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TECHNICAL SUPPLEMENT NO. 3

ANALYTICAL CONCEPTS AND METHODS

Prepared For

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Federal Aviation Administration

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APPENDIX F: ESTIMATES OF CONSUMER AND PRODUCER BENEFITS

As is discussed in chapter 2 of the Department's report, net benefits associated with a change in High Density Rule consist of *consumer benefits* and *benefits to producers (carriers)*, together with increases in *net revenues to airports*, *delay costs*, and *noise impacts*. This appendix elaborates on the calculation of consumer and producer benefits.[1] Benefit estimates were developed at a market-by-market, airline-by-airline level. The results reflect a change in surplus measures for consumers and producers based on market conditions as they existed in August 1993. This was the most recent peak-demand period for which complete data were available when the study began.

CONSUMER BENEFITS

A formal measure of consumer welfare both with and without the HDR in place is based on the economic concept of *consumer surplus*. This is defined as the difference between what consumers must pay for a given level of service and what they would be willing to pay.[2] For this study we defined the "price" of service in each city-pair market to include the average *money fare* plus an increment representing the value of *service time*. Service time, in turn, has two components: *travel time* plus *schedule delay*. The inclusion of travel time reflects the fact that consumers value the time spent in traveling between two points. Schedule delay refers to the gap between one's desired departure time and the departure time actually chosen.

Money Fare

The money fare in each market was calculated as the average (carrier-specific) fare indicated in the DB1A ticket sample for the period starting with the fourth quarter of 1992 and ending with the third quarter of 1993. The DB1A fare includes tax and therefore represents the relevant money price faced by consumers. Of course, these fares reflect prices in the HDR base case; there is some likelihood that fares would fall in the post-HDR case due to increased competition. Thus, we constructed

[1]The measurement of airport benefits and noise impacts is described in full in the Department's Report, Chapter 2. Additional details on the noise analysis also appear in Technical Supplement No. 1.

[2]When prices are allowed to vary, the change in consumer surplus between two different price levels can be calculated using the "compensating variation," defined as the amount of income that must be given to a consumer to make him or her just as well off after the price change as before.

estimates using two different fare levels in the post-HDR case: one with fares held constant, and one in which fares fall by five percent relative to the base case.[3]

Travel Time

Travel time is measured simply as the average scheduled block hour time in each market, as calculated from data in the Official Airline Guide (OAG). Travel time will not change whether the HDR is eliminated or left in place; nevertheless, we included it as part of the full price of travel in order to assess the level (as well as the change) of consumer surplus both with and without the HDR in force.[4]

Schedule Delay

Schedule delay is not directly observable since it depends on the desired distribution of demand over the course of the day. However, we obtained estimates using the following approach. First, it is reasonable to believe that, at non-HDR airports where operations may be scheduled whenever desired, carriers attempt to schedule flights at the times when passengers actually wish to fly. Thus, we chose the following non-HDR airports upon which to base the distribution of demand for each HDR airport:

HDR Airport	Non-HDR Airport
ORD	Dallas-Ft. Worth International
JFK	Washington Dulles International
LGA	Boston Logan International (domestic only)
DCA	Boston Logan International (domestic only)

Separate distributions were derived for arrival and departure times. However, a single distribution curve across all markets from a given airport is probably not representative of the demand distribution for individual markets, since the latter may vary according to both length of flight and perhaps changes in time zones. Thus, we constructed a number of distribution curves based on eight different mileage blocks and four different time zones for each of the non-HDR airports listed above. The total daily demand in each market at an HDR airport was then distributed according to the relevant mileage block/time zone category to which it belonged.

With estimates of market-specific desired distributions, it remained to obtain estimates of schedule delay before and after the HDR is removed. In both cases we assumed that, for each carrier, passen-

[3]The reduction in average fares is based on studies done by the U.S. General Accounting Office, Apogee Research and other researchers *(see Technical Supplement No. 2, Chapter 7)*. It reflects a scarcity premium captured by carriers because of HDR restrictions. The fare reductions were applied to all domestic and Canadian flights. Other international flights may be unaffected by the HDR due to access restrictions embedded in bilateral agreements. The cases examined in this study anticipated the recently announced U.S.-Canada aviation agreement which, from a competitive standpoint, should result in a close resemblance between affected markets of the two countries.

