Trends at United States International Gateway Airports to Europe

SUSAN J. HEIDNER

What impact will the ongoing and predicted changes in Europe have on the United States gateways that serve the North Atlantic market? Standard ground transportation modeling and analysis methodology (trip generation, trip distribution, modal split, and trip assignment) was used on the 24 United States and 33 European gateways with scheduled service in 1989. Using gross domestic product to predict gateway boardings, the average annual growth rate ranged from 3.3 percent under status quo conditions to 3.5 percent under a high-growth scenario. Using average seats per aircaft and load factor with gateway boardings resulted in a 4.1 percent average annual growth in operations to 2000 and 2.3 percent from 2000 to 2010. This could affect the air traffic control system. The concluding step used a market share method to distribute the market gateway boardings and operations to the individual gateways, enabling the impacts on the gateways to be quantified along with the overall market impacts. This growth is expected to be largely absorbed by gateways other than New York (Kennedy and Newark), which will see a decline in market share.

Major changes have been occurring in Europe recently [liberalization of Western European air transportation under European Economic Community rules (EC 1992) and liberalization of Eastern Europe]. More changes have been predicted as the European Economic Community becomes more unified and the Eastern European economies stabilize. These changes should have an impact on airline passenger traffic within Europe as well as in the North Atlantic market, a market accounting for more than 40 percent of United States international air traffic (*1*). Traffic changes in the North Atlantic market would affect the United States gateways serving Europe.

There are four stages to defining how the changes in Europe would affect United States gateways serving Europe. The stages are researching and predicting the changes in Europe, predicing how those changes would affect air transportation, predicting how the air transportation changes would affect the North Atlantic market, and predicting how the changes in the North Atlantic market would affect the United States gateways serving Europe.

CHANGES IN EUROPE AND IMPACTS ON AIR TRANSPORTATION

The changes in Europe can be divided into four major geographical areas: the unified European Economic Community influencing Western Europe; the liberalized countries of Eastern Europe and their formation of new market economies; the continuing movement of the Soviet Union toward a market economy; and the newly independent Baltic countries.

European Economic Community in 1992

The European Economic Community—Belgium, Denmark, France, West Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom—is currently committed to an ambitious program to eliminate all existing internal barriers to the free movement of goods and services, including air services, by January 1, 1993 (*2*). The goal is to achieve increased economic productivity and growth for all countries involved by attaining a market similar in size to the United States while preserving the cultural heritage of each country.

The EC 1992 rules affecting intra-European air transportation will eliminate restrictions on routes, resulting in an anticipated increase in European airline competition (*3*). Expected consolidation of European airlines will make them stronger. They will be more capable of being fare competitive with United States flag carriers, which will affect the North Atlantic market (*4*). Also, with economic growth, airline passenger growth is assumed to increase because of increases in disposable personal income. In addition, increased economic activity will attract more business travelers as companies establish suitable partnerships and joint ventures leading to new or expanded markets between the United States and Europe.

Eastern Europe, Soviet Union, and Newly Independent Countries

Most of the Eastern European countries, the Soviet Union, and the newly independent Baltic countries are striving to establish market economies. (Since independent numbers were not available for the Baltic countries, their traffic volume was calculated as part of the Soviet Union in this study.) However, at this time, most of these countries face severe growth limitations, both economically and technologically (*5*), which will result in a very gradual increase in capacity in the North Atlantic market. Former East Germany, now part of a reunified Germany, may experience much faster growth than the other countries.

These countries should eventually experience North Atlantic airline passenger traffic growth well above their current service. These increases would be impeded until the airport facilities are enlarged to accommodate more passengers and upgraded to meet all the international airport security stan-

Purdue University, West Lafayette, Ind. 47907.

dards. More and better tourist amenities such as hotels, restaurants, and convention facilities are also needed (*5*). Rapid growth in these areas would require a significant infusion of capital resources. Whereas most of these countries presently have airlines, they have a shortage of equipment required to adequately meet their current demand. Most countries also lack the capital to meet future equipment needs, which will result in several years, or decades, of slow North Atlantic passenger growth. This is because under most agreements the market split is approximately 50/50, and if one country is unable to increase capacity, it is doubtful it would allow other countries to increase capacity in that market (*5*).

IMPACTS ON THE NORTH ATLANTIC MARKET

The North Atlantic market is the most mature of any United States international market, and passenger volume is still increasing (*1*). Recently, the North Atlantic market has felt the negative effects of an economic recession in the United States, Operation Desert Storm, and a terrorist scare. These types of events have happened in the past. Figure 1 shows the 1982–1983 United States recession and the European recession that followed. In 1986 a perceived unsafe market resulting from the Chernobyl nuclear accident, TWA hijacking, and the bombing of Libya resulted in a significant drop in passenger traffic.

