Benefits and costs of airline mergers: a case study

Dennis W. Carlton,*
William M. Landes,**
and
Richard A. Posner***

This paper provides a methodology to analyze the potential benefits and costs of airline mergers. The methodology is applied to the recent merger between North Central Airlines and Southern Airways. Our analysis of benefits focuses on product improvement—the superior product created by a merger which increases the amount of single-carrier versus multiple-carrier service. A conditional logit model of travel demand is used to estimate the benefit of the introduction of a superior product. Our analysis of possible costs (in reduced competition) focuses on the definition of the market and the significance of potential competition.

1. Introduction

In the outpouring of academic and policy analysis that preceded the recent steps toward deregulation of rates, service, and entry and exit in the U.S. airline industry, little attention was paid to the structure of the industry after deregulation, except insofar as the denial of substantial economies of scale was taken to imply that there would be no significant changes in structure. Yet the experience with the securities brokerage industry, where the abrogation of fixed commission rates was followed by a drastic reduction, through bankruptcies and consolidations, in the number of brokerage houses, should have warned that deregulation might result in significant changes in industry structure. In the brokerage as in the airline industry, it has never been suggested that economies of scale are significant relative to the size of the market.

When statutory deregulation of airlines—as distinct from the administrative steps which the CAB had previously taken and which the courts might have reversed—became recognized, during 1978, as inevitable, a wave of merger proposals hit the CAB, and it became apparent for the first time that the history

* University of Chicago.
** University of Chicago.
*** University of Chicago.

This paper is based on a study made by the authors for Lexecon Inc., at the request of North Central Airlines and Southern Airways, and was submitted to the Civil Aeronautics Board in connection with the airlines’ request for approval to merge. The views expressed in the paper are solely the authors'. Comments from J. Rasenberger and members of Systems Analysis Research Corporation and the research assistance of Ann Bowler and John O’Donnell are gratefully acknowledged.
of consolidations in the brokerage industry after deregulation might be repeated in the airline industry. There was, however, an important difference. The number of brokerage firms on the eve of deregulation exceeded the number of airlines by an order of magnitude—there were hundreds of brokerage firms, and only 19 domestic scheduled airlines.1 A substantial consolidation of the existing airlines might result in a highly concentrated market.

At this writing, five merger proposals involving scheduled passenger airlines have been made to the CAB. Three involve National Airlines. Pan American and National sought permission to merge, while two other airlines, Eastern and Texas International, proposed to take Pan American’s place as National’s merger partner. Eastern and Texas International’s proposals were denied by the CAB. Continental and Western Airlines also sought permission to merge, but the Board denied permission (BNA, 1979, A-27). The smallest of the proposed mergers, that between North Central and Southern, has been approved by both the CAB and the President (CAB, 1979). The new airline is known as “Republic Airlines.”

The legal framework within which the CAB is evaluating the remaining merger proposals is a somewhat unfamiliar one in the regulatory context. The airline deregulation statute passed in the fall of 1978 (and applicable to all pending and future airline merger proposals)—the Airline Deregulation Act of 1979—has substituted for the traditional free-wheeling “public interest” standard a paraphrase of the federal antitrust statutes; and the legislative history makes clear that in considering any merger proposal the CAB shall be mainly concerned with whether the merger meets the standards of the antitrust laws—notably Section 7 of the Clayton Act, which imposes a stringent standard of liability on mergers subject to it.2 As liberalized by recent decisions of the Supreme Court, Section 7 of the Clayton Act now allows a fairly broad inquiry into factors relevant to the economic consequences of a challenged merger (United States v. General Dynamics Corporation, 415 U.S. 486 (1974); cf. Continental T.V. Inc. v. GTE Sylvania, Inc., 438 U.S. 36 (1977).

This paper, a case study of the North Central-Southern merger, is an effort to demonstrate the utility of economic analysis in assessing both the possible anticompetitive effects of a merger and its possible benefits. Our analysis of competitive effects focuses on problems in the definition of market and in the significance of potential competition. Our analysis of benefits focuses not on economies of scale, which previous studies of the airline industry have found to be unimportant,3 but on product improvement—the superior product that is created by a merger which increases the amount of single-carrier versus multiple-carrier service. This is a neglected aspect of airline consolidations. We find its quantitative significance to be considerable.

2. The North Central-Southern merger

North Central Airlines and Southern Airways are two of the nine so-called local service carriers certificated by the CAB as of December 31, 1977. They

---

1 This term refers to the ten domestic trunk carriers (including Pan American’s domestic operations) and the nine local service carriers certificated by the CAB as of December 31, 1977.


3 See Woodbury (1978) for a recent survey. The evidence, however, regarding network economies as distinct from output economies with a fixed network is too sparse to justify any conclusions.
are the fifteenth and eighteenth largest of the 19 domestic scheduled airlines, with total revenues in 1977 of $229 and $160 million, respectively. Their names are fairly indicative of the areas served. North Central feeds traffic from numerous cities in the north central United States into hubs like Minneapolis/St. Paul, Milwaukee, Chicago, and Detroit and also has a bridge route linking Detroit with Atlanta. Southern feeds traffic from numerous cities in the southeast United States into hubs like Atlanta, Nashville, and Memphis and also has bridge routes linking the last two cities with Chicago, Milwaukee, and Minneapolis/St. Paul.\footnote{North Central and Southern have extensions from their primary systems to New York (from Milwaukee and Greenville/Spartansburg) and Denver (from Minneapolis/St. Paul and Wichita), but the routings are too circuitous to serve as bridges for traffic flowing between the two systems.} Today a traveler between a small city in one of the north central states and a small city in one of the southern states who flies North Central or Southern must change airlines to get to his destination. The most dramatic effect of the merger will be to enable North Central-Southern (""Republic") to offer for the first time single-carrier service (and, in some instances, single-plane service) between more than 1400 city pairs in the carriers' regions.

Single-carrier service must be distinguished from single-plane service. The former involves changing planes, but not airlines, to get from origin to destination. The latter involves changing neither plane nor airline, though it may involve intermediate stops and is thus distinguishable from nonstop service. Although our empirical analysis will focus on the consumer benefits generated by the creation within the North Central-Southern service area of new single-carrier service, similar methods could be used to estimate the benefits of upgrading service from single-carrier to single-plane or from single-plane to nonstop.

3. Empirical analysis of benefits of the merger

This section attempts to estimate the consumer benefits, in increased single-carrier service, that the North Central-Southern merger will bring about. An advantage of studying the benefits of single-carrier service is that they flow more or less automatically from a merger and the resulting consolidation of fleets, terminal facilities, and sales forces. Only minimal assumptions need be made concerning postmerger operating changes. In contrast, estimating the benefits of single-plane or of nonstop service would involve conjectures regarding scheduling and equipment changes by the merged airlines and the probability of error in the estimates would be greatly increased.