[4]A better specification of the model would include expected delay time in travel time.

gers simply pick the nearest available flight to their desired departure or arrival time. (Because passengers may actually switch carriers when schedules change, this may tend to overstate schedule delay.) For the base case (with the HDR still in effect), the actual schedule of flights on the representative day, August 11, 1993, was used.

For the post-HDR case, we could not know for certain how many additional flights would be scheduled nor when they would be scheduled over the course of the day. To deal with this uncertainty, we assumed that carriers add flights according to our "best estimate" of operations without the HDR, and that each carrier schedules its flights so that average schedule delay is minimized across all of its passengers in each market (given the desired demand distribution). In reality, carriers may not be able to minimize schedule delay in each individual market due to other scheduling constraints. This underestimate of schedule delay in the post-HDR case tends to offset the overestimate described in the preceding paragraph.

Full Price of Travel (FPT)

With estimates of fares, travel times and schedule delay in hand, the calculation of the full price of travel, FPT, was as follows:

$$\begin{aligned} FPT = {} & \text{Fare} + [(1.70 \times \text{Hourly Wage}) \times \text{Travel Time} \\ & + [(0.15 \times \text{Hourly Wage}) \times \text{Schedule Delay}], \end{aligned}$$

where travel time and schedule delay are measured in hours. This equation is based on an econometric analysis of airline demand by Morrison and Winston.[5] Wages were measured in 1993 dollars.

Passenger Demand

Next we constructed an estimate of the passenger demand in each market that corresponded to the OAG schedule for August 11, 1993. To accomplish this, passenger counts were tabulated from T-100 submissions. The T-100 data represent monthly totals of the actual number of passengers flown between two points by a given carrier. Transformation of this monthly actual demand into an average weekday demand corresponding to August 11 required several steps.

First, to account for the possibility that some scheduled flights may not have been flown, the actual passenger counts were multiplied by the fraction $\frac{\text{Scheduled Flights}}{\text{Actual Flights}}$. (Both scheduled and actual flight counts are contained in the T-100 data.) Second, total weekday demand was then estimated

[5]Morrison, Steven A. and Winston, Clifford (1989). "Enhancing the Performance of the Deregulated Air Transportation System," in Baily and Winston, eds., Brookings Papers on Economic Activity--Microeconomics, The Brookings Institution: Washington, D.C., pp. 61-123. The hourly wage figures are consistent with those employed by FAA in developing value of time figures as published in "Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs," FAA-APO-89-10 (1989), as updated.

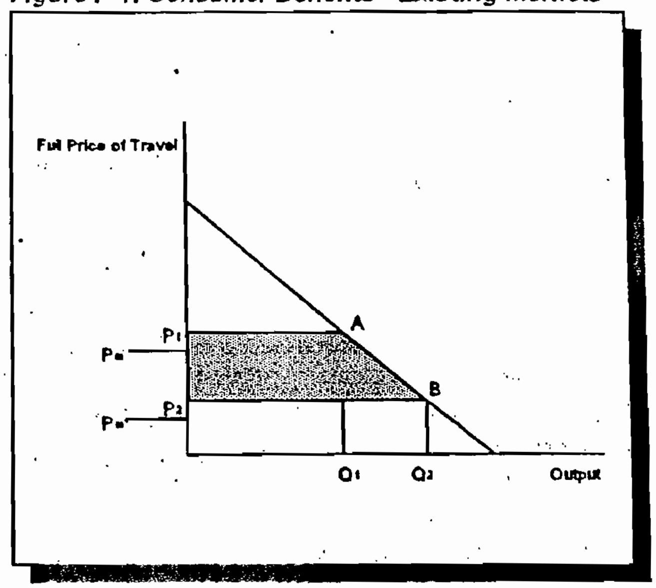
by applying the fraction $\frac{\text{Weekday Seats}}{\text{Total Seats}}$. Finally, division by the number of weekdays in the month yielded an estimate of the average weekday demand based on the scheduled service offerings.

Demand Curve

A change in the full price of travel in any given market will result in a change in passenger demand. We constructed a demand curve to reflect this relationship. For *existing* markets where we projected that new flights would be added, we derived the demand curves by assuming a specific percentage decline in the money fare in each such market, and then found the corresponding break-even load factor for the new flights.[6] A straight-line demand curve was then constructed which connects the "actual" FPT/quantity point with the projected new one.

