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THE DETERMINANTS OF AIRPORT HUB LOCATIONS, SERVICE, AND COMPETITION

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ABSTRACT

Although the airline industry has been studied extensively since passage of the Airline Deregulation Act of 1978, relatively little effort has gone into examining how hub location affects the level of service and degree of competition found at airports in the system. To help close this gap, we investigate the geographic distribution of airline hub operations, the level of service, and the extent of competition at 112 major U.S. airports, extending previous work by Bauer (1987) and Butler and Huston (1989). Our key innovation is that we derive our measures of service and competition from indicator matrices that describe each airline's route system.

Introduction

Many of the changes that have rocked the airline industry since passage of the Airline Deregulation Act of 1978 have received a great deal of attention from researchers.[1] The emphasis has been on the effect of deregulation on airline fares, mergers, and the development of hub-and-spoke route systems. Airlines have adopted hub-and-spoke networks to make more efficient use of their equipment--a trend that is exemplified by modification of United Airlines' route structure between 1965 and 1989 (see figure 1).

Our focus in this paper is somewhat different. We investigate the geographic distribution of airline hub operations, the level of service, and the extent of competition at major U.S. airports, extending previous work by Bauer (1987) and Butler and Huston (1989). Instead of using an aggregate measure of airline service, we utilize a new, comprehensive measure derived from individual airline route data. We then employ these data to develop and analyze new measures of competition at individual airports.

The first section of this paper utilizes information on nonstop service from the nation's 112 largest airports to examine the route structure of the 13 major U.S. airlines, to identify the location of airline hubs, and to measure the extent of competition at each facility.[2] Section II then develops a model of hub location, airline service, and concentration. Estimates of this model are presented in section III, and section IV summarizes our findings.

I. Characteristics of U.S. Airline Service

In this section, we use data on nonstop flights from airports in the nation's 100 largest

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[1]See, for example, Bailey and Williams (1988), Bailey, Graham, and Kaplan (1985), Borenstein (1992), Meyer and Oster (1987), and Morrison and Winston (1987).

[2]The 13 airlines included in our sample are Alaskan Airlines, American, America West, Braniff, Continental, Delta, Eastern, Midway, Northwest, Southwest, TWA, United, and USAir. According to the Air Transport Association (1990), U.S. passenger airlines with 1989 revenues in excess of $100 million per year included these 13 plus Pan American and Piedmont. We excluded Pan American because its route structure is primarily international, while Piedmont's routes were included in USAir's schedule.

metropolitan areas to determine the location of airport hubs.[3] We choose to rely on our data rather than statements from the airlines because this allows us to impose uniform standards across carriers. In addition, we develop new airport- and route-based measures of industry concentration, which are used as dependent variables in the model discussed in section II.

Data

Our sample consists of the airports, served by the major carriers, in the 100 most populous Metropolitan Statistical Areas (MSAs) in 1987.[4] Because some of these regions contain more than one airport, a total of 112 facilities are included.[5]

Our data set indicates whether an airline serves a particular route, but provides no information about flight frequency.[6] Thus, neither the level of actual activity nor passenger enplanements are captured. Still, we do have detail on routes and airlines not available in other data sets.[7] We exploit the service data by airline and destination to compute measures of competition based on both overall service and route-by-route information.

While it is well known that most airlines have adopted some form of hub-and-spoke

[3]A more extensive description of the data and a detailed analysis of each airline's route structure can be found in Bania, Bauer, and Zlatoper (1992).

[4]We used the Office of Management and Budget's 1988 definition of MSAs to form the list of qualifying regions.

[5]Many of the nation's largest MSAs are adjacent to another MSA (such as New York City and Newark, NJ). In such a case, the second MSA may contain another airport that is a potential substitute; however, even without a second airport, the combined economic activity of the two MSAs creates a greater demand for air service. Thus, we combined MSAs into larger metropolitan areas according to the Office of Management and Budget's 1988 definition of Consolidated Metropolitan Statistical Areas (CMSAs). This resulted in 10 metropolitan areas with multiple airports (a total of 26 airports). See table 1 for a complete listing.

[6]The sample includes a total of 12,432 possible routes. However, we collected data for only half of these and assumed that service was symmetric. For example, we held that if an airline serviced the Portland-Atlanta route, then it also serviced the Atlanta-Portland route. To check this, we selected one airline (American) and collected data for routes in both directions. The symmetry assumption was valid in all but one case.

[7]For example, Bauer (1987) includes data on passenger enplanements by airport, but contains no destination or airline-specific information.

system, the determination of what constitutes a hub is not straightforward.[8] Our approach is to construct, for each airline and airport combination, an index of hub activity that measures the degree to which that airport is connected to the rest of an airline's network. For an airport-airline combination, the index is the percentage of other airports in the airline's route system that can be reached via nonstop service. Hub locations are well connected to an airline's network, while spoke airports are not. In a hub-and-spoke network, we would expect to find only a small number of airports that are well connected, many that are not well connected, and few in between. Thus, the distribution of the hub index should be bimodal, with a large spike at low service levels (low hub-index values) and a much smaller spike at higher levels (high hub-index values). On the other hand, if an airline does not use a hub-and-spoke system, we would expect to find a relatively steady decline in the distribution of the hub index.

Hub Locations

To determine hub locations, we examined the hub-index distributions for each airline (displayed in figure 2). We found that in almost all cases, the hub locations were easily identified, since, as expected, very few had high service levels, a large number had extremely low levels, and few fell in the middle. The exceptions were the relatively diffuse carriers, USAir, Alaskan Airlines, and Southwest. These airlines do concentrate their activity in a small number of airports, but there is a relatively steady decline in the hub-index distribution. Thus, determining the lower bound of what constitutes hub service for them is somewhat more difficult. For these airlines, we arbitrarily designated airports with higher levels of service as hubs.[9]

Table 2 reports the 44 airport-airline combinations that we classified as hub locations.

[8]Researchers have taken several approaches to defining hubs. The Federal Aviation Administration (FAA) looks at total passenger boardings, while Butler and Huston (1989) use a functional definition of a hub as an "airport at which large blocks of incoming and outgoing flights are coordinated to create numerous potential connections." Our definition is also a functional one, based on an analysis of each airline's route structure.

[9]The lower bound varied across airlines primarily because of airline size differences. In small route networks, high hub-index values are easier to obtain; larger airlines showed much greater variety in the size of their hubs.

This list represents only 35 airports, since some of these have more than one airline with hub activity. Column 3 reports the total number of airports in the sample served by a given airline, column 4 is the number of those airports that can be reached with a nonstop flight, and column 5 is the number that can be reached with a one-stop flight.

Most airports served by a given airline can be reached via a nonstop or a one-stop flight from the hub airports. This can be seen by comparing the sum of columns 4 and 5 with column 3. For example, from Cleveland, passengers have nonstop service to 25 of the 71 other airports served by Continental. Another 44 airports can be reached with one-stop service. The key variable that we used to classify hubs--the hub index--is contained in column 6. High values correspond to the relatively small number of well-connected airports in the frequency distributions displayed in figure 2. The hub index ranges from a high of 100 percent for Midway Airlines at Chicago Midway airport to a low of 17 percent for United Airlines at Los Angeles International.

Measures of Competition

If the airline industry were perfectly contestable, there would be no point in calculating any measures of the extent of competition, since such measures would have no meaning. Because no one has found that the airline industry meets these conditions--in fact, most studies show that the more competitors there are on a route, the lower fares tend to be--we construct various measures of the extent of competition based on the number of carriers offering service on a route or from an airport.[10] Our measures do assign a large role for *potential* competition by treating infrequent service on a route in the same way as more frequent service.