\textbf{The value of a single carrier.} Using data from 33 city pairs that in 1977 received both single and multicarrier service but will receive additional single-carrier service as a result of the North Central-Southern merger, we analyze the determinants of a single carrier's market share to assess the value that consumers place on travel by a single versus multiple carriers.\footnote{Our analysis could have used data from any city pair where both single and multiple carriers compete. The particular city pairs used in the analysis are city pairs in North Central's and Southern's service area where both single and multiple carriers compete. Since there is no reason to think there is anything unusual about consumer preferences in the data sample we have used, our results are applicable to the 1400 city pairs for which the merger will enable single-carrier service to be offered for the first time.} If consumers prefer single- to multicarrier service, then in city pairs where both types of
TABLE 1

PERFORMANCE OF SINGLE VS. MULTIPLE CARRIERS, 1977

| 1. AVERAGE MARKET SHARE OF SINGLE CARRIERS | 75% |
| 2. AVERAGE TIME GAIN (MINUTES) OF SINGLE OVER MULTIPLE CARRIER PER CITY PAIR | 37 |
| 3. RATIO OF AVERAGE TIME GAIN TO AVERAGE TIME OF SINGLE CARRIER | .13 |
| 4. RATIO OF AVERAGE NUMBER OF SINGLE CARRIER TO AVERAGE TOTAL FLIGHTS PER WEEK PER CITY PAIR | .39 |

NOTE: BASED ON 28 CITY PAIR COMBINATIONS THAT HAD BOTH SINGLE AND MULTICARRIERS SERVICE IN 1977. MULTICARRIERS SERVICE IS DEFINED BY A LISTING IN THE OFFICIAL AIRLINE GUIDE, SEPT. 15, 1977. THE SEPTEMBER ISSUE OF THE OAG IS CONSIDERED THE MOST REPRESENTATIVE OF FLIGHT PATTERNS DURING THE YEAR SINCE IT IS NOT INFLUENCED BY SEASONAL PEAKS OR TROUGHS. FROM OUR INITIAL 33 CITY PAIRS, FIVE WERE DELETED BECAUSE THERE WAS NO LISTING FOR MULTICARRIERS SERVICE IN THE OAG. THE ABSENCE OF A LISTING, HOWEVER, MEANS NOT THAT THERE IS NO MULTICARRIER SERVICE FOR THAT CITY PAIR BUT THAT THE CONNECTION TIME BETWEEN CARRIERS EXCEEDS THE MAXIMUM OF TWO HOURS ALLOWED FOR AN OAG LISTING.

carriers offer similar fares, travel times, and number of flights, the single carrier should have the larger market share. Table 1 summarizes data for 28 city pairs that were served by both single and multiple carriers in 1977 and will receive an additional single carrier as a result of the North Central and Southern merger.

Table 1 indicates that on average the single carrier has a significantly larger market share, a shorter travel time,6 and offers slightly fewer flights per week than competing multiple carriers. The market share of single carriers is three times that of multiple carriers. However, one cannot determine from Table 1 how much of this difference results from the public’s preference for a single carrier and how much from a preference for shorter travel time. We use multiple-regression analysis across city pairs to disentangle the effects of flight frequency and travel time from other possible benefits of single carrier service. Those benefits may include more convenient scheduling that is uncorrelated with the number of single-carrier flights, reduced walking in the terminal, improved luggage handling, and greater coordination in the face of traffic delay.7

☐ Statistical analysis. The market share (MS) of a single carrier versus multiple carriers is a function of the variables that influence a passenger’s choice between single and multiple carriers.8 Since MS is an estimate of the

---

6 The shorter travel time of single carriers in our sample results not from the presence of single plane service (only 8 percent of the flights involve single plane service) but from the closer scheduling of connecting flights for the single carrier.

7 A possibly offsetting factor we ignore is that greater coordination in the face of traffic delay may impose costs on some passengers—those nonconnecting passengers whose flight is delayed because the airline is waiting for connecting passengers from one of its other flights. On the other hand, we do not attempt to model the determinants of flight frequency, scheduled trip time, and total passenger travel, though those three variables may be favorably affected by the provision of single-carrier service. The first two variables would be complicated to model because they depend heavily on the existing route and aircraft scheduling network in the rest of the airline’s system. This consideration suggests that any simultaneity bias resulting from correlation between flights, times, and errors in the equation determining market share is likely to be small.

8 Since fares were usually identical for single and multicarrier service for the city pairs used in the analysis, fare levels would usually not influence a passenger’s choice between single
probability of selecting a single carrier (and so $1 - MS$ is the probability of selecting a multiple carrier), we expect it to be positively related to both the number of single compared with multicarrier flights and the travel time of multiple compared with single-carrier flights.

We estimated regression equations for two city pair samples. The first sample (Sample I) contains 28 city pairs for which we have scheduled-time data for both single and multiple carriers. The second sample (Sample II) contains 33 city pairs—the above 28 plus five for which there was no OAG (Official Airline Guide) time data for multiple carriers (see the note to Table 1). (Multiple carriers did serve these five city pairs. This is shown by the fact that the single carriers’ market share was about 75 percent in the five pairs.) Lacking data for these five city pairs, we assumed that a multicarrier flight was two hours longer than a single-carrier flight. We use the results from the larger Sample II as a check on the robustness of the results derived from the smaller Sample I. However, because the time variable is only a rough estimate for the five city pairs on which time information is lacking in Sample II, we regard the results from Sample I as more reliable.

The following notation is used for the variables:

- $MS =$ market share of single carrier(s)\(^9\);
- $F_1 =$ number of weekly flights of a single carrier including single-plane flights;
- $F_2 =$ number of weekly flights of multiple carriers
- $F_3 =$ number of weekly single-plane flights of a single carrier;
- $T_1 =$ average scheduled travel time in minutes of single carrier (weighted average of single-plane and multiple-plane trip times)
- $T_2 =$ average scheduled travel time in minutes of multiple carrier
- $n =$ number of observations.

The theory that underlies the specification of the functional form of our empirical analysis is as follows. Let the consumer’s utility of single carrier and multicarrier service equal, respectively,

$$U_{sc} = \alpha_0 + \alpha_1 T_1 + \alpha_2 (F_1 - F_3) + \alpha_3 F_3 + Z_1 + \epsilon_1$$

$$U_{mc} = \alpha_1 T_2 + \alpha_2 F_2 + Z_2 + \epsilon_2,$$

where $Z_1$ and $Z_2$ are the effect of unobservable influences on consumer behavior (e.g., closeness of terminal to parking facilities) that are not correlated with the provision of single or multiple carrier service or with the number of flights or with the time per flight and $\epsilon_1$ and $\epsilon_2$ are independent random terms which vary independently among individuals. We hypothesize that the utility from airline service (other things constant) decreases the greater the trip time ($\alpha_1 < 0$) and increases the greater the number of available flights ($\alpha_2 > 0$ and $\alpha_3 > 0$).\(^{10}\)

---

\(^9\) In both samples only five city pairs received single-carrier service from more than one airline, and no city pair received such service from more than two airlines. Market shares were calculated from CAB (1978b, Tables 8 and 10). Because of the slightly different coverage between Tables 8 and 10, our $MS$ is probably downward biased. This means that our benefit estimates derived later will be conservative estimates of the true benefits.