The process of estimating the change in consumer benefits for added flights in existing markets is illustrated in Figure F-1 below. The vertical axis shows the full price of travel; the horizontal line shows the quantity of output (passengers).

Figure F-1: Consumer Benefits - Existing Markets



Assume the initial full price of travel is given by P_1 with the corresponding output of Q_1. At this level, the money price of travel is P_m. If the money price is reduced to P_m', the FPT declines to P_2 and output increases to Q_2. The measure of consumer benefit -- the *increase in consumer surplus* -- is defined by the shaded area P_1P_2BA.

Conceptually, benefits would be estimated in the same way in those cases where there is a money fare reduction in the market, but no increase in flights. In such cases the elasticity of demand was assumed. Given a percentage change in money price (from P_m to P_m'), it was possible to calculate the change in output and therefore a change in consumer surplus.

The load factor calculation assumes that when a new flight is added, it is a "generic" flight with seats equal to the average seat size of existing flights in the market. To calculate costs, we used data from Form 41 submissions to obtain estimates of total aircraft cost per seat-block hour for each aircraft type used on each route. This estimate incorporates both direct flight costs and indirect overhead

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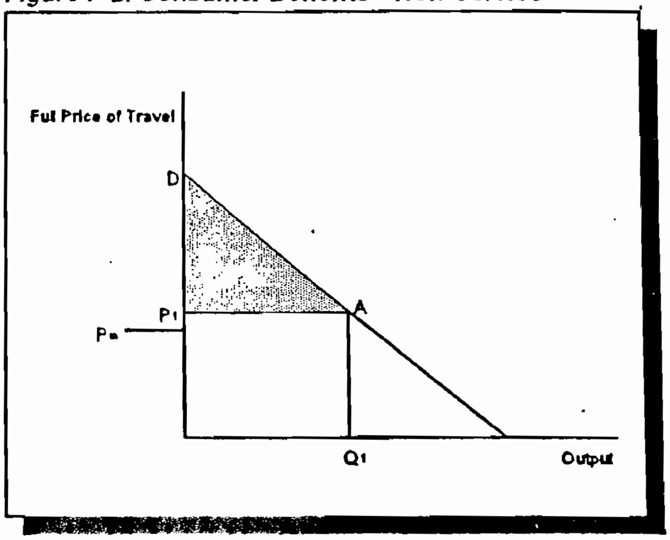
[6]All additional flights are assumed to "break-even" on a fully allocated cost basis.

costs. In addition, we also used estimates of passenger-related costs per revenue-passenger-mile (RPM).

For *new* markets, an aircraft was assigned to the route and all flights were assumed to break even, implying a unique money price/output combination. Travel time and schedule delay costs were added to the money price to derive the FPT. The demand curve was derived by assigning each city-pair market to one of two categories -- business or vacation. Each category has a specific assumed price elasticity of demand (-1.0 for business, -1.5 for vacation), which was then applied to the existing observed market demand and FPT to generate a straight-line demand curve.

The benefit of new service to consumers is illustrated in Figure F-2. Point **D** in the exhibit represents no new service, either because the full price of travel is prohibitively high or because restrictions on access *(e.g.,* slot controls) preclude new service. Now assume that as a consequence of increased competition, the full price of travel is P_1, the money price is P_m and output is Q_1. In this case, the measure of consumer benefit -- the increase in consumer surplus -- is defined by the shaded triangle P_1AD.

Figure F-2: Consumer Benefits - New Service



PRODUCER (CARRIER) BENEFITS

Producer benefits are measured as a change in airline net profits, which were defined as revenues minus fully allocated costs. Carrier revenues in each market were computed as the average money fare described earlier (excluding tax), times the number of passengers carried in the market. Carrier costs are divided into two components: passenger-related costs and aircraft-related costs. We assumed that passenger-related costs consist of sales and promotion costs plus passenger servicing costs as reported on Form 41. Estimates of average passenger costs per RPM were then developed for each carrier. All remaining operating expenses were treated as aircraft-related costs. An average cost per seat-block-hour was computed for each major aircraft type for each carrier submitting Form 41 financial data. A primary aircraft was then assigned to each market in order to compute total aircraft-related costs.

In the analysis, producer surplus declines in existing markets because of the five-percent reduction in fares; however, this is offset to some extent by increased demand due to lower prices. The impact was computed based on the relationship between carrier yields (before and after an HDR change) and fully allocated costs per RPM.