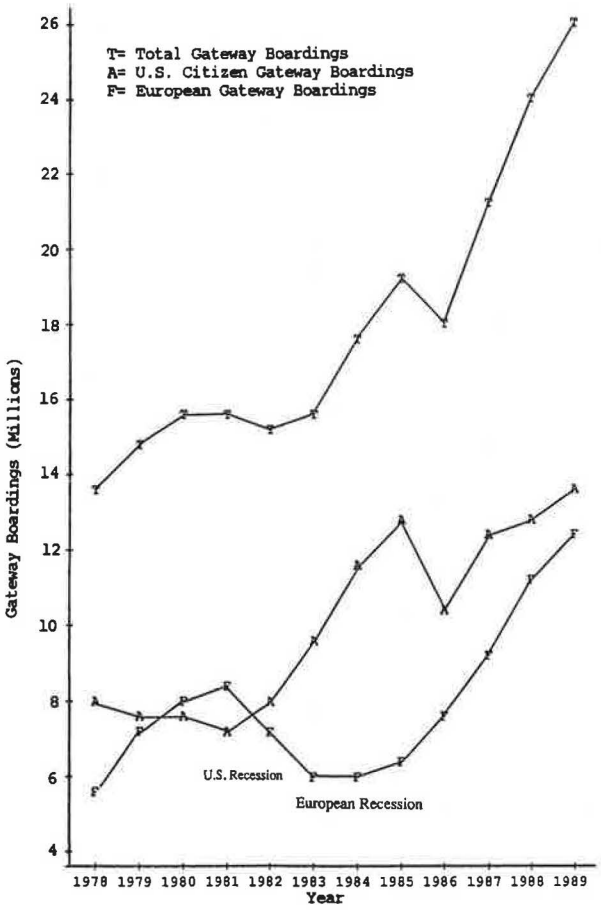

FIGURE 1 Gateway boardings by citizenship (source: U.S. International Air Travel Statistics).

Along with these types of events three main factors influence passenger growth in the North Atlantic market: (*a*) the changing structure of the international airline industry with renegotiated bilateral agreements and longer-range aircraft; (*b*) the interdependence of the countries involved in the international airline industry, so that travel between countries is possible; and (*c*) the regulation and deregulation of the international airline industry. Most airlines outside of the United States were and still are government controlled and subsidized, a situation that is not changing rapidly because most do not want to give up their "safety net."

CONVENTIONS AND BILATERAL AGREEMENTS

International air transportation is not a deregulated industry. Conventions and bilateral agreements constrain the growth of the market, with political and economic implications as discussed by Kasper (*6*), O'Connor (*7*), Taneja (*8,9*), and de Murias (*10*). The key factors of these agreements are as follows:

- Capacity control: Capacity control is the specified number of flights per week or market share that is allowed. Only recently have some of these controls been relaxed, leading to increased competition.
- Fare approval: Until recently all fares for the North Atlantic market were set exclusively by the IATA fare-setting forum. Under some agreements now, the fares are set and approved or rejected by the individual countries, which has allowed increased freedom for fare competition.
- Route authorization: This authorization controls what airlines operate on a specific route between what gateways. A recent example was the negotiations that took place to get authorization for American and United Airlines to fly into Heathrow instead of Gatwick as was specified in the bilateral agreement. Route authorization controls the third (right to set down traffic originating in the carrier's country in a foreign country), fourth (right to fly traffic from a foreign country to the carrier's country), and fifth (right to carry traffic between two foreign countries) freedoms. (First freedom is the right to transit over a country without landing, and second freedom is the right to stop for nontraffic purposes such as refueling.)
- Cabotage: Under bilateral agreements, cabotage, the right of a foreign airline to carry domestic passengers within that country, is denied. The question has been raised whether a unified Europe would lead to excluding intra-European flights by non-European airlines. In this study, it was assumed that this would not be possible until a single body negotiates all the European bilateral agreements, an event not looked upon happily by most European countries.
- United States domestic deregulation: After deregulating the domestic airline industry in the United States, the United States government tried to export deregulation to the rest of the world to increase competition. The limited result in the North Atlantic market was slightly more liberal bilateral agreements (*1*).

IMPACTS ON UNITED STATES GATEWAYS SERVING EUROPE

The standard ground transportation planning and analysis methodology was attempted using the 24 United States and 33 European gateways that had scheduled service in the North Atlantic market in 1989, the final year of data. The gateways are Kennedy, Chicago, Boston, Los Angeles, Atlanta, Miami, Newark, Dallas, Houston, Washington, D.C., Detroit, Orlando, San Francisco, Seattle, St. Louis, Cincinnati, Philadelpha, Baltimore, Charlotte, Denver, Minneapolis, Pittsburgh, Raleigh, San Diego, London, Frankfurt, Paris, Amsterdam, Copenhagen, Madrid, Rome, Brussels, Milan, Shannon, Helsinki, Dusseldorf, Oslo, Warsaw, Stockholm, Zurich, Moscow, Manchester, Belgrade, Zagreb, Dublin, Vienna, Prague, Lyon, Nice, Hamburg, Munich, Athens, Keflavik, Luxembourg, Lisbon, Geneva, and Prestwick.

The ground transportation planning and analysis methodology includes four steps: trip generation, trip distribution, modal split, and trip assignment. The first three steps were applied to this research with confidence. The results of trip assignment were not reliable, so this step was not pursued.

Trip Generation

Trip generation predicts the total number of trips taking place in a market regardless of their origin or destination. An important part of trip generation is the data base.

Data Sources

The data sources available and applicable to this study were *United States International Air Travel Statistics 1978–1989* (*11*), *In-Flight Survey* (*12*), *FAA Forecast for the Fiscal Years 1991–2002* (*13*), *Outlook for Commercial Aircraft 1991–2010* (*14*), *Current Market Outlook* (*15*), *Traffic by Flight Stage* (*16*), *Civil Aviation Statistics of the World* (*17*), and *On Flight Origin and Destination* (*18*).