We computed a measure of the overall degree of competition at each airport by

[10]See Bailey, Graham, and Kaplan (1985), Bauer and Zlatoper (1989), Borenstein (1989), Call and Keeler (1985), Hurdle et al. (1989), and Morrison and Winston (1987).

calculating two versions of the Herfindahl index for both nonstop and one-stop service.[11] In table 3, we report the nonstop and one-stop service levels at each airport in the sample (columns 2 and 3), as well as the nonstop and one-stop Herfindahl index computed on the basis of overall service from an airport (columns 4 and 5). These measures are sensitive only to the level of service, not to the destination. The formula is

$$HO_i = 10{,}000 \cdot \sum_j \left(nroutes_{ij} \Big/ \sum_j nroutes_{ij} \right)^2 ,$$

where $nroutes_{ij}$ is the number of nonstop routes from airport i for the j^{th} airline.[12] A similar measure ($H1_i$) was calculated for one-stop routes.

The main limitation of these measures is that they are not destination sensitive. For example, suppose an airport has 10 airlines each serving a different nonstop route. The Herfindahl index for this airport will be equal to its theoretical minimum for 10 carriers (1,000), even though there is no nonstop competition at the route level. Although these airlines are not competing directly at the route level, the presence of other airlines at a given airport represents potential competition in that providing new service on a given route is easier if an airline already has gate space. Thus, while this measure is not sensitive to the actual destinations of flights departing from a given airport, it does measure the potential competition posed by other airlines serving the same facility. This is an important distinction, because while deregulation has freed airlines to provide service on any route, acquiring gate space may be difficult or impossible at some airports.

An alternative measure of airport-level competition that is more sensitive to the actual

[11]The one-stop calculation involved an aggregation of the nonstop and one-stop data, since we consider nonstop flights to be competition for one-stop flights. We applied this same principle to all of the one-stop measures of competition discussed herein.

[12]The Herfindahl index is a measure of concentration, with larger values corresponding to greater concentration and therefore less competition. For a more detailed description of this measure, see Koch (1980), pp. 179-80.

level of competition on a route-by-route basis can be computed using another version of the Herfindahl index, calculated as

$$HHO_{ik} = 10,000 \cdot \sum_j \left(dservice_{ijk} \Big/ \sum_j dservice_{ijk} \right)^2,$$

where $dservice_{ijk}$ is one if the j^{th} airline flies the route from i to k, and zero otherwise. HHO_{ik} is the nonstop Herfindahl index for the route between airport i and airport k. To get an overall measure for each airport (HHO_i), we used the unweighted average of HHO_{ik} computed over all routes k. A similar measure ($HH1_i$) was calculated for one-stop connections. The results are reported in table 3, columns 6 and 7.

This route-by-route Herfindahl measure has two main limitations. First, while it is sensitive to route patterns of competition, it is not sensitive to the actual level of service (as measured by the number of airports that can be reached with a nonstop connection). Thus, an airport with 10 carriers all serving the same nonstop route would have an HHO value of 1,000--indicating a great deal of competition--even though the facility is not well connected to other cities. A second problem is that this measure misses potential competition from other carriers currently serving different routes at the same airport. For example, an airport having 10 carriers each serving a different nonstop route would have a Herfindahl index equal to its maximum value (10,000), indicating the absence of competition.

Although a Herfindahl index of 3,200 would be considered very high in most industries (i.e., the Department of Justice's antimerger guidelines would be violated), there is reason to treat this as a somewhat moderate level for the airlines. For example, one study finds that air fares cease to fall once three carriers are serving a route--equivalent to a Herfindahl index of about 3,200 using our definitions.[13]

[13]See Bauer and Zlatoper (1989).

In general, three patterns emerge from the Herfindahl indexes. First, one-stop competition is much greater than nonstop competition, whether airport- or route-based measures are employed.[14] Second, the route-by-route measures indicate much less competition than do the overall indexes. Finally, the coefficients of variation indicate that there is much more fluctuation in the level of competition for one-stop routes than for nonstop routes.

II. Model of Hub Location, Airport Service, and Competition

Here, we investigate what factors influence hub location, the level of service provided to an airport, and the degree of competition at each facility. A three-equation model of activity at an airport can be written as

$$(1) \quad H = h(R,D,A,W)$$

$$(2) \quad S = s(R,D,A,W)$$

$$(3) \quad C = c(R,D,A,W),$$

where H is a measure indicating whether an airport serves as a hub, S is the level of service, and C is the level of competition. Equation (1) is similar to the hub equation specified in Bauer (1987) and Huston and Butler (1990), while equations (2) and (3) are introduced here. The presence of a hub carrier is likely to affect the level of service (S) and concentration (C) independently from the effect of regional economic activity (R), distance (D), airport characteristics (A), and weather (W). Therefore, equations (2) and (3) are not part of a structural model and should be viewed as reduced-form equations.[15]

[14]Strictly speaking, the one-stop Herfindahl index is bounded from above by the nonstop index, since we treat nonstop flights as competition for one-stop flights. See footnote 10.

[15]There are two possible approaches to this problem. One would be to use the fitted values from the estimation of equation (1) in equations (2) and (3) (Maddala [1983]). The drawback to this is that the calculation of the standard errors is not straightforward, due to the nonlinearity of equation (1). An alternative approach is to derive maximum likelihood estimates. We intend to pursue both of these methods in future work.

A statistical summary of the variables used in the analysis, with definitions and data sources for each, appears in table 4. The measure used to approximate S is SERVICE, the number of airports that can be reached via a nonstop flight on any airline from any given airport. H is represented by HUB, a variable equal to one if an airport has at least one hub carrier. (These airports are listed in table 2.) Finally, C is approximated by several measures of concentration: HO, H1, HHO, and HH1 (the Herfindahl indexes described in section I). The values of these indexes are presented for all airports in table 3.

The likelihood that an airport will have a hub carrier depends in part on R, a vector of regional economic activity. Factors such as a larger population (POP), higher per capita income (INCOME), more business- and tourist-related travel (BUSTOUR), and a greater number of large corporate headquarters (CORP) increase the demand for air travel and thus should raise the level of service (S), as well as make the airport a more likely candidate for hub operations.

Our measure of business- and tourist-related travel (BUSTOUR) is constructed by regressing the log of the sum of employment in hotels (SIC 70) and amusement parks and recreational services (SIC 79) on the log of population and of per capita income. The residual from this regression, which captures the extent to which local economic activity is insufficient to support employment in SICs 70 and 79, can therefore be viewed as a gauge of business and tourist travel to a given airport.[16]

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[16]The regression is

$$\log(EMP70+EMP79) = \underset{(2.92)}{15.4} + \underset{(0.04)}{0.89}\log(POP) + \underset{(0.34)}{1.27}\log(INCOME),$$

where EMP70 is employment in hotels (SIC 70) and EMP79 is employment in amusement parks and recreational services (SIC 79). The adjusted r-squared is 0.89, and the standard errors appear in parentheses. All three coefficients are significant at the 1 percent level. The three airports with the largest residual from this regression are Las Vegas, Orlando, and Daytona Beach. The three with the smallest residuals are Toledo, Fresno, and Dayton. By construction, the residual represents the portion of business and tourist travel that is unrelated to either population or income. For example, some portion of tourist travel to New York City is related to characteristics of the city that stem in part from its large population and high income (such as myriad restaurants and cultural events). This stands in contrast to tourist travel to Orlando or Las Vegas, most of which is probably not related to population or income.