\(^{10}\) The model in the text postulates that a consumer’s utility depends directly on the number
We assume that, conditional on a decision to fly, the consumer chooses the travel mode that yields the greatest utility, i.e., he chooses between single and multijarrier service according to whether $U_{sc} \equiv U_{mc}$. The parameter $\alpha_0$ is a measure of the attractiveness of single carrier service, holding constant trip time, flight frequency, and the observable factors discussed above. Alternatively, $\alpha_0$ can be thought of as the mean effect of all those unobservable influences that are correlated with the provision of single-carrier service (e.g., reduced walking time between terminals). If $\alpha_0$ is positive, consumers on average prefer single to multijarrier service.

If $\epsilon_1$ and $\epsilon_2$ follow a Weibull probability distribution, then one can show that the market share of the single carrier (or equivalently the probability of choosing a single carrier) will be between 0 and 1 and will satisfy the following logistic relation:

$$\ln \frac{MS}{1 - MS} = \alpha_0 + \alpha_1(T_1 - T_2) + \alpha_2(F_1 - F_2 - F_3) + \alpha_3F_3 + V,$$

where $\ln (MS/(1 - MS))$ denotes the natural logarithm of the odds of choosing a single carrier, $T_1 - T_2$ the average time differential between single and multiple-carrier service, $F_1 - F_2 - F_3$ the flight frequency differential (excluding single-plane flights) between single and multiple carriers, $F_3$ the number of single-plane flights, and $V$ an error term.

Our estimates of equation (3) for the two samples are ($t$-ratios in parentheses):

Sample I ($n = 28$):

$$\ln \frac{MS}{1 - MS} = .863 + .013(T_1 - T_2) + .008(F_1 - F_2 - F_3) + .021F_3,$$

(4.26) (3.78) (5.13) (3.33)

$R^2 = .71.$

of flights. A consumer gains utility from additional flights not because extra flights bring him more satisfaction directly, but rather because they provide him with more options from which to choose. The model in the text does not consider this option value explicitly, although it does provide the correct positive relationship between utility and flights. An alternative modeling approach would be to assume that for each flight the consumer's utility is a function of trip characteristics plus an error term. The error term can be assumed to be independent across individuals and across flights. One interpretation of the error term could be as a reflection of the closeness of the scheduled departure time of the flight to the individual's desired travel time. (A more complicated specification could make the error distribution depend on the time of day.) The probability of choosing a single carrier would then depend on whether the utility from flying on the most desirable single-flight carrier exceeded the utility from flying on the most desirable multiple-carrier flight. Such a model is estimated in Carlton, Landes, and Posner (1979). The results of this more complicated model are very similar to those reported in the text.

11 Since the consumer's behavior is determined only by comparisons of utility, any transformation that preserves the order of the utility indices in (1) and (2) could serve as a utility index.

12 This is a common assumption in the travel demand literature. See, e.g., Domencich and McFadden (1975). The main advantage of this assumption is the resulting analytic simplicity. The assumption can be defended in general on the ground that the analysis based on this assumption gives results that turn out to be very similar to those that would result had the more familiar normal distribution been assumed for the independent error term (Domencich and McFadden, 1975).

The cumulative distribution function of the Weibull is $F(e) = \exp(-\exp(-e))$.

13 In terms of the previous notation, $V = Z_1 - Z_2$. Because $MS$ is estimated from very large samples, there is unlikely to be any significant error introduced by using an estimate of $MS$ instead of its actual value. The mean of $V$ is zero, by definition of $Z_1$ and $Z_2$. We assume that $V$ is independent across different markets.
Sample II ($n = 33$):

\[
\ln \frac{MS}{1 - MS} = 1.044 - 0.005(T_1 - T_2) + 0.007(F_1 - F_2 - F_3) + 0.021F_3, \\
(4.53) \quad (1.70) \quad (3.90) \quad (2.90)
\]

\[R^2 = .55.\]

(5)

All regression coefficients are of the predicted sign and highly significant (except for the coefficient on $T_1 - T_2$ in (5)). The regression coefficients measure the percentage change in the odds of a traveler’s choosing a single carrier per unit increase in the relevant explanatory variable. Equation (4) indicates, for example, that each 10-minute increase in the $T_1 - T_2$ differential decreases the odds of taking a single carrier by 13 percent, and each 10-flight increase (per week) in the $F_1 - F_2 - F_3$ differential increases the odds of taking a single carrier by 8 percent.

Equations (4) and (5) yield positive and significant estimates of $\alpha_0$, implying a substantial advantage to a carrier providing single-carrier service. For example, even if a single carrier had no single-plane service ($F_3 = 0$), offered the same number of flights ($F_1 = F_2$), the same average travel time ($T_1 = T_2$), and the same unobservable factor ($Z_1 = Z_2$) as a multiple carrier, the market share of the single carrier would still approximate 70 and 74 percent (equations (4) and (5), respectively). Recall that if the expected utility from single and multicarrier service were equal, there would be an equal probability ($=.5$) of selecting the single or multiple carrier. Equal probabilities, in turn, imply equal market shares. The fact that we do not predict equal market shares or probabilities, assuming flight frequency, travel time, and unobservable factors the same and no single-plane service, is equivalent to showing that consumers on average receive more utility from single-carrier service. Alternatively, the advantage of a single over a multiple carrier is equivalent to a time savings of about 66 and 209 minutes (equations (4) and (5), respectively). That is, if $(F_1 - F_2 - F_3) = 0$, $F_3 = 0$, $Z_1 - Z_2 = 0$, and a single carrier’s time exceeded a multiple carrier’s time by 66 minutes and 209 minutes (for equations (4) and (5), respectively), the probability of selecting the single carrier would equal .5, and hence the market shares of single and multiple carriers would be equal.

□ The dollar-equivalent benefits of single-carrier service. This analysis enables us to estimate the dollar equivalent of the benefits to consumers of new single-carrier service. To isolate these benefits, we assume that total flights, scheduled trip time, and other unobservable factors remain unchanged after the introduction of single-carrier service to city pairs now having only multicarrier service. We first calculate the difference in a consumer’s expected utility between a situation where only multiple-carrier service is offered and one where half the flights are single carrier and half are multiple carrier. Using the

---

14 Although the regression coefficient on single-plane service ($F_3$) is significant in (4) and (5), it is insignificant in an alternative specification discussed in footnote 10.