United States International Air Travel Statistics collected by the U.S. Immigration and Naturalization Service (INS) and published by the Transportation Systems Center (TSC) of the U.S. Department of Transportation were the main data base for this study. These data are the number of trips between the United States gateway (airport in the United States immediately preceding or following the trans-Atlantic flight segment) and the European gateway where the passenger embarks on or disembarks from the flight with the same flight number, on the same airline, as the flight segment having a trip end in the United States. The data reflect gateways, not the actual origin and destination of the travelers. The data on United States domestic flights or intra-European flights immediately preceding or following the international trans-Atlantic flight were sought from the other sources, but the data were not available in the public domain.

The standard convention of passenger enplanements was not used with these data because FAA counts a businessman who travels from New York to Paris, where he clears customs, spends the day in a meeting, and then reboards a United States carrier for Rome, as two enplanements in the North Atlantic market. The data used in this study only counted the one enplanement in New York. To avoid confusion, the enplanements in this study were labeled gateway boardings.

Status Quo Model Development

Standard regression techniques were used to develop a model that would effectively translate the historical data into a forecast of North Atlantic gateway boardings (*19*). The regression used the following independent variables:

- Dollar—the weighted average of the U.S. dollar against major world currencies as calculated by the Federal Reserve Board to measure growth due to the rate of exchange (*20*);
- GDP—the combined United States and European gross domestic product, in billions of 1980 U.S. dollars, to measure growth related to economic conditions (*14,21,22*);
- EGDP—European gross domestic product only, also in billions of 1980 U.S. dollars, to measure growth of European citizen traffic (*14,21,22*);
- USGDP—United States gross domestic product only, in billions of 1980 U.S. dollars, to measure growth of U.S. citizen traffic (*14,21,22*);
- Yield—the North Atlantic airline yields of U.S. carriers (*23*) adjusted to real terms with the "CPI for airfares" (*24*), to measure the influence of fare on the volume of passengers; and
- "Fear variable"—a "zero or one" variable for world events that cause people to be afraid of flying or traveling (applied to 1986) to measure the passengers dropping out of the North Atlantic market because of a fear of unsafe European travel.

The following variables were also examined: time since 1978, United States national unemployment, United States GNP, and a "zero or one" variable for recession. Table 1 shows the four best sets of regression equations. The chosen equation set, Case 1, shown in Equations 1 and 2, used EGDP and U.S. dollar in an equation for foreign citizens and USGDP and U.S. dollar in an equation for U.S. citizens. This equation set allowed the flexibility to adjust the growth of U.S. and European citizens independently. Past growth patterns had been different.

European citizen gateway boardings:

$$\text{Eurocitz} = -7{,}895{,}044 + 3{,}911.64\,(\text{EGDP}) - 56{,}912\,(\text{dollar})$$

$$R^2 = 0.7903 \quad (0.774) \quad (0.0003) \quad (0.0043)$$

$$(\text{probability} > |\text{T}|) \qquad (1)$$

U.S. citizen gateway boardings:

$$\text{UScitz} = -154{,}276{,}641 + 7{,}147.38\,(\text{USGDP}) + 41{,}065\,(\text{dollar})$$

$$R^2 = 0.9205 \quad (0.0001) \quad (0.0001) \quad (0.0052)$$

$$(\text{probability} > |\text{T}|) \qquad (2)$$

The regression results are sensible. The positive correlation between the GDP variables and gateway boardings explains that the higher the GDP, the stronger the economy and the

TABLE 1 FOUR BEST REGRESSION EQUATIONS (SETS) FOR TOTAL GATEWAY BOARDINGS

Case 1. Separate Equations for Citizens

ForCitz = -7895044 + 3911.64(FGDP) - 56912(dollar) R2 = 0.7903
(0.0774) (0.0003) (0.0043)
Predicted: Forcitz 2000 = 16446498 Forcitz 2010 = 22685173

Amcitz = -15427641 + 7147.38(AGDP) + 41065(dollar) R2 = 0.9205
(0.0001) (0.0001) (0.0052)
Predicted: Amcitz 2000 = 20379585 Amcitz 2010 = 27891485

Predicted: Total 2000 = 36826083 Total 2010 = 50576658

Case 2. One Equation for All Citizens

Total = -26482187 + 5207.50 (GDP) R2 = 0.9417
(0.0001) (0.0001)
Predicted: Total 2000 = 35679741 Total 2010 = 49458264

Case 3. Separate Equations for Citizens Utilizing Fear Variable for U.S. Citizens Only

Forcitz = -7895044 + 3911.64(FGDP) - 56912(dollar) R2 = 0.7903
(0.0774) (0.0003) (0.0043)
Predicted: Forcitz 2000 = 16446498 Forcitz 2010 = 22685173

Amcitz = -15963579 + 7408.95(AGDP) + 39893(dollar) - 1374430(fear) R2 = 0.9405
(0.0001) (0.0001) (0.0027) (0.0552)
Predicted: Amcitz 2000 = 20940065 Amcitz 2010 = 28726872