In the absence of hubbing activity, concentration should fall with increases in POP, INCOME, BUSTOUR, and CORP. However, hub networks by their very nature increase the concentration of nonstop flights, since most airports do not have a broad enough economic base to support even one hub carrier with only local traffic. As a result, hub carriers tend to dominate these airports' nonstop flights. One-stop flights should be much less concentrated, because passengers can use one leg of their flight to reach a competing hub.[17]

The distance variable, D, is a measure of the central location of an airport. For each airline, we measured the sum of air miles from each airport to every other airport in that airline's route network.[18] Airports in favorable locations (smaller D values) are more likely to have hub carriers and to receive more service. Concentration could be affected by hubbing activity, as discussed above. In the absence of hubbing activity, a better location would be expected to support more competition. However, if an airport has a hub airline, its presence may intimidate other carriers, since they would find it harder to compete with the hub carrier's more frequent nonstop flights.

A is a vector of regional factors that differentiate airports. Specific components include SLOT, OTHER, MINOR, and GATEWAY. SLOT is equal to one if an airport faces FAA restrictions on the number of takeoff and landing slots. Only four facilities have a value of one: John F. Kennedy International, La Guardia, Chicago O'Hare, and Washington National. If access to these airports were not limited, carriers would offer more service and would be more likely to set up hub-and-spoke operations. Concentration might then be higher because of the barrier to entry, or lower because regulators act to discourage concentration.

OTHER indicates the presence of another airport in a given airport's economic region.

[17]We do not present results for two-or-more-stop flights because they closely mirror those for the one-stop routes.

[18]We also tried three other measures of distance: the sum of miles between a given airport and every other destination, weighted by the population of each destination; the sum of the natural log of miles between airports; and the sum of the natural log of miles between airports, weighted by the population of the destination. Each of these measures performed similarly to those reported here.

For example, Cleveland Hopkins and Akron Canton Regional would both have a value of OTHER equal to one. MINOR, on the other hand, indicates that the airport has significantly less capacity in terms of ground and flight facilities than others in its region. To continue our above example, Cleveland Hopkins would have a MINOR value equal to zero, while Akron Canton Regional would have a value equal to one.[19] Finally, GATEWAY indicates whether an airport has international nonstop connections to Europe, Asia, or the South Pacific.

W is a vector of weather-related variables. Good flying conditions should result in more service and thus a greater probability of having a hub carrier. To the extent that the weather is worse for flying, concentration may be higher. To control for these possible effects, we obtained data on the average number of days per year during which snowfall exceeded one inch (SNOW) for each airport, as well as on the number of days per year that fog reduced visibility to less than one-quarter mile (FOG).[20]

III. Estimation

Using the data discussed above, we estimated equation (1) using logit rather than probit.[21] The two techniques yield similar results, but the disturbance in the logit model allows for more outliers in the error term. Equations (2) and (3) were estimated in log linear form.

[19]Although we defined this variable in a rather ad hoc way, our approach is equivalent to estimating the service equation with individual airport dummies for airports in regions having more than one facility, and then assigning MINOR to equal one when the coefficient on the airport dummy is significantly less than the coefficients for other airports in the region. The values of OTHER and MINOR for metropolitan areas with multiple airports are listed in table 1.

[20]The weather variables were divided by 365 so that they represented the portion of the year affected by these two conditions.

[21]Because the determinants of hub location, air service, and competition in Alaska and Hawaii are likely to differ from those for airports in the continental United States, all of the equations were estimated both with and without the Honolulu and Anchorage airports. We report regressions only for the sample excluding these two cities, since the results are similar.

Hub Determinants

Table 5 presents the regression results for the various models. We found that four factors increase the likelihood of an airport's having a hub carrier: a larger regional population, a better location (a lower D value), gateway connections to Europe, Asia, or the South Pacific, and more business and tourist travel. The effect of each of the remaining variables was statistically insignificant.

Table 6 ranks the airports by their estimated likelihood of having a hub carrier. The most likely new hubs based on these results are Miami International, Boston's Logan International, New York's La Guardia, New Orleans International, and Louisville. The least likely existing hubs are Washington National, Charlotte/Douglas International, Dayton International, Dallas Love Field, and El Paso International. It is worth noting that two of these unlikely hubs are associated with Southwest, a relatively small regional carrier. Southwest is the only airline operating out of Dallas Love Field and is the dominant carrier operating out of El Paso International. Another of the unlikely hubs, Dayton International, has since lost hub service from USAir.

Service Determinants

Ordinary least squares (OLS) estimates of the service regression are presented in table 5. The results indicate that SERVICE rises less than proportionally with population and falls as location worsens (distance to other airports increases). The effect of per capita income is positive but statistically insignificant. Both OTHER and MINOR have a negative and statistically significant effect, with their magnitudes implying that the presence of another airport in the region lowers SERVICE 34 percent for nonMINOR airports and 72 percent for MINOR airports. International connections (GATEWAY) have a positive and significant effect, increasing SERVICE by 34 percent. Finally, the effect of business and tourist travel (BUSTOUR) is positive and statistically significant. With the exception of SNOW, the remaining variables have the expected sign, although none is statistically significant.

Concentration Determinants

Table 5 also presents OLS estimates of the determinants of concentration at both the airport and route levels for nonstop and one-stop flights, using measures derived earlier. For nonstop flights and the airport-level concentration measures, the results indicate that a *less* central location reduces concentration. While somewhat counterintuitive, this could be a result of airlines' reluctance to compete head to head with nonstop flights. Under these circumstances, the more distant airports, which are less likely to be hubs, will have lower nonstop measures of concentration. Two other statistically significant factors are MINOR and GATEWAY, which result in higher concentrations (84 percent and 52 percent, respectively).[22]

For route-level measures of concentration, the results for nonstop flights are qualitatively consistent with those for the airport-level measures. A worse location is associated with lower concentration levels, although the magnitude of the effect is smaller. MINOR airports have higher concentration levels, but the effect is only marginally significant. The effect of the presence of gateway connections is not statistically significant.

We find much more explanatory power, using either measure of concentration, for the one-stop equations. For such service, the results using airport-level measures indicate that concentration falls with population and business- and tourist-related activity, but rises for MINOR airports. Unexpectedly, FOG is associated with higher concentration levels, although the effect is only marginally significant.

Using route-level measures, we find that population, income, and a better location decrease concentration, while the presence of another airport in the region and status as a MINOR airport tend to be associated with higher concentration levels.

An apparent paradox is that central location lowers concentration for one-stop routes, but raises it for nonstop routes. If an airport has a favorable location, it is more likely to be a hub and

[22]Of course, concentration should be measured at the regional level if one is interested in determining how much control over fares carriers might have.

to have highly concentrated nonstop service, because hub carriers tend to dominate service at their airports. But having a favorable location also means that other airlines (with hubs at other airports) will offer at least some service. Consequently, one-stop concentrations tend to be lower as a result of interhub competition.

IV. Summary

We use route-level data to develop measures of the degree to which airlines employ a hub-and-spoke route structure, and explicitly identify the location of airline hub activity using a new approach. Our data set allows us to develop airport- and route-specific measures of concentration that indicate a great deal of variance, particularly at the nonstop level. This is true even among airports having hub carriers.

We find that the location of airline hub activity is positively related to population and negatively related to distance from other airports. Regions that have access to international flights and that are desirable business and tourist destinations are also more likely to have hub carriers. On the other hand, weather conditions, the presence of large corporate headquarters, per capita income, and airport slot restrictions play a very small role.

