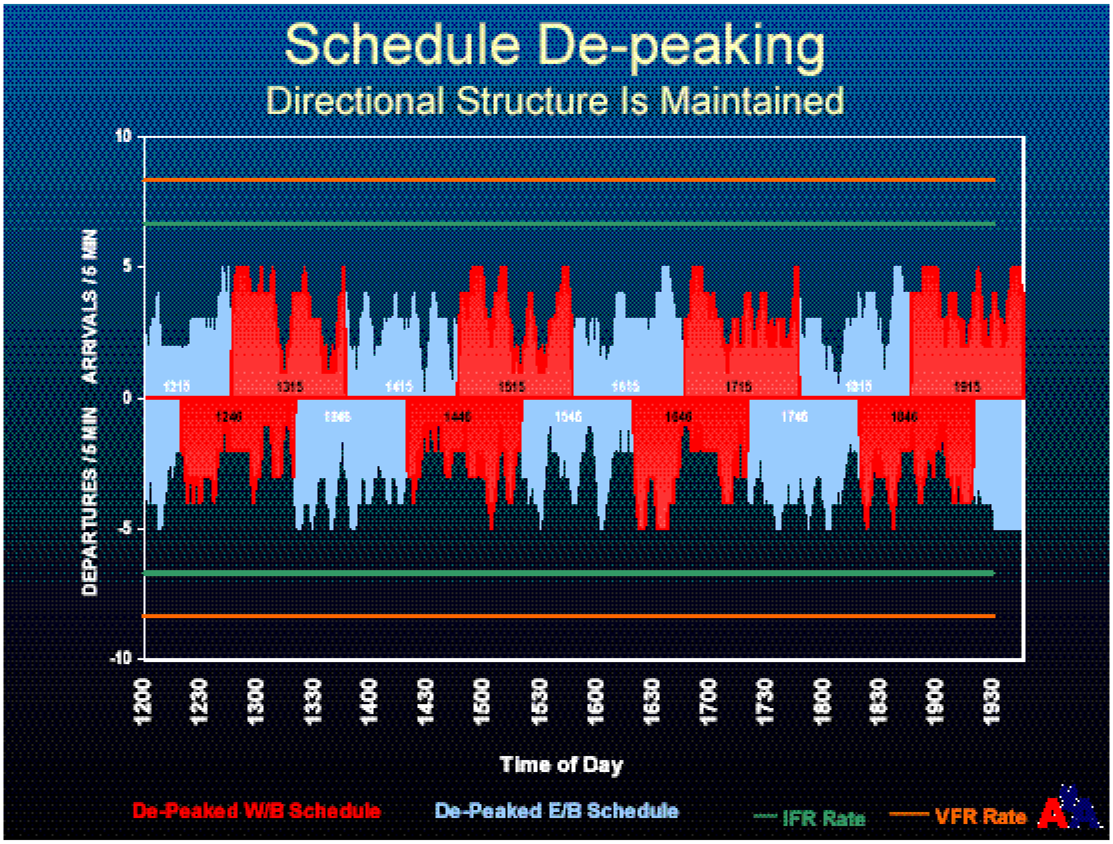

FIGURE 2 Directional banks after depeaking.

Source: American Airlines, Schedule De-peaking, Presentation to Free Flight Steering Committee May 8, 2003