Predicted: Total 2000 = 37386563 Total 2010 = 51412045

Case 4. One Equation for All Citizens Utilizing Fear Variable

Total = -28290887 + 5447.91 (GDP) - 2925186(fear) R2 = 0.9682
(0.0001) (0.0001) (0.0033)
Predicted: Total 2000 = 36740815 Total 2010 = 51555440

(Probability > |T|)

Source: GDP from WEFA Group (up to 1996), extrapolated to 2010 with growth rate from McDonnell Douglas
GDP 2000 = 11937.0 GDP 2010 = 14582.9 1980 U.S. Dollars
FGDP 2000 = 7386.8 FGDP 2010 = 8981.7 1980 U.S. Dollars
AGDP 2000 = 4550.2 AGDP 2010 = 5601.2 1980 U.S. Dollars

TABLE 2 OTHER EQUATIONS CONSIDERED FOR TOTAL GATEWAY BOARDINGS

Linear: GDP and Yield

Total = -41982542 + 6551.58(GDP) + 4355494(Yield) R2 = 0.9417
(0.0005) (0.0001) (0.0626)
Predicted: Total 2000 = 38858740 Total 2010 = 55988857

Logarithmic: GDP

Log(10)Total = -2.0623 + 2.3686Log(10)GDP R2 = 0.9382
(0.0166) (0.0001)
Predicted: Total 2000 = 39293049 Total 2010 = 63119323

(Probability > |T|)

Source: GDP from WEFA Group (up to 1996), extrapolated to 2010 with growth rate from McDonnell Douglas 1991
GDP 2000 = 11937.0 GDP 2010 = 14582.9 1980 U.S. Dollars
Source: North Atlantic Yield from Airline Monitor Nov. 1991, adjusted with CPI for airfares from U.S. Statistical Abstract and growth rate from Boeing 1991(1990-2000, extrapolated to 2010)
Yield 2000 = 6.05 Yield 2010 = 5.58 1982-1984 U.S. Cents per RPM

more people can afford to travel, which leads to an increase in gateway boardings. The negative correlation between European citizen gateway boardings and the U.S. dollar is a result of travel to the United States becoming more expensive as the U.S. dollar gets stronger. The reverse is true for U.S. citizens; foreign travel is less expensive when the U.S. dollar is strong, thus more people can afford to travel.

It was decided not to include the "fear variable" because there is only a small improvement in the coefficient of determination and a slight increase in the growth rate by discounting the bad year. Also, there is no method of predicting when world events that cause a bad year will happen.

The equations that were also considered are given in Table 2. GDP and yield are standard variables used to predict air travel. These variables were used in the forecasts by Boeing (*15*) and Greenslet (*25*) for world revenue passenger miles (RPM). The correlation between gateway boarding and GDP should be positive as was found in this study. It was expected that the correlation between yield and gateway boardings would be negative because a lower yield stems from lower fares designed to encourage more people to fly. The regression results in this study showed a positive correlation, which is counter intuitive. This unexpected result has not been rationalized. Therefore it was not used, even though this equation resulted in a higher growth rate and coefficient of determination.

Two possible hypotheses were offered but not proven. First, the positive correlation between yield and total gateway boardings could result from poor gateway boarding growth, which caused the airlines to lower fares to attract passengers. However, the airlines still were not able to attract enough passengers to cover the decrease in revenue from lower fares (conversation with John W. Drake, Dec. 11, 1991). Second, passengers, especially business travelers, have become smarter about buying lower-fare, advance-purchase tickets. If that is true there would not be a major change in market or fare structure, but the yields would be lower (conversation with John W. Drake, Dec. 11, 1991).

One of the other models examined was the logarithmic model. The linear model was chosen over the logarithmic model because the logarithmic model corresponds to a developing market and linear models correspond to a mature market like the North Atlantic market (*1*).

Comparison of Forecasts

Table 3 compares the resulting annual growth rates with the FAA, Boeing, and McDonnell Douglas forecasts. The results of the regression equation are lower. This could be due to several items:

- The data set for the FAA enplanement forecast and this gateway boarding regression model are different.
- The yield was dropped from the model because of the unexplained positive correlations.
- Twelve years of data were examined, and there is a risk of examining only part of an economic cycle, which would yield a different growth rate than a full cycle.
- Encouraging low fares may have matured the market more rapidly, resulting in a lower growth rate.
- RPM growth rates should be higher because they incorporate the increase in the number of people flying as well as the trend toward longer nonstop flights.

Growth Scenarios

To model the changes in Europe from the status quo conditions, an increase in average annual GDP growth rates, which translates into increased gateway boardings, was assumed. Three different levels of growth were assumed for each region. There are several steps in calculating the growth scenarios.

- An increase in the average annual GDP growth rate was assumed for each scenario by region.

TABLE 3 COMPARISON OF VARIOUS FORECASTS

Time Period	Forecast	Average Annual Growth Rate: Gateway Boardings	Rev. Pax. Enplanements	Rev. Pax. Miles	Enplanements or Gateway Boardings Data Source
1989-2000	Federal Aviation Administration	-	4.21%	4.62%	RSPA Form 41
1990-2000	Boeing	-	-	4.8%	unknown
1990-2000	McDonnell Douglas	-	-	4.9%*	unknown
2000-2010	McDonnell Douglas	-	-	4.5%*	unknown
1989-2000	Regression (Case 1)	3.29%	-	-	TSC/INS
1989-2010	Regression (Case 1)	3.26%	-	-	TSC/INS
2000-2010	Regression (Case 1)	3.22%	-	-	TSC/INS

*Revenue Passenger Kilometers
- not available

Sources: McDonnell Douglas, Outlook for Commercial Aircraft 1991-2010
FAA Aviation Forecasts Fiscal Years 1991-2002
Boeing, Current Market Outlook 1991

- The individual GDPs were calculated and used in the appropriate equation to yield gateway boardings.
- The gateway boardings were divided into the European regions under assumed market shares.