Our findings also show that service (as measured by the number of nonstop connections from a given airport) increases with population, favorable location, business- and tourist-related activities, and access to international flights. The presence of multiple airports in a metropolitan region tends to have just the opposite effect, as do weather, corporate headquarters, per capita income, and airport slot restrictions.

The results concerning the degree of competition are mixed, depending on the particular measure employed and whether the unit of analysis is nonstop or one-stop connections. The only consistent result is that concentration is higher at MINOR airports. Airports in more-populous regions that are frequented by business travelers and tourists have lower one-stop concentration measures; however, these factors do not appear to affect nonstop concentration. A favorable location lowers one-stop concentration measures, but raises nonstop concentration measures.

One explanation for this phenomenon is that while an airport in a favorable location has a higher probability of attracting a hub carrier that will dominate its nonstop service, it is also more likely to be a spoke for many other carriers, leading to lower one-stop measures of concentration.

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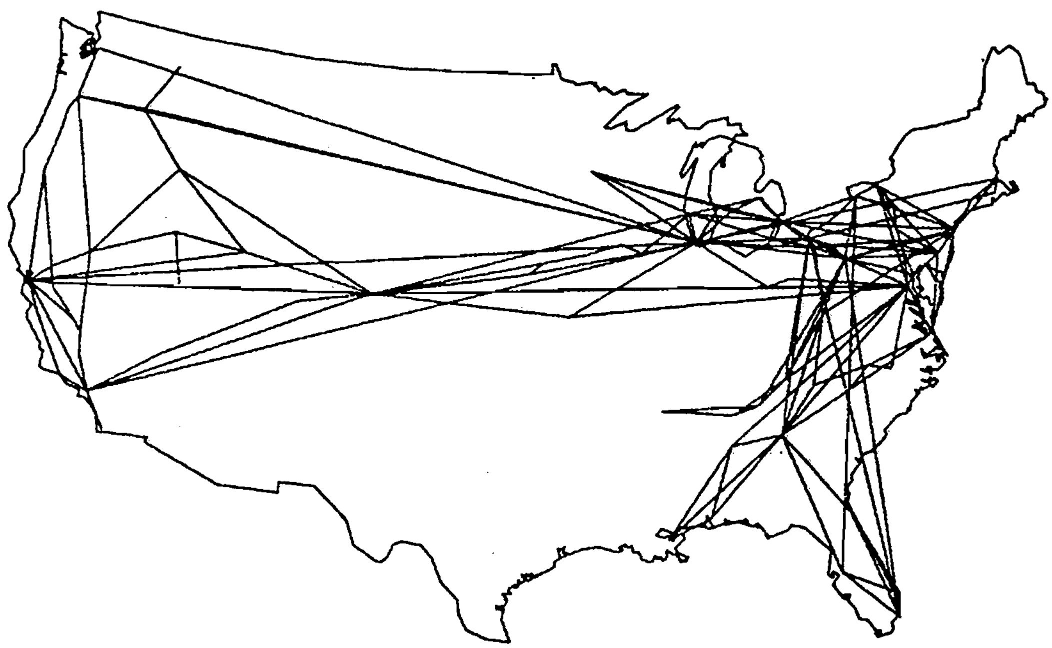
Figure 1. United Airlines Route Structure, 1965 and 1989

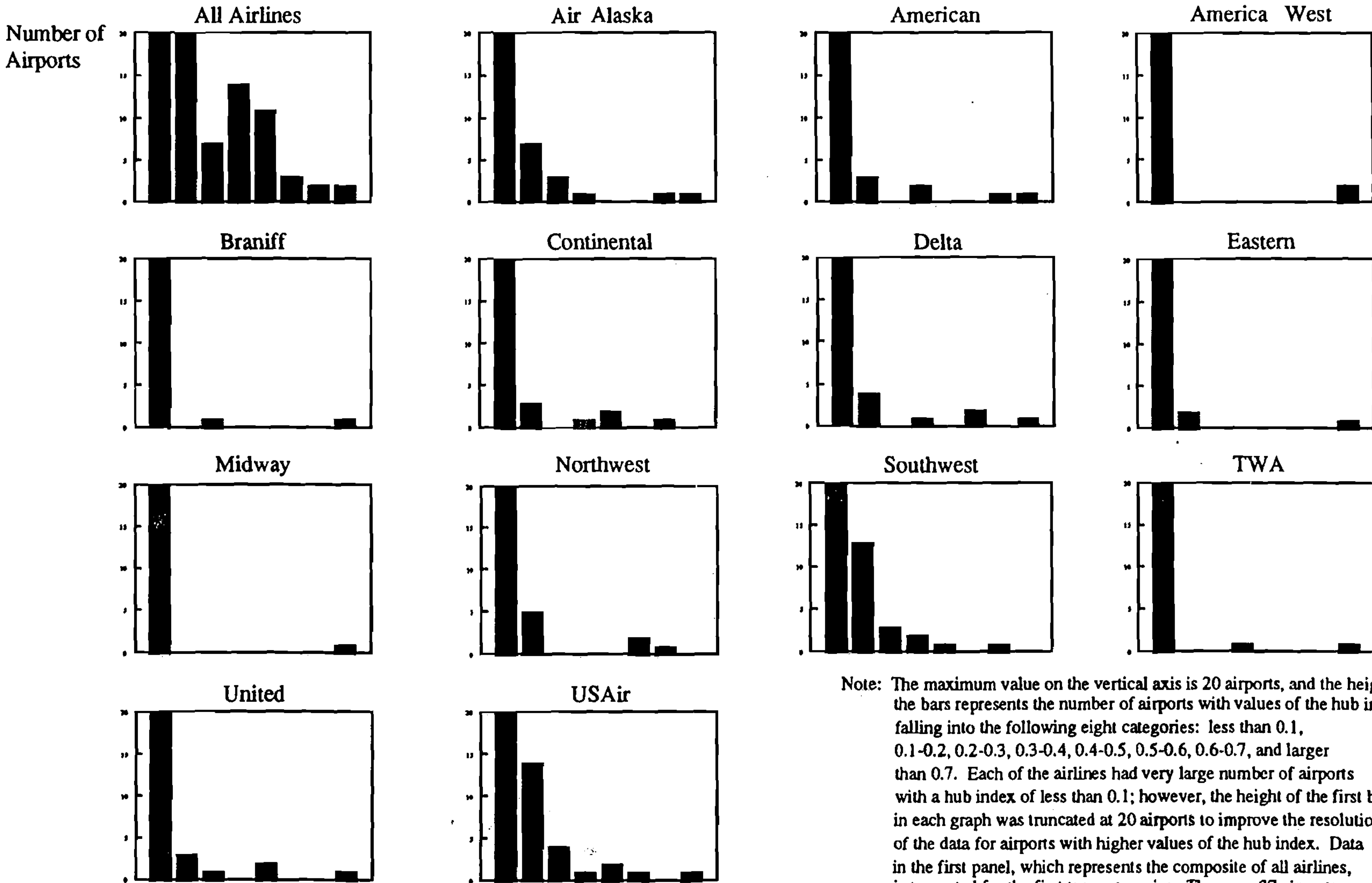
1965



1989

Source: United Airlines schedule guides, 1965 and summer 1989.

Figure 2. Distribution of Nonstop Service by Airline and Airport



Source: Various airline schedule guides, 1989, and authors' calculations.