15 Single carriers offer on average lower scheduled trip times than multiple carriers for both Sample I and Sample II. Single carriers offer slightly fewer flights in Sample I and approximately the same number of flights in Sample II as multiple carriers. On routes that will be provided with new single-carrier service as a result of the merger, it is likely that the number of single-carrier flights will exceed the number of multiple-carrier flights, and that the scheduled trip time of single carriers will be less than that of multiple carriers. Our benefit measure is, therefore, a conservative estimate of the benefits that are likely to result from single-carrier service.
regression estimates of equations (4) or (5), we can convert the measure of increased utility into a time-savings equivalent. For example, equations (1) and (4) imply that a 10-minute reduction in travel time raises the utility index by about .013 units. This, in turn, can be converted into a dollar estimate by placing a monetary value on time. DeVany (1974, pp. 77–82) estimated that in 1968, one hour of travel time was worth about $7.28; in 1978 dollars, this value would be $12.68.\footnote{The Consumer Price Index (CPI) was 104.2 in 1968 and 181.5 in 1977. The $12.68 was derived by multiplying $7.28 by the ratio of 181.5 to 104.2. This is a conservative estimate of the value of travel time. In the recently completed Transcontinental Low-Fare Route Proceeding (CAB, 1977), economists from the CAB’s Bureau of Pricing and Domestic Aviation, relying on Port of New York Authority travel surveys, placed the value of one hour of travel time (in 1977 dollars) at $8.00 for pleasure travelers and $25.00 for business travelers. Since business travel predominates in both the North Central and Southern systems, the weighted average of the two values would in all probability be well in excess of the figure used in the text. See footnote 20. Observe also that DeVany’s estimate refers mainly to in-aircraft time. Since travel demand studies typically find that consumers assign higher costs to out-of-vehicle waiting time, and since a significant fraction of the travel time in our sample is waiting for connecting flights, our benefit estimates, which utilize DeVany’s value of time calculations, are likely to understate the benefits of single-carrier service. We are indebted to an anonymous referee for this point.}

If the only service available to a passenger is multiple-carrier service of \( F \) flights, \( T \) trip time, and \( Z \) unobservable factors, then from (2) his utility is

\[
U_0 = \alpha_1 T + \alpha_2 F + Z + \epsilon_0,
\]

where \( \epsilon_0 \) is a random term that varies among consumers. Alternatively, when half the flights are provided by a single carrier (but \( T \) and \( Z \) remain unchanged), the consumer will have the option of flying single or multiple carrier. If he chooses single-carrier service, his utility (using (1)) will be

\[
U_1 = \alpha_0 + \alpha_1 T + \alpha_2 \frac{F}{2} + Z + \epsilon_1,
\]

and if he chooses multiple-carrier service, his utility (using (2)) will be

\[
U_2 = \alpha_1 T + \alpha_2 \frac{F}{2} + Z + \epsilon_2,
\]

where \( \epsilon_1 \) and \( \epsilon_2 \) are random terms that vary among consumers.

Since the consumer will choose the travel mode that offers him the most satisfaction, his utility will equal the maximum of \( U_1 \) and \( U_2 \) when single-carrier service is offered. The difference between the expected value of the maximum of \( U_1 \) and \( U_2 \) and the expected value of \( U_0 \) is the average increase in expected utility that single-carrier service provides to a consumer. We denote this average increase or benefit by \( B \). Denoting single and multiple-carrier service by \( sc \) and \( mc \), respectively, and expected values by \( E \), and recalling that \( MS \) equals the single-carrier market share or the probability of choosing a single carrier when both single and multicarrier service are available, we can write

\[
B = E(U_1|sc)MS + E(U_2|mc)(1 - MS) - E(U_0).\tag{9}
\]

Using the definitions of \( U_0 \), \( U_1 \), and \( U_2 \), we can rewrite the benefit expression as

\[
B = \alpha_0 MS - \alpha_2 (F/2) + MS \cdot E(\epsilon_1|sc) + (1 - MS) \cdot E(\epsilon_2|mc) - E(\epsilon_0).\tag{10}
\]

To calculate (10) we use the estimates of \( \alpha_0 \) and \( \alpha_2 \) from equation (4) or (5); use
TABLE 2

CALCULATION OF BENEFIT EXPRESSION

<table>
<thead>
<tr>
<th>MS</th>
<th>F</th>
<th>( \alpha_0 \text{ MS} )</th>
<th>( \alpha_2 (F/2) )</th>
<th>EXPECTED VALUE OF RANDOM ERROR TERMS</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>.70</td>
<td>30</td>
<td>.60</td>
<td>.12</td>
<td>.61</td>
<td>1.09</td>
</tr>
<tr>
<td>.70</td>
<td>60</td>
<td>.60</td>
<td>.24</td>
<td>.61</td>
<td>.97</td>
</tr>
<tr>
<td>.70</td>
<td>100</td>
<td>.60</td>
<td>.40</td>
<td>.61</td>
<td>.81</td>
</tr>
</tbody>
</table>

NOTE: SEE APPENDIX FOR DETAILED CALCULATIONS.

(4) or (5) to predict market share (\( MS \)) under the assumption that multiple single carriers offer equal flight frequency, scheduled travel time, and unobservable factors; select an average value for flights (\( F \)) on the relevant city pairs; and compute the three expectations involving the random error terms. As shown in the Appendix, the expression for benefits can be simplified to

\[
B = \alpha_0 MS - \alpha_2 F/2 - MS \ln MS - (1 - MS) \ln (1 - MS). \tag{11}
\]

Table 2 presents estimates of \( B \) using regression equation (4) and assuming three alternative values (30, 60, and 100) for average total weekly flights on city pairs provided with single carrier service as a result of the merger.\(^{17}\)

A benefit of .81, .97, or 1.09 equals the increase in the expected utility index from having single-carrier service, which is equivalent to about 62, 75, and 84 minutes of decreased travel time, respectively.\(^{18}\) Assuming that the value of time of air travelers is on average $12.68 per hour (the DeVany estimate expressed in current dollars), the provision of single-carrier service on a city pair now receiving only multicity carrier service (and assuming single and multiple carriers have the same number of flights, scheduled travel time, and unobservable factors) would be worth between $13.10 and $17.75 per traveler, depending on how many flights we assume are offered. Observe that the $13.10 to $17.75 benefit represents about 11.2 to 15.2 percent of the average fare of $117 in our sample city pairs. Relative to the full costs of air travel (fare plus value of time using DeVany’s $12.68 estimate), the benefits of single-carrier service are between 7.0 and 9.8 percent.

Although the dollar value passenger of the benefit of single carrier service is a modest figure, the cumulative benefits are substantial. About 270,000 consumers will have access to single-carrier service for the first time as a result of the North Central-Southern merger; the total annual consumer benefit of the merger will therefore be approximately $3.54 to $4.79 million.\(^{19}\)

\(^{17}\) The average total number of weekly flights was about 140 per city pair in the data set used for the regression analysis. These city pairs, however, already had single-carrier service and a greater volume of traffic than the city pairs that currently do not receive single-carrier service, but will as a result of the merger. Thus, an assumption of fewer flights on these city pairs is reasonable. A figure of 30 flights corresponds to about two round trip flights per day.

\(^{18}\) Recall that the utility functions in (1) and (2) include the term \( \alpha_i T_i \). Since \( \alpha_i \) equals –.013 (equation (4)), an increase in the utility index of .81, .97, and 1.09 is equivalent to a time savings of 62 (=.81/.013), 75 (=.97/.013), and 84 (=1.09/.013) minutes, respectively.