Western Europe was assumed to have a 5 percent increase in the average annual GDP growth rate under low growth, 10 percent under medium growth, and 20 percent under high growth for 1990 to 2010.

Eastern Europe and the Soviet Union (separately) were assumed to have the average annual GDP growth rate increased by 5 percent under low growth, 10 percent under medium growth, and 20 percent under high growth for 1990 to 2000. Once these countries stabilize their economies, they have a greater potential for growth; thus from 2000 to 2010 the average annual GDP growth rate was assumed to increase 10 percent under low growth, 20 percent under medium growth, and 40 percent under high growth. The Soviet Union is starting from a predicted negative growth rate due to the current instability in that country (*21*).

The United States was assumed to experience induced economic growth because of European economic growth that would increase markets for United States exports. The United States average annual GDP growth rates were assumed to be 0 percent under low growth, 5 percent under medium growth, and 10 percent under high growth.

The assumed increases in the average annual GDP growth rates for all regions are given in Table 4. The resulting average annual GDP growth rates are given in Table 5.

The percentage of citizens traveling to and from each region in Europe was also estimated. It was assumed that with growth in Eastern Europe, it would gain a greater share of the market. The percentage share of the market by citizenship is given in Tables 6 and 7.

The resulting gateway boardings are given in Table 8 for all the scenarios.

TABLE 4 PERCENT CHANGE IN AVERAGE ANNUAL GDP GROWTH RATE BY SCENARIOS

Region	Year	Status Quo	High Growth	Medium Growth	Low Growth
United States	1991-2000	0.00	10.00	5.00	0.00
	2001-2010	0.00	10.00	5.00	0.00
Western Europe	1991-2000	0.00	20.00	10.00	5.00
	2001-2010	0.00	20.00	10.00	5.00
Eastern Europe (excluding USSR)	1991-2000	0.00	20.00	10.00	5.00
	2001-2010	0.00	40.00	20.00	10.00
Soviet Union	1991-2000	0.00	20.00	10.00	5.00
	2001-2010	0.00	40.00	20.00	10.00

TABLE 5 AVERAGE ANNUAL GDP GROWTH RATE BY SCENARIO

Region	Year	Status Quo	High Growth	Medium Growth	Low Growth
United States	1991-2000	2.60	2.86	2.73	2.60
	2001-2010	2.10	2.31	2.21	2.10
Western Europe	1991-2000	2.60	3.12	2.86	2.73
	2001-2010	2.10	2.52	2.31	2.21
Eastern Europe (excluding USSR)	1991-2000	0.50	0.60	0.55	0.53
	2001-2010	2.40	3.36	2.88	2.64
Soviet Union	1991-2000	-1.02	-0.82	-0.92	-0.97
	2001-2010	1.20	1.68	1.44	1.32

Source: Status Quo GDP Rates from WEFA Group up to 1996, 1997-2010 growth rate from McDonnell Douglas 1991

TABLE 6 PERCENT OF U.S. CITIZEN GATEWAY BOARDINGS BY EUROPEAN REGION

Region	Year	Status Quo	High Growth	Medium Growth	Low Growth
Western Europe	1989	98.28	-	-	-
	2000	98.00	96.00	97.00	97.75
	2010	98.00	94.00	95.50	97.00
Eastern Europe (excluding USSR)	1989	1.45	-	-	-
	2000	1.50	2.50	2.00	1.50
	2010	1.50	3.50	2.75	2.00
Soviet Union	1989	0.27	-	-	-
	2000	0.50	1.50	1.00	0.75
	2010	0.50	2.50	1.75	1.00

- not applicable

Source: 1989 data from U.S. International Air Travel Statistics (TSC/INS)

TABLE 7 PERCENT OF EUROPEAN CITIZEN GATEWAY BOARDINGS BY EUROPEAN REGION

Region	Year	Status Quo	High Growth	Medium Growth	Low Growth
Western Europe	1989	98.08	-	-	-
	2000	98.00	96.00	97.00	97.75
	2010	98.00	94.00	95.50	97.00
Eastern Europe (excluding USSR)	1989	1.25	-	-	-
	2000	1.25	2.50	2.00	1.50
	2010	1.25	3.50	2.75	2.00
Soviet Union	1989	0.67	-	-	-
	2000	0.75	1.50	1.00	0.75
	2010	0.75	2.50	1.75	1.00

- not applicable

Source: 1989 data from U.S. International Air Travel Statistics (TSC/INS)

Trip Distribution

The next step in transportation modeling methodology is to distribute the trips to the regions of their origin or destination. The Fratar method of network balancing or the Gravity Model of attractiveness to distribute the gateway boardings to the individual gateways was desired, but the available data failed to yield a reliable result. Therefore, the distribution of gate-