Note: The maximum value on the vertical axis is 20 airports, and the height of the bars represents the number of airports with values of the hub index falling into the following eight categories: less than 0.1, 0.1-0.2, 0.2-0.3, 0.3-0.4, 0.4-0.5, 0.5-0.6, 0.6-0.7, and larger than 0.7. Each of the airlines had very large number of airports with a hub index of less than 0.1; however, the height of the first bar in each graph was truncated at 20 airports to improve the resolution of the data for airports with higher values of the hub index. Data in the first panel, which represents the composite of all airlines, is truncated for the first two categories. There are 37 airports with a hub index less than 0.1 and 35 airports with a hub index between 0.1 and 0.2.

Table 1. Metropolitan Areas with Multiple Airports

Metropolitan Area	Airport	OTHER	MINOR
Chicago-Gary-Lake County, IL-IN-WI CMSA	Chicago Midway	1	1
	Chicago O'Hare	1	0
Cleveland-Akron-Lorain, OH CMSA	Akron Canton Regional	1	1
	Cleveland Hopkins International	1	0
Dallas-Fort Worth, TX CMSA	Dallas Love Field	1	1
	Dallas Ft. Worth International	1	0
Houston-Galveston-Brazoria, TX CMSA	William P. Hobby	1	0
	Houston Intercontinental	1	0
Los Angeles-Anaheim-Riverside, CA CMSA	Burbank-Glendale-Pasadena	1	1
	Los Angeles International	1	0
	Long Beach	1	1
	Ontario International	1	1
	John Wayne Airport	1	1
Miami-Fort Lauderdale, FL CMSA	Fort Lauderdale	1	0
	Miami International	1	0
New York-N. New Jersey-Long Island, NY-NJ-CT CMSA	Long Island MacArthur	1	1
	Newark International	1	0
	John F. Kennedy International	1	0
	La Guardia	1	0
San Francisco-Oakland-San Jose, CA CMSA	Metropolitan Oakland	1	1
	San Francisco International	1	0
	San Jose International	1	1
Tampa-St. Petersburg-Clearwater, FL MSA	St. Petersburg-Clearwater	1	1
	Tampa International	1	0
Washington, DC-MD-VA MSA	Washington National Airport	1	0
	Washington Dulles Airport	1	0

Source: Authors' assignments.

Table 2. Selected Statistics for Hub Airport-Airline Combinations

Metropolitan Area [1]	Airline [2]	Airports Served by Airline [3]	Hub Service: Nonstop [4]	Hub Service: One-stop [5]	Hub Index [6]	Percent Regional [7]
Atlanta, GA MSA	Delta	101	79	21	79	66
Atlanta, GA MSA	Eastern	53	51	1	98	80
Baltimore, MD MSA	USAir	89	37	49	42	76
Charlotte-Gastonia-Rock Hill, NC-SC MSA	USAir	89	51	36	58	75
Chicago-Gary-Lake County, IL-IN-WI CMSA (Midway)	Midway	35	34	0	100	79
Chicago-Gary-Lake County, IL-IN-WI CMSA (O'Hare)	American	102	63	38	62	60
Chicago-Gary-Lake County, IL-IN-WI CMSA (O'Hare)	United	100	84	14	85	63
Cincinnati-Hamilton, OH-KY-IN CMSA	Delta	101	51	49	51	78
Cleveland-Akron-Lorain, OH CMSA (Hopkins International)	Continental	71	25	44	36	72
Cleveland-Akron-Lorain, OH CMSA (Hopkins International)	USAir	89	21	66	24	71
Dallas-Ft. Worth, TX CMSA (International)	American	102	73	28	72	44
Dallas-Ft. Worth, TX CMSA (International)	Delta	101	52	48	52	50
Dallas-Ft. Worth, TX CMSA (Love Field)	Southwest	27	10	10	38	100
Dayton-Springfield, OH MSA	USAir	89	23	63	26	78
Denver-Boulder, CO CMSA	Continental	71	36	33	51	72
Denver-Boulder, CO CMSA	United	100	45	51	45	67
Detroit-Ann Arbor, MI CMSA	Northwest	89	57	31	65	75
El Paso, TX MSA	Southwest	27	10	13	38	70
Houston-Galveston-Brazoria, TX CMSA (Hobby)	Southwest	27	13	12	50	100
Houston-Galveston-Brazoria, TX CMSA (Intercontinental)	Continental	71	46	23	66	48
Indianapolis, IN MSA	USAir	89	21	61	24	81
Kansas City, MO-KS MSA	Braniff	43	38	4	90	63
Las Vegas, NV MSA	America West	36	26	8	74	81
Los Angeles-Anaheim-Riverside, CA CMSA (LA International)	Delta	101	20	78	20	75
Los Angeles-Anaheim-Riverside, CA CMSA (LA International)	United	100	17	77	17	59
Los Angeles-Anaheim-Riverside, CA CMSA (LA International)	USAir	89	18	69	20	50
Memphis, TN-AR-MS MSA	Northwest	89	50	38	57	68
Minneapolis-St. Paul, MN-WI MSA	Northwest	89	47	41	53	47
Nashville, TN MSA	American	102	37	64	37	84
New York-N. NJ-Long Island, NY-NJ-CT CMSA (JFK)	TWA	76	26	48	35	69
New York-N. NJ-Long Island, NY-NJ-CT CMSA (Newark)	Continental	71	34	36	49	74
Orlando, FL MSA	Braniff	43	12	30	29	83
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD CMSA	USAir	89	35	46	40	86
Phoenix, AZ MSA	America West	36	33	2	94	82
Phoenix, AZ MSA	Southwest	27	17	8	65	88
Pittsburgh-Beaver Valley CMSA	USAir	89	64	24	73	64
Portland-Vancouver, OR-WA CMSA	Air Alaska	15	10	4	71	100
Raleigh-Durham, NC MSA	American	102	39	61	39	92
Salt Lake City-Ogden, UT MSA	Delta	101	35	64	35	80
San Francisco-Oakland-San Jose, CA CMSA (SF International)	United	100	25	69	25	60
Seattle-Tacoma, WA CMSA	Air Alaska	15	13	1	93	100
St. Louis, MO-IL MSA	TWA	76	72	3	96	50
Washington, DC-MD-VA MSA (Dulles)	United	100	44	54	44	75
Washington, DC-MD-VA MSA (National)	USAir	89	43	43	49	81

Source: Various airline service guides, summer 1989, and authors' calculations.