\(^{19}\) If regression equation (5) had been used instead of (4) to measure benefits, the total annual benefits would be about double the estimates presented in the text. This occurs because the regression coefficient on \( T_1 - T_2 \) in (5) is relatively small (−.005). Regression (5), however, is based on Sample II, which has a less accurate measure of total time than Sample I. This would tend to bias towards zero the regression coefficient on \( T_1 - T_2 \), which may explain the difference between the coefficient on \( T_1 - T_2 \) in the two samples.
If we assume that the number of air travelers in these city pairs will grow at an annual rate of 5 percent, then the present value of the annual benefits (assuming a 10-percent discount rate) of single-carrier service is between $70.8 and $95.8 million.\textsuperscript{20}

Moreover, this measure of the benefits is probably an underestimation for two reasons:

(1) We observed in Table 1 that single carriers offered a 12-percent average savings in scheduled trip-time (i.e., equal to a 37 minute savings) compared with multicarrier service.\textsuperscript{21} Our regression analysis indicated that consumers significantly value lower travel time, and single-plane service, in addition to single-carrier service. To the extent that the ability to provide these services is created or enhanced by single-carrier service (rather than simply being correlated with single-carrier service in the sample), this is another important benefit of such service.

(2) The finding that consumers value single-carrier over multiple-carrier service is equivalent to showing that the “real” price of a given quality of airline service diminishes when single-carrier service is provided. Since demand is a negative function of price, the provision of single-carrier service in city pairs where only multiple-carrier service is now being provided should lead to a net increase in travel in the affected markets. That is, a single carrier does not merely divert traffic from multiple carriers because of its higher quality service; it also creates new traffic.\textsuperscript{22}

4. Possible adverse competitive effects of the merger\textsuperscript{23}

Having estimated the dollar benefits of the North Central-Southern merger, logically we should next estimate its dollar costs in deadweight or other losses.

\textsuperscript{20} If we use the $25.00 and $8.00 estimates of value of travel time for business and pleasure travelers (see footnote 13) and assume 50 percent are business and 50 percent are pleasure travelers, the value of time figure would be $16.50, and our estimate of benefits for 1978 would be 4.60 to 6.24 million dollars. In present value terms, this equals 92.1 to 124.7 million dollars.

\textsuperscript{21} This time savings is based on Sample I and therefore probably underestimates the true differential because it excludes multicarrier flights where the trip time exceeds the maximum amount allowable in the \textit{Official Airline Guide}.

\textsuperscript{22} A question unanswered by the empirical analysis is whether the benefits of single-carrier service could be achieved without merger, simply by each carrier’s unilaterally expanding its route system into areas served by the other carrier. However, neither carrier anticipated entering the region served by the other, as is shown by the fact (see below) that neither carrier had ever made an application for new route authority on a route already served by the other, although both had sometimes applied for new route authority on the same route. In addition, most of the routes served by each carrier were too thin to support another carrier, and even if it were assumed that, if the merger were blocked, each carrier would proceed to enter the other’s markets, this process would obviously take considerable time, so that the benefits from internal expansion would be smaller in a present-value sense.

\textsuperscript{23} An expanded version of this section appears in Carlton, Landes, and Posner (1979).
resulting from the effect of the merger (if any) in allowing the merged entity to charge a price above marginal cost. To do this, however, would require estimating the change in the elasticity of demand for the merging firms’ services that was brought about by the merger, an exceedingly difficult measurement which we have not attempted. But even when the dollar costs of a merger in terms of reduced competition cannot be determined, economic analysis can enable the policymaker to make a qualitative assessment of whether competition is likely to be reduced substantially. If it is not likely to be reduced substantially, then the social costs of the merger are presumably small and the estimate of social benefits becomes decisive.

Most economists believe that, other things remaining unchanged, increases in concentration resulting from a merger increase the probability of collusion, whether tacit or express, and hence the probability of supracompetitive pricing. But there is no consensus on the particular levels of concentration that trigger a substantial and not merely theoretical danger of collusive pricing. In these circumstances the economist’s principal contribution to the assessment of the competitive effects of proposed airline mergers may be to determine the definition of the relevant market in which concentration levels should be measured. Concentration ratios calculated from a reasonable market definition can then be used to assess qualitatively the likely impact of the merger on competition. In general, one would also want to consider any effects of the merger on potential competition in other markets. For example, is entry by several firms into new markets made less likely as a result of the merger?

Market definition and concentration. One possible approach to the question of market definition in the airline industry is to treat the nation as a whole as the market. Even though no airline serves every part of the nation, under the deregulation statute airlines are free to enter new markets. At the other extreme, it is arguable that at least from the customer’s standpoint, the relevant market is each individual city pair. An intermediate possibility, and the one we incline to, is to define a regional market. We discuss these possibilities in the context of the North Central-Southern merger.

The airline passenger market, viewed nationally, is only moderately concentrated. The four-firm and eight-firm concentration ratios were .54 and .75 in 1976 based on the share of enplaned domestic passengers, .58 and .84 based on the share of revenue passenger miles, and .56 and .81 based on total operating revenue (before any subsidy). No trend towards increasing concentration is perceptible; on the contrary, Table 3 shows that concentration in every group of firms within the top eight has declined over the last 10 years.

Table 4 shows that if a national market is used to evaluate the North Central-Southern merger, the effect on concentration and hence the presumed anticompetitive effect of the merger are negligible. The resulting firm will not be among the eight largest airlines in the country, and hence will not

24 To be sure, during a transitional period which expires in 1981, some residual restrictions on automatic entry will remain (see Airline Deregulation Act of 1978, §12), although the Board retains authority to permit entry on routes where automatic entry is not permitted. Presumably the Board will continue its liberal entry policies in cases where automatic entry is not authorized. All things considered, an assumption of free entry into city pairs, which we employ throughout this paper, seems a tolerable approximation to the somewhat complex legal-regulatory reality.

25 Concentration ratios are calculated from Tables 5, 6, 8, and 11 of Civil Aeronautics Board (1978a).
### TABLE 3
(OPERATING REVENUES BEFORE SUBSIDY)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LARGEST AIRLINE</td>
<td>20.8</td>
<td>22.0</td>
<td>21.3</td>
<td>20.2</td>
<td>20.6</td>
<td>20.6</td>
<td>19.9</td>
<td>18.9</td>
<td>18.9</td>
<td>19.6</td>
</tr>
<tr>
<td>2 LARGEST</td>
<td>36.6</td>
<td>38.1</td>
<td>36.4</td>
<td>34.7</td>
<td>34.7</td>
<td>34.7</td>
<td>33.9</td>
<td>32.7</td>
<td>33.4</td>
<td>33.2</td>
</tr>
<tr>
<td>3 LARGEST</td>
<td>48.5</td>
<td>49.8</td>
<td>48.0</td>
<td>46.6</td>
<td>46.6</td>
<td>46.5</td>
<td>45.9</td>
<td>44.8</td>
<td>45.2</td>
<td>45.4</td>
</tr>
<tr>
<td>4 LARGEST</td>
<td>60.3</td>
<td>61.1</td>
<td>59.2</td>
<td>57.2</td>
<td>57.9</td>
<td>57.5</td>
<td>57.5</td>
<td>56.5</td>
<td>56.5</td>
<td>56.8</td>
</tr>
<tr>
<td>5 LARGEST</td>
<td>69.0</td>
<td>70.2</td>
<td>68.4</td>
<td>66.7</td>
<td>66.9</td>
<td>67.2</td>
<td>68.0</td>
<td>67.1</td>
<td>66.7</td>
<td>66.5</td>
</tr>
<tr>
<td>6 LARGEST</td>
<td>73.5</td>
<td>74.2</td>
<td>72.8</td>
<td>71.3</td>
<td>73.2</td>
<td>72.1</td>
<td>73.1</td>
<td>72.2</td>
<td>71.9</td>
<td>70.9</td>
</tr>
<tr>
<td>7 LARGEST</td>
<td>77.9</td>
<td>77.6</td>
<td>76.8</td>
<td>75.7</td>
<td>77.3</td>
<td>76.3</td>
<td>77.4</td>
<td>76.7</td>
<td>76.2</td>
<td>75.3</td>
</tr>
<tr>
<td>8 LARGEST</td>
<td>81.8</td>
<td>81.1</td>
<td>80.6</td>
<td>79.7</td>
<td>80.4</td>
<td>80.4</td>
<td>81.4</td>
<td>80.9</td>
<td>80.1</td>
<td>79.5</td>
</tr>
</tbody>
</table>