TABLE 8 TOTAL GATEWAY BOARDINGS UNDER VARIOUS SCENARIOS

Region	Year	Status Quo	High Growth	Medium Growth	Low Growth
Western Europe					
(U.S. citizens)	1989	13572931	-	-	-
	2000	19971993	20395448	20200866	19921044
	2010	27333655	27144925	27050875	27054740
(Western European	1989	11753510	-	-	-
Citizens)	2000	16117568	17365173	16909948	16725934
	2010	22231470	22854920	22431748	22405522
Eastern Europe					
(excluding USSR)					
(U.S. Citizens)	1989	200099	-	-	-
	2000	305694	531131	416513	305694
	2010	418372	1010715	778952	557830
(Eastern European	1989	149677	-	-	-
Citizens)	2000	205581	452218	348659	256664
	2010	283565	850981	645940	461970
Soviet Union					
(U.S. Citizens)	1989	37445	-	-	-
	2000	101898	318679	208256	152847
	2010	139457	721939	495697	278915
(Soviet Citizens)	1989	80845	-	-	-
	2000	123349	271331	174329	128332
	2010	170139	607844	411053	230985
Total	1989	25794507	-	-	-
	2000	36826083	39333980	38258571	37490515
	2010	50576658	53191324	51814265	50989962

- not applicable

Source: 1989 data from U.S. International Air Travel Statistics (TSC/INS)

way boardings was approached by using a market share forecast.

The history of market share indicated that except for New York, most of the market shares varied only slightly, making regression inaccurate (see Table 9). New service at gateways mainly drew market share away from New York (Kennedy and Newark), thus reducing its market share, even though the volume of gateway boardings from the North Atlantic market still grew.

The first step in distributing the gateway boardings to the gateways was to form a regression equation with GDP as an independent variable to predict the gateway boardings (arriving and departing) at New York, Kennedy and Newark combined (see Equation 3).

$$\text{New York total} = -5{,}682{,}648 + 1{,}793.37\ (\text{GDP})$$

$$R^2 = 0.8390 \qquad (0.0180) \qquad (0.0001)$$

$$(\text{probablity} > |T|) \qquad (3)$$

The reduction in market share at Kennedy was distributed to the other gateways by grouping them in four categories: premier gateways, East Coast gateways, internal gateways, and thru-traffic hub gateways, on the basis of characteristics such as major carriers, location, and growth potential.

Premier Gateways

There are three premier gateways in the United States: New York, Chicago, and Los Angeles. They attract traffic from international markets because of their strategic location and the fact that they directly serve the largest population centers in the United States. They are also convenient hubs to serve other nearby population centers. It was assumed that the market share among these gateways will continue to shift to Chicago and Los Angeles. The overall share of these gateways will decrease somewhat as some of New York's market share shifts to other types of gateways.

East Coast Gateways

Several gateways are important because of their East Coast location and convenient service to a fair proportion of the United States domestic market: Boston, Atlanta, Washington, Orlando, Philadelphia, Charlotte, and Raleigh.

Thru-Traffic Hubs

Several United States gateways appear to serve primarily as hubs to bring South and Central American traffic together with European traffic. Others on the West Coast serve Far Eastern markets. These gateways are Miami, Dallas, Seattle, Houston, and San Francisco.

Internal Gateways

Detroit, Cincinnati, Minneapolis, St. Louis, Denver, and Pittsburgh combine to serve only 4 percent of the market. They will continue to be served primarily by domestic flights in the United States or the less frequent flights from London or Paris.

The 1989 market share at each gateway and the predicted market share are given in Table 10 (the percentages do not sum to 100 because his table does not include gateways with only charter service). The gateway boardings by gateway are given in Table 11.

Aircraft Operations

Aircraft operations at each gateway were forecast by calculating the average seats on an aircraft at each gateway from the July 1991 International OAG airline schedules, which include aircraft type (*26*). The aircraft were categorized as follows on the basis of seating capacity:

- B747—400 seats;
- DC10, MD11, and L1011—250 seats; and
- B767 and A310—200 seats.

The average aircraft size at each gateway is given in Table 12. In the North Atlantic market the average number of seats per aircraft was 278. This was higher than the FAA forecast average seats per aircraft of 272 for the Atlantic routes in 1991 because FAA includes only United States carriers, which use a higher percentage of twin-engine wide-bodies than the Europian carriers, although the European carriers are also increasing use of twin-engine wide-bodies. FAA forecast the average seating capacity to decline by 19 seats during the next 6 years from the trend toward using more twin-engine wide-bodies. FAA forecast that, starting in 1998, the number of seats per aircraft would increase by one to two seats per year because congested European airspace would lead to the use