Table 3. Concentration Statistics for Airports in Large Metropolitan Areas, 1989

Metropolitan Area	Airports Served by All Airlines		Herfindahl Index (overall service)		Herfindahl Index (airport pairs)	
Metropolitan Area [1]	Nonstop [2]	One-stop [3]	Nonstop [4]	One-stop [5]	Nonstop [6]	One-stop [7]
Albany-Schenectady-Troy, NY MSA	16	92	1,872	1,398	7,938	3,500
Albuquerque, NM MSA	16	90	1,479	1,266	7,292	2,877
Allentown-Bethlehem, PA-NJ MSA	8	99	3,333	2,637	9,375	4,924
Anchorage, AK MSA	4	88	3,061	4,056	8,125	7,509
Atlanta, GA MSA	84	27	3,810	1,104	6,538	1,912
Augusta, GA-SC MSA	1	83	5,000	5,232	5,000	7,073
Austin, TX MSA	13	98	1,247	1,417	7,436	3,302
Baltimore, MD MSA	47	64	3,905	1,191	8,652	2,152
Baton Rouge, LA MSA	7	95	3,125	2,690	9,286	4,828
Birmingham, AL MSA	17	89	1,818	1,710	8,725	3,212
Boston-Lawrence-Salem-Lowell-Brockton, MA NECMA	43	68	1,418	1,025	8,109	1,783
Buffalo-Niagara, NY CMSA	19	90	2,986	1,515	8,860	3,300
Charleston, SC MSA	14	93	3,772	2,166	8,929	4,332
Charleston, WV MSA	9	83	4,074	3,540	10,000	5,489
Charlotte-Gastonia-Rock Hill, NC-SC MSA	51	60	7,278	1,712	9,248	3,055
Chattanooga, TN MSA	6	84	1,837	2,097	9,167	4,372
Chicago-Gary-Lake County, IL-IN-WI CMSA (Midway)	38	72	5,165	1,701	8,969	3,915
Chicago-Gary-Lake County, IL-IN-WI CMSA (O'Hare)	90	21	3,603	1,098	6,056	1,822
Cincinnati-Hamilton, OH-KY-IN CMSA	53	58	6,445	1,712	9,088	3,011
Cleveland-Akron-Lorain, OH CMSA (Akron-Canton)	7	99	1,875	1,748	9,286	3,929
Cleveland-Akron-Lorain, OH CMSA (Hopkins)	43	68	2,491	1,096	7,345	2,020
Colorado Springs, CO MSA	9	93	1,901	1,833	8,889	4,102
Columbia, SC MSA	9	98	2,893	2,175	8,889	4,552
Columbus, OH MSA	21	88	1,534	1,172	8,095	2,438
Corpus Christi, TX MSA	4	74	3,750	4,370	10,000	6,644
Dallas-Fort Worth, TX CMSA (International)	76	35	3,958	1,224	6,086	2,011
Dallas-Fort Worth, TX CMSA (Love Field)	10	49	10,000	10,000	10,000	10,000
Daytona Beach, FL MSA	7	81	1,800	2,103	8,333	4,688
Dayton-Springfield, OH MSA	30	80	5,650	1,680	9,833	3,066
Denver-Boulder, CO CMSA	56	55	3,431	1,013	6,711	1,852
Des Moines, IA MSA	8	94	1,800	1,656	8,750	3,776
Detroit-Ann Arbor, MI CMSA	60	51	4,554	1,058	8,056	1,916
El Paso, TX MSA	14	90	3,580	2,442	8,810	5,372
Evansville, IN-KY MSA	8	100	2,188	2,268	10,000	4,399
Fayetteville, NC MSA	8	95	2,500	2,103	10,000	4,832
Fort Myers-Cape Coral, FL MSA	23	87	1,177	1,141	9,022	2,272
Fort Wayne, IN MSA	10	96	1,944	1,882	9,000	4,259
Fresno, CA MSA	12	57	2,465	1,960	8,083	5,299
Grand Rapids, MI MSA	9	88	1,736	1,595	8,889	3,525
Greensboro-Winston-Salem-High Point, NC MSA	15	94	4,815	2,058	9,000	3,856
Greenville-Spartanburg, SC MSA	4	85	1,875	2,076	6,667	4,309
Harrisburg-Lebanon-Carlisle, PA MSA	12	88	2,781	1,788	9,583	3,472
Honolulu, HI MSA	13	97	1,720	1,690	7,692	3,289
Houston-Galveston-Brazoria, TX CMSA (Hobby)	28	83	2,246	1,221	9,286	2,650
Houston-Galveston-Brazoria, TX CMSA (International)	52	59	4,854	1,184	8,750	2,413
Indianapolis, IN MSA	35	76	2,309	1,065	8,238	1,959
Jackson, MS MSA	8	95	4,074	3,519	9,375	5,433
Jacksonville, FL MSA	20	90	1,982	1,348	8,667	2,513
Kansas City, MO-KS MSA	45	66	3,262	964	7,796	1,933
Knoxville, TN MSA	14	95	1,765	1,480	9,167	2,804
Las Vegas, NV MSA	40	71	1,892	1,060	7,496	2,225
Lexington-Fayette, KY MSA	13	95	3,491	2,122	10,000	3,939
Little Rock-North Little Rock, AR MSA	11	95	1,733	1,957	8,485	4,204
Los Angeles-Anaheim-Riverside, CA CMSA (Burbank)	13	76	1,875	2,458	9,103	5,337
Los Angeles-Anaheim-Riverside, CA CMSA (John Wayne)	13	89	2,500	2,702	8,846	4,920
Los Angeles-Anaheim-Riverside, CA CMSA (LA International)	53	58	1,287	951	6,670	1,762
Los Angeles-Anaheim-Riverside, CA CMSA (Long Beach)	13	89	1,300	1,740	8,141	4,528
Los Angeles-Anaheim-Riverside, CA CMSA (Ontario)	18	91	1,289	1,214	7,037	3,122
Louisville, KY-IN MSA	18	91	2,107	1,467	8,889	2,544
Madison, WI MSA	6	90	2,653	2,134	9,167	4,078

Table 3. Concentration Statistics for Airports in Large Metropolitan Areas, 1989, continued