**NOTES:**
1. DOMESTIC TRUNKS AND LOCAL SERVICE CARRIERS.
2. FIGURES ARE FOR FISCAL YEARS ENDING 6/30.

**SOURCE:**
1969–1976: [CAB], VARIOUS YEARS.
1977–1978: [CAB], JUNE 1978C.

The figures in Table 3. It is very doubtful that such a merger could significantly affect the probability of supracompetitive pricing in the airline industry, if the market is in fact a national one.

The narrowest conceivable market in the airline industry is the individual city pair. There is a surface plausibility to such a definition. If a person wants to fly from Chicago to Houston, the fact that some airline which does not fly this route has service from Washington to Denver is small comfort. But if the market were defined as the individual city pair, then the North Central-Southern merger would not even be a horizontal merger, because before the merger neither airline served any city pair served by the other. (We defer for the moment the question whether the merger might still be objectionable on an economic analysis because it eliminated potential competition between the airlines.) In any event, to define the market as the individual city pair is improper, because it ignores high cross-elasticity of supply. Imagine that airline A offers service between cities X and Y, and B between Y and Z, and no other airline offers service between X and Y. If the relevant market is

---

26 The market shares presented in Table 4 do not violate the merger guidelines of the Department of Justice. See Commerce Clearing House (1968). Both the level of concentration and its trend place the airline passenger industry in the category of the guidelines that requires higher market shares of the acquiring and acquired firm for the Department to "ordinarily challenge" a merger than is the case for a concentrated industry or for an industry whose concentration has been increasing over time. Given that Southern has less than 2 percent of the market, North Central would have to have 10 percent for the merger to violate the applicable guidelines. Moreover, the guidelines, representing as they do the Justice Department's enforcement policy toward mergers within its jurisdiction, constitute a somewhat extreme view of the reach of current antitrust law. It is doubtful that the present Supreme Court would treat mergers as harshly as the guidelines do.

A point to be considered, although we do not have any good ideas as to how to bring it into the analysis, is that the use of historical industry concentration data to predict the possible competitive effects of a merger presupposes that concentration will (but for the effect of the merger) remain reasonably stable over time. There is no basis for such an assumption in the airline industry, given the possibly extreme effects of deregulation on the industry's market structure. This point applies equally to the discussion below of regional market shares.
TABLE 4
NORTH CENTRAL AND SOUTHERN MARKET SHARES, NATIONWIDE, 1976

<table>
<thead>
<tr>
<th>MEASURE</th>
<th>NORTH CENTRAL</th>
<th>SOUTHERN</th>
<th>COMBINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENPLANED PASSENGERS</td>
<td>2.5%</td>
<td>1.6%</td>
<td>4.1%</td>
</tr>
<tr>
<td>REVENUE PASSENGER MILES</td>
<td>.8%</td>
<td>.7%</td>
<td>1.5%</td>
</tr>
<tr>
<td>TOTAL OPERATING REVENUE</td>
<td>1.3%</td>
<td>1.0%</td>
<td>2.3%</td>
</tr>
<tr>
<td>BEFORE SUBSIDY</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SOURCE: SEE TABLE 3.

defined as the individual city pair, then A has a 100-percent market share—a monopoly. Yet A has no monopoly power. If it tried to raise rates above the competitive level, then, assuming that rates were at the competitive level on the Y and Z route, airlines such as B serving that route would initiate service to X (they could readily do so, since they already were serving one of the cities of the X-Y pair and thus could feed traffic into that route from Y-Z) to share in the monopoly profits generated by A’s monopolistic rates.

The CAB must itself believe that the individual city pair is not an economically meaningful market. Such a belief is a necessary premise of the policy of deregulation that the Board adopted even before deregulation legislation was enacted. An individual city pair will rarely support more than three or four airlines and many city pairs will support no more than one. If, therefore, the individual city pair were the relevant market for evaluating competition in the airline industry, a policy of deregulation would be questionable, for it would lead to the creation of unregulated monopoly and oligopoly power in virtually all of the country’s airline markets.

Although the mobility of the capital stock (mainly aircraft) of the airline industry may seem to argue for a national market, the difficulty of deploying and utilizing planes in a city pair that is not approximately contiguous to city pairs that the carrier is already serving means that in the short run carriers may not be effective competitors in distant city pairs. In light of this factor, we suggest that the appropriate market in which to determine the effect of a proposed airline merger on concentration (and hence on competition) is a regional market coextensive with the operating areas of the parties to the merger.

The regional market share of the parties to a merger is their output divided by the output of all of the firms in the region. While the output of the parties to an airline merger is of course known, the total output of the market can only be approximated, because airline statistics are not collected or published on a regional basis. The CAB does, however, collect and publish the number of enplaned passengers at what are called large, medium, and small “hubs” (cities or other local areas). It is straightforward to determine which hubs are located in the service areas of the parties to the proposed merger and then compare the number of passengers enplaned by them (the numerator) with the total number of passengers enplaned by all airlines in the large, medium, and small hubs located in those areas. Since these hubs contain 96 percent of total airline enplanements in the United States, the procedure provides a reasonable estimate of the merging parties’ share of total enplanements in their service areas.

This approach to market definition is based on data availability, but can be
defended theoretically. The ability of carriers to serve passengers located in some area, an ability proxied by the number of passengers they enplane there, also enables them to integrate city pairs within the area into their existing route structures, and thus makes them effective competitors in the area. For example, if, having merged, North Central and Southern were to raise the price of their service between Chicago and Atlanta, two cities that they serve, any airline which enplaned a substantial number of passengers at either hub could compete with North Central-Southern in the Chicago-Atlanta city pair, even if it did not serve that route prior to the price rise.

To illustrate the approach, Table 5 presents two different calculations of the regional market in which North Central and Southern operate. The first (Market I) is narrower and excludes Denver, Miami, and several other points in Southern Florida. The second (Market II) is broader and includes these points, but excludes (as does Market I) all points in the Northeast roughly east of Buffalo, such as Boston, New York, and Philadelphia. Although all of the excluded points are in fact served by one or both of the carriers, we exclude them, out of caution, because they lie at the fringes of each carrier’s service area. Were they included, the two carriers’ market shares would be even lower, and would in fact approximate their national market shares.

There are several points to be noted about the calculations in Table 5.