TABLE 9 MARKET SHARE HISTORY OF U.S. GATEWAYS

Gateways	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Kennedy	57.01	56.96	53.87	52.77	54.70	58.17	54.97	49.60	48.52	47.86	46.12	43.96
Chicago	8.05	7.04	6.51	6.04	6.15	5.41	6.11	6.12	7.28	7.59	7.04	7.45
Los Angeles	5.78	5.90	7.77	8.09	6.94	6.54	6.82	6.84	7.57	7.21	6.84	6.71
Miami	3.79	4.47	7.38	8.65	7.11	4.93	4.19	3.41	5.17	5.52	6.60	6.62
Boston	7.17	6.95	7.59	6.47	6.54	6.39	6.33	6.48	5.90	5.93	6.31	6.37
Atlanta	0.94	1.84	2.11	3.40	3.90	3.80	3.77	4.93	4.27	4.60	4.29	4.22
Washington DC	3.50	3.36	2.97	2.48	2.08	2.35	2.55	2.96	3.22	3.51	3.40	3.49
Dallas	1.01	1.63	1.63	1.01	1.43	1.38	1.75	2.53	2.67	3.12	3.09	3.12
Newark	0.35	0.39	0.04	0.35	0.11	0.86	2.63	3.01	3.54	2.72	2.83	3.28
San Francisco	1.54	2.09	2.27	2.52	2.59	2.17	2.45	2.22	2.40	2.63	2.71	2.41
Orlando	0.01	0.03	0.03	0.10	0.08	0.07	0.04	0.22	0.50	0.79	1.67	2.32
Houston	2.12	1.26	1.48	1.67	1.87	1.33	1.34	1.69	2.23	1.91	1.64	1.67
Seattle	2.60	2.15	2.01	1.94	1.67	1.40	1.53	1.45	1.45	1.32	1.26	1.28
Detroit	1.20	0.79	0.53	0.47	0.47	0.98	0.47	1.00	0.76	0.92	0.85	1.23
Philadelphia	0.95	1.15	0.71	0.47	0.45	0.45	0.64	0.78	0.74	0.53	0.62	0.55
Minneapolis	0.96	0.61	0.66	1.04	1.06	0.77	0.96	1.04	1.04	0.88	0.66	0.62
St. Louis	0.06	0.02	1.18	0.22	0.10	0.06	0.29	1.11	0.52	0.64	0.77	0.55
Cincinnati	0.02	0.02	0.01	0.00	0.10	0.01	0.00	0.00	0.00	0.26	0.48	0.44
Baltimore	0.06	0.22	0.06	0.62	1.27	1.59	1.86	3.35	1.29	0.54	0.58	0.42
Denver	0.06	0.05	0.04	0.36	0.10	0.12	0.06	0.05	0.06	0.24	0.41	0.35
Pittsburgh	0.09	0.05	0.01	0.13	0.00	0.00	0.00	0.01	0.09	0.08	0.10	0.12
Charlotte	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.48	0.44
Raleigh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.34
San Diego	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10

Source: U.S. International Air Travel Statistics (TSC/INS)

TABLE 10 FORECAST MARKET SHARE AT UNITED STATES GATEWAYS

		1989		2000		2010		
Type of Gateway	Gateway Name	Market Share	Gateways Served	Market Share	Gateways Served	Market Share	Gateways Served	Forecast Basis
Premier	New York*	47.24	32	42.7	34	40.5	34	Regression of gateway boardings
	Chicago	7.45	18	8.65	20	9.60	23	American and United Airlines Hub, 2nd largest North Atlantic gateway 3rd airport proposed
	Los Angeles	6.71	9	7.85	12	8.55	15	Increased aircraft range Stopover for Far East
East Coast	Boston	6.37	10	6.2	10	6.0	11	Maintain strong gateway
	Atlanta	4.22	7	4.5	8	4.7	9	Delta Hub, Delta expanding in Europe
	Washington**	3.91	4	4.4	5	4.4	6	World political center
	Orlando	2.32	3	2.6	4	2.65	4	Florida attractions and service to South America
	Philadelphia	0.7	2	0.6	2	0.5	2	May keep current traffic
	Raleigh	0.34	1	0.5	1	0.6	2	American Airlines hub, expand service
	Charlotte	0.44	1	0.50	1	0.5	2	Domestic hub will attract
Thru-Traffic Hubs	Miami	6.62	6	6.6	6	6.5	6	Maintain strong gateway
	Dallas	3.12	4	3.8	5	4.2	5	Delta and American Airlines hub, new runways proposed
	San Francisco	2.41	3	2.5	3	2.55	3	Growth on existing routes
	Houston	1.67	4	1.65	4	1.6	4	Maintain, Connects to South America
	Seattle	1.28	3	1.25	3	1.25	4	Stopover on great circle route to Far East
	San Diego	0.1	1	0	0	0	0	Service Discontinued
Internal	Detroit	1.23	3	1.6	4	1.7	5	Northwest Airlines hub foreign carrier service
	Cincinnati	0.65	2	0.7	2	0.8	3	Delta hub
	Minneapolis	0.62	1	0.7	2	0.8	3	Northwest hub, most Europe traffic routed thru other hubs foreign carrier service
	St. Louis	0.55	3	0.40	2	0.1	1	Lose most service if TWA stops flying
	Denver	0.35	1	0.6	2	0.8	3	New airport, United Airlines Hub, increased aircraft capability
	Pittsburgh	0.12	1	0.12	1	0.12	1	Philadelphia continuation

*J.F. Kennedy and Newark combined

**Dulles and Baltimore-Washington combined

Source: 1989 data from U.S. International Air Travel Statistics 1989 (TSC/INS)