Metropolitan Area [1]	Airports Served by All Airlines: Nonstop [2]	Airports Served by All Airlines: One-stop [3]	Herfindahl Index (overall service): Nonstop [4]	Herfindahl Index (overall service): One-stop [5]	Herfindahl Index (airport pairs): Nonstop [6]	Herfindahl Index (airport pairs): One-stop [7]
Melbourne-Titusville-Palm Bay, FL MSA	6	82	1,852	1,804	8,056	4,444
Memphis, TN-AR-MS MSA	54	57	6,206	1,510	9,259	2,677
Miami-Fort Lauderdale, FL CMSA (Fort Lauderdale)	25	85	1,689	1,152	7,300	2,189
Miami-Fort Lauderdale, FL CMSA (Miami International)	33	78	1,248	1,099	7,848	2,027
Milwaukee-Racine, WI CMSA	22	87	2,628	1,203	8,636	2,604
Minneapolis-St. Paul, MN-WI MSA	49	62	5,184	1,120	8,469	2,286
Mobile, AL MSA	8	94	2,099	2,097	9,375	4,502
Nashville, TN MSA	44	67	4,186	1,379	8,674	2,417
New Orleans, LA MSA	30	81	1,358	1,139	9,111	2,084
New York-N. NJ-Long Island, NY-NJ-CT CMSA (JFK)	39	72	2,847	1,565	8,034	3,078
New York-N. NJ-Long Island, NY-NJ-CT CMSA (La Guardia)	43	68	1,460	1,159	7,849	2,060
New York-N. NJ-Long Island, NY-NJ-CT CMSA (Long Island)	10	89	4,200	3,156	10,000	5,643
New York-N. NJ-Long Island, NY-NJ-CT CMSA (Newark)	48	63	2,710	1,091	7,500	1,903
Oklahoma City, OK MSA	15	96	1,690	1,415	8,667	3,129
Omaha, NE-IA MSA	13	98	1,327	1,264	9,615	2,876
Orlando, FL MSA	41	70	1,552	1,088	7,244	1,892
Pensacola, FL MSA	8	84	2,593	2,089	9,375	4,313
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD CMSA	48	63	3,217	1,096	8,438	1,968
Phoenix, AZ MSA	53	58	1,918	937	7,280	1,807
Pittsburgh-Beaver Valley, PA CMSA	64	47	6,778	1,217	9,010	2,446
Portland-Vancouver, OR-WA CMSA	21	88	1,717	1,439	7,528	3,181
Providence-Pawtucket-Woonsocket, RI MSA	12	95	1,953	1,569	8,333	3,788
Raleigh-Durham, NC MSA	42	68	5,233	1,734	8,690	2,865
Richmond-Petersburg, VA MSA	13	94	3,010	2,171	8,462	4,212
Roanoke, VA MSA	10	97	3,400	2,695	10,000	4,631
Rochester, NY MSA	17	91	3,950	1,793	9,118	3,843
Rock Island, IL MSA	7	88	1,563	1,613	9,286	3,595
Sacramento, CA MSA	18	84	2,117	1,727	7,639	3,855
Salt Lake City-Ogden, UT MSA	35	76	5,898	1,632	8,714	3,246
San Antonio, TX MSA	20	91	1,201	1,151	7,917	2,558
San Diego, CA MSA	26	85	1,172	1,114	7,427	2,350
San Francisco-Oakland-San Jose, CA CMSA (Oakland)	17	85	1,879	1,740	7,255	5,016
San Francisco-Oakland-San Jose, CA CMSA (San Francisco)	44	67	1,504	1,017	6,498	1,831
San Francisco-Oakland-San Jose, CA CMSA (San Jose)	20	82	1,935	1,514	6,583	3,422
Santa Barbara-Santa Maria-Lompoc, CA MSA	10	92	3,163	3,265	8,333	6,212
Sarasota, FL MSA	14	96	1,450	1,340	8,393	2,873
Savannah, GA MSA	8	94	2,400	2,143	8,750	4,480
Seattle-Tacoma, WA CMSA	34	77	1,483	1,058	7,125	1,803
Shreveport, LA MSA	8	93	3,827	2,672	9,375	5,000
South Bend-Mishawaka, IN MSA	10	91	1,405	1,438	9,500	3,729
Spokane, WA MSA	6	87	2,600	2,600	7,222	5,670
St. Louis, MO-IL MSA	72	39	5,960	1,125	8,565	2,165
Syracuse, NY MSA	20	89	3,989	1,520	9,250	3,304
Tampa-St. Petersburg-Clearwater, FL MSA (St. Petersburg)	3	89	10,000	10,000	10,000	10,000
Tampa-St. Petersburg-Clearwater, FL MSA (Tampa)	37	74	1,463	1,092	8,545	1,995
Toledo, OH MSA	9	99	1,736	1,547	8,889	3,781
Tucson, AZ MSA	15	92	1,136	1,259	8,000	3,336
Tulsa, OK MSA	16	95	1,519	1,428	8,438	3,131
Washington, DC-MD-VA MSA (National)	57	54	3,141	1,103	8,260	1,985
Washington, DC-MD-VA MSA (Dulles)	50	61	5,340	1,344	9,050	2,343
West Palm Beach-Boca Raton-Delray Beach, FL MSA	9	82	4,321	3,486	10,000	5,778
Wichita, KS MSA	13	95	1,328	1,196	8,846	3,163
Mean	24.55	80.32	2,926.79	1,884.71	8,470.13	3,572.40
Standard Deviation	19.50	16.52	1,720.19	1,332.75	1,002.11	1,548.00
Coefficient of Variation	0.79	0.21	0.59	0.71	0.12	0.43

Source: Various airline service guides, summer 1989, and authors' calculations.

Table 4. Variable Definitions and Data Sources

Variable Name	Definition	Data Source	Mean	Standard Deviation	Minimum	Maximum
HUB	Equal to 1 if airport has a hub carrier (see table 2); zero otherwise	Authors' calculations	0.31	0.47	0.00	1.00
SERVICE	Number of airports in sample reachable by nonstop air service from airport in 1989	Airline flight schedules	24.55	19.57	1.00	90.00
INCOME	1987 per capita personal income for MSA containing airport	U.S. Department of Commerce, county personal income computer tape file	15,896.06	2,469.18	9,541.00	21,534.00
POP	1987 population for MSA containing airport	U.S. Department of Commerce, county personal income computer tape file	2,624,541.96	4,171,725.32	123,500.00	17,944,600.00
CORP	Number of Standard & Poor's 500 companies headquartered in MSA or CMSA containing airport	Standard & Poor's Register of Corporations, Directors, and Executives, Volume 1, 1989	6.73	12.29	0.00	54.00
D	Sum of air miles from airport to each of other airports in sample	U.S. Department of Transportation, Air Carrier Statistics, Origin and Destination City Pair Summary	122,403.68	47,058.39	86,738.00	441,100.00
E70	1987 total employment in hotels and other lodging places (SIC 70) for MSA containing airport	U.S. Department of Commerce, county business patterns computer tape file	13,805.34	18,311.88	829.00	64,291.00
E79	1987 total employment in amusement and recreation services (SIC 79) for MSA containing airport	U.S. Department of Commerce, county business patterns computer tape file	10,666.14	17,969.31	433.00	73,088.00
BUSTOUR	Business-tourist activity proxy: residual from regression of log(E70+E79) on log(POP) and log(INCOME)	Authors' calculations	0.00	0.41	-0.61	2.61
SNOW	Average number of days snowfall exceeded one inch	Local Climatological Data, National Oceanic and Atmospheric Administration	6.23	7.68	0.00	33.00
FOG	Average number of days visibility was 1/4 mile or less	Local Climatological Data, National Oceanic and Atmospheric Administration	21.57	13.13	0.00	98.00
GATEWAY	Equal to 1 if airport has service to Europe, Asia, or South Pacific; zero otherwise	Airline flight schedules	0.19	0.39	0.00	1.00
OTHER	Equal to 1 if metropolitan area has another airport; zero otherwise	Authors' calculations	0.22	0.42	0.00	1.00
MINOR	Equal to 1 if airport is not the metropolitan area's major airport (see text for details); zero otherwise	Authors' calculations	0.10	0.30	0.00	1.00
SLOT	Equal to 1 if airport is subject to FAA landing & takeoff restrictions; zero otherwise	FAA	0.04	0.19	0.00	1.00

Table 5. Regression Results

Variable	Logit, Hub Equation Dep. Var: HUB Estimated Coefficient	Wald Chi-Square	OLS, Service Equation Dep. Var: SERVICE Estimated Coefficient	T-Ratio	OLS, Nonstop, Airport Dep. Var: H0 Estimated Coefficient	T-Ratio
log(POP)	1.52	4.26 **	0.61	5.97 ***	-0.01	-0.08
log(INCOME)	-4.76	2.28	0.70	1.60	-0.22	-0.50
log(CORP+1)	0.60	1.04	0.01	0.08	0.00	-0.05
log(D)	-4.08	5.18 **	-0.55	-2.23 **	-0.85	-3.45 ***
OTHER	-1.67	1.77	-0.41	-2.06 **	-0.11	-0.56
MINOR	-1.60	1.23	-1.28	-5.20 ***	0.61	2.46 **
SLOT	0.56	0.07	-0.13	-0.45	0.08	0.25
GATEWAY	3.72	8.57 **	0.29	1.79 *	0.42	2.56 **
SNOW/365	11.72	0.49	3.57	1.45	2.67	1.08
FOG/365	-13.14	1.17	-1.83	-1.30	0.46	0.33
BUSTOUR	2.12	6.45 **	0.56	4.48 ***	0.01	0.08
CONSTANT	70.92	3.95 **	-5.73	-1.32	19.80	4.56 ***
N	110		110		110	
-2 log L	139.091					
R-Squared			0.70		0.22	

Variable	OLS, Nonstop, Route Dep. Var: HH0 Estimated Coefficient	T-Ratio	OLS, One Stop, Airport Dep. Var: H1 Estimated Coefficient	T-Ratio	OLS, One Stop, Route Dep. Var: HH1 Estimated Coefficient	T-Ratio
log(POP)	-0.02	-0.93	-0.24	-3.65 ***	-0.28	-5.70 ***
log(INCOME)	0.02	0.22	-0.31	-1.08	-0.41	-1.95 *
log(CORP+1)	-0.01	-0.32	-0.06	-0.93	-0.02	-0.32
log(D)	-0.19	-3.33 **	-0.07	-0.41	0.24	2.04 **
OTHER	0.00	0.10	0.18	1.42	0.16	1.71 *
MINOR	0.11	1.98 *	1.06	6.55 ***	0.98	8.22 ***
SLOT	-0.05	-0.69	0.30	1.51	0.22	1.54
GATEWAY	-0.06	-1.47	0.13	1.17	0.01	0.11
SNOW/365	0.54	0.96	-2.64	-1.63	-1.30	-1.10
FOG/365	0.44	1.36	1.66	1.79 *	1.06	1.58
BUSTOUR	0.00	0.01	-0.18	-2.14 **	-0.25	-4.16 ***
CONSTANT	11.29	11.35 ***	14.44	5.05 ***	12.95	6.21 ***
N	110		110		110	
-2 log L						
R-Squared	0.26		0.53		0.69	

Note: *, **, and *** denote 10, 5, and 1 percent significance levels, respectively.