1. The market-share estimates are based on enplanements, because this is the only type of data available on a regional basis. Yet, as a physical and nonstandardized measure of output, it is inferior to either revenue passenger miles or operating revenues (both of which tend to adjust enplanements by the number of miles a passenger is carried) as an index of market power. Table 4 showed that North Central and Southern’s combined market share on a national basis was about twice as great for enplanements as for revenue passenger miles of operating revenue, reflecting the shorter

---

27 The aggregate output of the regional market is based on the number of enplaned passengers at large, medium, and small hubs in the area of the U.S. embraced by the combined route authority of North Central and Southern as of July 1, 1976. Since enplanements outside these three types of hub are excluded from our estimate of the aggregate output of the region, our estimate of North Central and Southern’s market share would be biased upward because we use total North Central and Southern enplanements from all hubs. The original estimate was accordingly corrected by multiplying by .958 and it is the corrected figure that we use in our market-share calculations.

28 Our North Central-Southern regional market comprises 40 (Market I) and 47 (Market II) percent of total U.S. enplanements.
average passenger hop for North Central and Southern than for the larger carriers. Thus, if Table 5 were expressed in terms of regional revenue passenger miles of operating revenue, North Central and Southern would have even smaller market shares.

(2) Table 5 excludes output produced outside the region that could be diverted to it should opportunities for higher profits arise there. Logically, all of the output of carriers that provide a significant fraction of their service in the North Central-Southern region should be included in the region's output. To do so would significantly reduce the market shares of North Central and Southern, since other carriers (notably the big trunk line carriers) have much larger out-of-region business than North Central and Southern do.

(3) The combined market share of North Central and Southern is well below 10 percent. The small market share, together with the two points just made, suggests that there is little basis for believing that the merger will have any significant adverse competitive effect, barring potential-competition effects discussed below.

(4) We have not attempted to calculate regional four or eight-firm concentration ratios. Because the large trunk carriers are not specific to a region, concentration ratios for a region comprising as large a fraction of the national market as does the region under consideration should approximate national ones.

Potential competition. A final issue we address is the weight to be given in an airline-merger proceeding to the possible effect of the merger on potential competition in other markets. This issue is closely bound up with that of market definition. The more broadly the market is defined, the less likely it is that an airline in that market is a potential competitor in other markets. This point is illustrated by the fact that in all of the instances in which prior to the merger North Central and Southern applied for the same new-route authority (instances, that is, where merger would have reduced the number of potential entrants by one), the routes in question lay within the regional market defined above.

At least with regard to the smaller regional carriers, then, the argument that a merger may eliminate potential competition (i.e., affect competition in other markets) is plausible only if the market is defined as the individual city pairs served by the airlines. Even then, judging by the facts of the North Central-Southern case, the argument is likely to fail because of a plethora of other, equally strong potential entrants. In every instance where both North Central and Southern applied for the same new route authority, there were many other applicants (this was prior to deregulation). For example, when both applied for new route authority from Midway Airport in Chicago (Midway II, CAB Docket 33019), 19 other carriers applied too. In no instance has there not been a large number of other applicants. To be sure, merely filing an application

---

29 Suppose a merger occurs between two producers that sell all of their output in $X$, a local area where producer $A$ sells 50 percent of his output. Assume that transportation costs across areas are not significant. In computing the market share of the merged firms, all of $A$'s production, not just the amount that $A$ sells in $X$, should be included in the denominator, because $A$'s sales outside of $X$ are available for sale in $X$ should the price rise there.

30 The market shares in Table 5 fall within the permitted range in the DOJ Guidelines (Commerce Clearing House, 1968).

31 See footnotes 32 and 33.
for new route authority does not necessarily connote a serious intention to offer service on that route in the foreseeable future; in the twilight of regulation, it became common for "all comers'" route awards to be "banked" in the hope that they might confer bargaining advantages in future regulatory contests.\textsuperscript{32} On the other hand, on no route on which both North Central and Southern, prior to the merger, applied for new route authority did both airlines indicate a willingness to compete against all of the other applicants, and in most instances neither airline, or only one of them, actually indicated that it would offer service.\textsuperscript{33} If the other applicants could not be considered serious competitors merely by virtue of their applications, neither could North Central or Southern.

The existence of other potential entrants of similar ability to North Central and Southern would seem to preclude concern with elimination of potential competition, for there is no basis in economic theory for fear that reducing the number of potential competitors in a market from 19 to 18 can substantially impair competition in the market (Posner, 1976, pp. 113–125). And the number of applicants understates the number of potential competitors, since, as mentioned earlier, the extreme flexibility of airline capital enables any airline within a region to enter a new city pair should competition fail to constrain the price to the competitive level.

To summarize, potential competition is likely to be a serious issue in an airline-merger case only if the market is defined, improperly, as the individual city pair; even then, there are likely to be many other potential entrants besides the parties to the proposed merger, in which event no significance can be assigned to the elimination of one potential entrant by the merger. We conclude that in most cases the CAB would be ill-advised to ignore potential-competition arguments in weighing the competitive affects of a proposed merger.\textsuperscript{34}

\textsuperscript{32} We are informed that neither North Central nor Southern actually intended to provide service in the Midway markets at issue. In the Caribbean Area Service Investigation (CAB Docket No. 30697), North Central and Southern applied for authority to serve most Caribbean points from a large number of U.S. cities, including New York and Atlanta. A total of seven carriers applied in the New York/Atlanta-Caribbean markets, and neither North Central nor Southern in fact anticipated offering service in the markets. Both carriers also had applications pending in the Dallas/Ft. Worth-New Orleans-Florida Points Case (CAB Docket No. 32711) and the Florida Service Case, cases where there were 12 and 18 applicants, respectively, but North Central did not intend to provide service in any of the markets at issue.

\textsuperscript{33} In the Florida-Atlanta Case (CAB Docket No. 30679), the last of the five cases where North Central and Southern had applications in common, North Central, Southern, and four other carriers applied for authority in the Atlanta-Tallahassee/Sarasota/Daytona Beach markets, markets that are Eastern monopolies. Southern indicated that it could not operate if more than one new carrier (in addition to Southern) were authorized or if that new carrier were Delta. North Central was in a somewhat better position because of its traffic support from Detroit, but its Tallahassee proposal, an integral part of the entire operation, was excluded as outside the scope of the case. In other words, if all applications had been granted, Southern would not have entered the markets and it is at least questionable whether North Central could have mounted a profitable operation.

\textsuperscript{34} Moreover, Section 2 of this paper argued that the two firms will become a more viable competitor as a result of the merger, since the merger will allow the firms to offer a service superior to that provided by the two unmerged firms. The trivial reduction in the number of potential competitors, in particular city pairs, as a result of the merger must therefore be balanced against the likely increase in competition in other city pairs as a result of the merger. The merged firm will be able to seek new route authority in markets which neither firm would have sought to enter on its own. The Board should also weigh in the balance the fact that within the region now served by the two carriers, as distinct from the new markets that together or separately they
5. Conclusion

Sound government policy toward airline mergers entails balancing the consumer benefits of single-carrier service against the adverse effects of increasing concentration. We have developed a methodology for estimating consumer benefits resulting from a merger, and our analysis, employing that methodology, of the North Central-Southern merger indicates that airline mergers may confer substantial consumer benefits in the form of superior service (single-carrier in place of multiple-carrier). This makes it all the more important to assess the possible competitive detriments of such mergers carefully. In this regard, we have suggested a regional-market approach that should enable the CAB to make reasonable estimates of the effects on concentration of mergers between regional carriers. We have further argued that alleged adverse effects on potential competition should generally not be considered in evaluating the competitive effect of an airline merger.