Source: Authors' calculations.

Table 6. Actual and Predicted Hub Values

Metropolitan Area	Hub	Predicted Value
Chicago-Gary-Lake County IL-IN-WI CMSA (O'Hare)	1	0.998
St. Louis, MO-IL	1	0.995
New York-N. New Jersey-Long Island, NY-NJ-CT (Newark)	1	0.992
Minneapolis-St. Paul, MN-WI	1	0.992
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD	1	0.991
Cincinnati-Hamilton OH-KY-IN CMSA	1	0.990
Atlanta, GA	1	0.990
Detroit-Ann Arbor, MI CMSA	1	0.988
Denver-Boulder, CO CMSA	1	0.985
New York-N. New Jersey-Long Island, NY-NJ-CT (JFK)	1	0.984
Dallas-Fort Worth, TX CMSA (International)	1	0.980
Houston-Galveston-Brazoria, TX CMSA (Intercontinental)	1	0.975
Los Angeles-Anaheim-Riverside, CA CMSA (LA International)	1	0.969
Miami-Fort Lauderdale, FL CMSA (Miami International)	0	0.950
Boston-Lawrence-Salem, MA-NH CMSA	0	0.911
Las Vegas, NV	1	0.852
New York-N. New Jersey-Long Island, NY-NJ-CT (La Guardia)	0	0.842
Washington, DC-MD-VA (Dulles)	1	0.834
Pittsburgh-Beaver Valley, PA CMSA	1	0.824
New Orleans, LA	0	0.769
San Francisco-Oakland-San Jose, CA CMSA (San Francisco)	1	0.730
Orlando, FL	1	0.684
Chicago-Gary-Lake County, IL-IN-WI CMSA (Midway)	1	0.656
Raleigh-Durham, NC	1	0.602
Portland-Vancouver, OR-WA CMSA	1	0.600
Kansas City, MO-KS	1	0.586
Louisville, KY-IN	0	0.547
Seattle-Tacoma, WA CMSA	1	0.544
Memphis, TN-AR-MS	1	0.537
Nashville, TN	1	0.536
Cleveland-Akron-Lorain, OH CMSA (Hopkins)	1	0.527
Houston-Galveston-Brazoria, TX CMSA (Hobby)	1	0.489
Columbus, OH	0	0.453
San Antonio, TX	0	0.425
Phoenix, AZ	1	0.365
Salt Lake City-Ogden, UT	1	0.355
New York-N. New Jersey-Long Island, NY-NJ-CT (Long Island)	0	0.352
Indianapolis, IN	1	0.340
Miami-Fort Lauderdale, FL CMSA (Fort Lauderdale)	0	0.327
Milwaukee-Racine, WI CMSA	0	0.313
Buffalo-Niagara Falls CMSA	0	0.308
Tulsa, OK	0	0.288
Baltimore, MD	1	0.278
Oklahoma City, OK	0	0.265
Harrisburg-Lebanon-Carlisle, PA	0	0.255
Charleston, SC	0	0.248
Birmingham, AL	0	0.241
Tampa-St. Petersburg-Clearwater, FL (Tampa)	0	0.226
El Paso, TX	1	0.224
Daytona Beach, FL	0	0.207
Dallas-Fort Worth, TX CMSA (Love Field)	1	0.197
Dayton-Springfield, OH	1	0.193
Knoxville, TN	0	0.179
Charlotte-Gastonia-Rock Hill, NC-SC	1	0.176
Washington, DC-MD-VA (National)	1	0.176
Los Angeles-Anaheim-Riverside, CA CMSA (Burbank)	0	0.168
Syracuse, NY	0	0.151

Table 6. Actual and Predicted Hub Values, continued

Metropolitan Area	Hub	Predicted Value
Jacksonville, FL	0	0.148
Los Angeles-Anaheim-Riverside, CA CMSA (Ontario)	0	0.145
Los Angeles-Anaheim-Riverside, CA CMSA (John Wayne)	0	0.139
Cleveland-Akron-Lorain, OH CMSA (Akron-Canton)	0	0.137
Rochester, NY	0	0.135
Jackson, MS	0	0.127
Greenville-Spartanburg, SC	0	0.127
Los Angeles-Anaheim-Riverside, CA CMSA (Long Beach)	0	0.124
Omaha, NE-IA	0	0.120
Chattanooga, TN-GA	0	0.118
Grand Rapids, MI	0	0.115
San Diego, CA	0	0.114
Mobile, AL	0	0.112
Tucson, AZ	0	0.112
Toledo, OH	0	0.090
Shreveport, LA	0	0.090
Little Rock-North Little Rock, AR	0	0.087
Richmond-Petersburg, VA	0	0.083
Lexington-Fayette, KY	0	0.082
Wichita, KS	0	0.076
Colorado Springs, CO	0	0.073
Greensboro-Winston-Salem-High Point, NC	0	0.071
Albuquerque, NM	0	0.067
Davenport-Rock Island-Moline, IA-IL	0	0.067
Austin, TX	0	0.064
West Palm Beach-Boca Raton-Delray Beach, FL	0	0.060
Tampa-St. Petersburg-Clearwater, FL (St. Petersburg)	0	0.056
Des Moines, IA	0	0.052
Pensacola, FL	0	0.052
Corpus Christi, TX	0	0.047
Melbourne-Titusville-Palm Bay, FL	0	0.045
Albany-Schenectady-Troy, NY	0	0.044
Augusta, GA-SC	0	0.044
Fayetteville, NC	0	0.043
Baton Rouge, LA	0	0.041
Evansville, IN-KY	0	0.036
Roanoke, VA	0	0.036
Columbia, SC	0	0.036
Fort Wayne, IN	0	0.032
South Bend-Mishawaka, IN	0	0.031
Allentown-Bethlehem, PA-NJ	0	0.027
Fort Myers-Cape Coral, FL	0	0.025
Savannah, GA	0	0.023
Providence-Pawtucket-Fall River, RI-MA CMSA	0	0.021
Madison, WI	0	0.021
San Francisco-Oakland-San Jose, CA CMSA (San Jose)	0	0.014
San Francisco-Oakland-San Jose, CA CMSA (Oakland)	0	0.014
Charleston, WV	0	0.007
Sacramento, CA	0	0.005
Sarasota, FL	0	0.005
Fresno, CA	0	0.002
Spokane, WA	0	0.002
Santa Barbara-Santa Maria-Lompoc, CA	0	0.001

Source: Authors' calculations.