Appendix

Derivation of benefits formula

We derived the benefit, $B$, of providing first single-carrier service in the text (see equation (9)) and reproduce it below:

$$B = E(U_1|sc)MS + E(U_2|mc)(1 - MS) - E(U_0),$$

(A1)

where

$E =$ expectation operator;

$U_1 =$ utility from single carrier when both single- and multiple-carrier options are available;

$U_2 =$ utility from multiple carrier when both single- and multiple-carrier options are available;

$U_0 =$ utility from multiple carrier when only multiple-carrier service is available;

$MS =$ market share of single carrier;

$sc =$ single carrier is chosen; and

$mc =$ multiple carrier is chosen.

We assume that before single-carrier service was available, multiple carriers offered $F$ flights, trip time $T$, and unobservable factor $Z$. When single-carrier service is introduced, both the single and multiple carrier offer $F/2$ flights, trip time $T$, and unobservable factor $Z$. Using the definitions of $U_0$, $U_1$, and $U_2$ (see (1) and (2) in the text) yields

multiple carrier service: $U_0 = \alpha_1 T + \alpha_2 F + Z + \epsilon_0$  \hspace{1cm} (A2)

single carrier service: $U_1 = \alpha_0 + \alpha_1 T + \alpha_2 F/2 + Z + \epsilon_1$  \hspace{1cm} (A3)

multiple carrier service: $U_2 = \alpha_1 T + \alpha_2 F/2 + Z + \epsilon_2$.  \hspace{1cm} (A4)

Observe that a single carrier is chosen over a multiple carrier, when both are available, only if $U_1$ exceeds $U_2$, or if $\epsilon_1 - \epsilon_2 > -\alpha_0$. Alternatively, if
\[ \varepsilon_2 - \varepsilon_1 > \alpha_0, \] then a multiple carrier is chosen. Therefore, we can write
\[ E(U_1 | sc) = \alpha_0 + \alpha_1 T + \alpha_2 F/2 + Z + E(\varepsilon_1 | \varepsilon_1 - \varepsilon_2 > -\alpha_0), \quad (A5) \]
\[ E(U_2 | mc) = \alpha_1 T + \alpha_2 F/2 + Z + E(\varepsilon_2 | \varepsilon_2 - \varepsilon_1 > \alpha_0), \quad \text{and} \quad (A6) \]
\[ E(U_0) = \alpha_1 T + \alpha_2 F + Z + E(\varepsilon_0), \quad (A7) \]
where \( E(U_1 | sc) \) denotes the expected utility of a consumer from single-carrier service, \textit{given} that he chooses single over multiple-carrier service, \( E(U_2 | mc) \) the expected utility from multiple-carrier service, \textit{given} that he chooses multiple over single-carrier service, and \( E(U_0) \) the expected utility from multiple-carrier service when no choice is available.

The difference between expected utility when multiple- and single-carrier service are available and expected utility when only multiple-carrier service is available is given by (A1) and using (A5)–(A7) equals
\[ B = MS\alpha_0 - \alpha_2 F/2 + E(\varepsilon_1 | \varepsilon_1 - \varepsilon_2 > -\alpha_0)MS \]
\[ + E(\varepsilon_2 | \varepsilon_2 - \varepsilon_1 > \alpha_0)(1 - MS) - E(\varepsilon_0). \quad (A8) \]

Since estimates of \( \alpha_0, \alpha_2, \) and \( MS \) are provided by the regression analysis, we turn to the computation of the last three terms in (A8).

The probability density of \( \varepsilon_i, i = 0, 1, 2, \) is \( \exp(-\varepsilon_i) \exp(-\exp(\varepsilon_i)) \), the cumulative density is \( \Phi(\varepsilon_i) = \exp(-\exp(-\varepsilon_i)) \), and the expected value of \( \varepsilon_1 \) equals Euler's constant (Johnson and Kotz, 1972, p. 252). The probability density of \( \varepsilon_i \) conditional on \( \varepsilon_1 - \varepsilon_2 > -\alpha_0 \) can be written as
\[ \Psi(\varepsilon_i) = \frac{\exp(-\varepsilon_i) \exp(-\exp(-\varepsilon_i)) \Phi(\varepsilon_i + \alpha_0)}{\int_{-\infty}^{\infty} \exp(-\varepsilon_i) \exp(-\exp(-\varepsilon_i)) \Phi(\varepsilon_i + \alpha_0) d\varepsilon_i}, \]
which can be simplified to
\[ \Psi(\varepsilon_i) = 1/MS \exp(-\varepsilon_i)(\exp(-\exp(-\varepsilon_i - MS^{-1}))), \]
where \( MS \) is the probability of choosing single-carrier service which, under the assumptions made, equals \( \exp\alpha_0/(1 + \exp\alpha_0) \).

Using the formula just derived for \( \Psi(\varepsilon_i) \), we can calculate \( E(\varepsilon_i/\varepsilon_1 - \varepsilon_2 > -\alpha_0) \) as
\[ E(\varepsilon_i/\varepsilon_1 - \varepsilon_2 > -\alpha_0) = \int_{-\infty}^{\infty} \varepsilon_1 \Psi(\varepsilon_i) d\varepsilon_i, \]
or performing the integration,
\[ E(\varepsilon_i/\varepsilon_1 - \varepsilon_2 > -\alpha_0) = -\gamma - \ln (MS), \]
where \( \gamma \) is Euler's constant \((\gamma = -0.577)\). Similarly,
\[ E(\varepsilon_2/\varepsilon_2 - \varepsilon_1 > -\alpha_0) = -\gamma - \ln (1 - MS), \]

where \( 1 - MS \) is the probability a multiple carrier is chosen, which under the assumptions made, is \( 1/(1 + \exp\alpha_0) \). Since \( E(\varepsilon_0) = -\gamma \) (Euler's constant), (A8) can be written as
\[ B = MS\alpha_0 - \alpha_2 F/2 - MS \ln MS - (1 - MS) \ln (1 - MS). \quad (A9) \]

In Table 2 in the text, we use (A9) to compute the value of \( B \) from the
estimated coefficients in (4) under the assumption that multiple and single carriers have equal number of flights, scheduled travel time, and unobservable factors and that total weekly flights $F$ equals 30, 60, or 100.

References


BNA. Antitrust and Trade Regulation Reporter, No. 927 (August 16, 1979).


COMMERCIAL CLEARING HOUSE. Trade Regulation Reporter, para. 4510 (1968).


———. Transcontinental Low-Fare Route Proceeding, Docket No. 30356 (1977).


———. Caribbean Area Service Investigation, Docket No. 30697.


———. Florida-Atlanta Case, Docket No. 30679.