TABLE 11 MARKET SHARE OF GATEWAY BOARDINGS (ARRIVALS PLUS DEPARTURES) AT UNITED STATES GATEWAYS

	1989		2000					2010				
	Market	Gateway	Market	Gateway Boardings				Market	Passengers			
Gateway	Share	Boardings	Share	Status Quo	Low	Medium	High	Share	Status Quo	Low	Medium	High
New York	43.96	11276741	39.20	14439745	14696282	14997360	15418920	36.50	18460480	18611336	18912207	19414833
Chicago	7.45	1912087	8.65	3186321	3242930	3309366	3402389	9.60	4855359	4895036	4974169	5106367
Los Angeles	6.71	1721158	7.85	2891633	2943005	3003298	3087717	8.55	4324304	4359642	4430120	4547858
Miami	6.62	1698690	6.60	2431181	2474374	2525066	2596043	6.50	3287483	3314348	3367927	3457436
Boston	6.37	1635050	6.20	2283837	2324412	2372031	2438707	6.00	3034599	3059398	3108856	3191479
Atlanta	4.22	1083614	4.50	1657624	1687073	1721636	1770029	4.70	2377103	2396528	2435270	2499992
Washington DC	3.49	894544	4.00	1473443	1499621	1530343	1573359	4.00	2023066	2039598	2072571	2127653
Newark	3.28	841208	3.50	1289263	1312168	1339050	1376689	4.00	2023066	2039598	2072571	2127653
Dallas	3.12	800948	3.80	1399771	1424640	1453826	1494691	4.20	2124220	2141578	2176199	2234036
San Francisco	2.41	618366	2.50	920902	937263	956464	983350	2.55	1289705	1300244	1321264	1356379
Orlando	2.32	596404	2.60	957738	974753	994723	1022683	2.65	1340281	1351234	1373078	1409570
Houston	1.67	428168	1.65	607795	618593	631266	649011	1.60	809227	815839	829028	851061
Seattle	1.28	327502	1.25	460451	468631	478232	491675	1.25	632208	637375	647678	664892
Detroit	1.23	316079	1.60	589377	599848	612137	629344	1.70	859803	866829	880843	904253
Philadelphia	0.71	183096	0.60	221016	224943	229551	236004	0.50	252883	254950	259071	265957
Cincinnati	0.65	167089	0.70	257853	262434	267810	275338	0.80	404613	407920	414514	425531
Minneapolis	0.62	157935	0.70	257853	262434	267810	275338	0.80	404613	407920	414514	425531
St. Louis	0.55	141527	0.40	147344	149962	153034	157336	0.10	50577	50990	51814	53191
Charlotte	0.44	113767	0.50	184180	187453	191293	196670	0.50	252883	254950	259071	265957
Baltimore	0.42	106793	0.40	147344	149962	153034	157336	0.40	202307	203960	207257	212765
Denver	0.35	89475	0.60	221016	224943	229551	236004	0.80	404613	407920	414514	425531
Raleigh	0.34	86123	0.50	184180	187453	191293	196670	0.60	303460	305940	310886	319148
Pittsburgh	0.12	30716	0.12	44203	44989	45910	47201	0.12	60692	61188	62177	63830
San Diego	0.10	24783	0	0	0	0	0	0	0	0	0	0

Source: 1989 Data from U.S. International Air Travel Statistics 1989 (TSC/INS)

TABLE 12 AVERAGE SEATS PER AIRCRAFT AT EACH GATEWAY

Gateway	1991	2000	2010
New York	277	265	279
Chicago	254	242	256
Los Angeles	274	262	276
Miami	335	323	337
Boston	258	246	260
Atlanta	244	232	246
Washington DC	261	249	263
Newark	319	307	321
Dallas	254	242	256
San Francisco	286	274	288
Orlando	283	271	285
Houston	351	339	353
Seattle	319	307	312
Detroit	250	238	252
Philadelphia	307	295	309
Cincinnati	236	224	238
Minneapolis	380	368	370
St. Louis	300	288	302
Charlotte	260	248	262
Baltimore	225	213	227
Denver	250	238	252
Raleigh	200	200	200
Pittsburgh	300	288	302
San Diego	200	200	200
Total	278	266	280

Note: If currenlly serviced by all B767's and/or A310's (200 seats) then average seats per aircraft remained constant.

of larger aircraft (*13*). This growth rate was extrapolated to 2010. The opeations by gateway are given in Table 13.

Modal Split

Modal split is the choice between different types of transportation. In this study, the choice is actually between types of service rather than mode, because the split is between scheduled and charter traffic or between traffic carried on United States flag carriers and on foreign flag carriers. Charter flights played an important role in the North Atlantic market for many years because of their lower fares. But, as the North Atlantic market matured and became more competitive, the total market share dropped from 19 percent in 1978 to 7 percent in 1989. In the future, charter traffic is expected to stay at its 1989 market share of 7 percent or decrease unless some special niche reopens in the market (e.g., scheduled fares become less competitive).

The other split is between passengers carried on United States and foreign flag carriers. The percentage of United States flag carrier traffic varied slightly, maintaining about 45 percent of the total North Atlantic traffic during this study time frame. There is no reason to expect this to change. The 45 percent is lower than an expected 50/50 split because, when a government enters into an agreement that gives it access to Fifth Freedom traffic, it is, in effect, bartering some of its Third and Fourth Freedom traffic for access to Fifth Freedom traffic. This is not necessarily a one-to-one exchange, but it is inherent in the whole bilateral system that the right to carry traffic between two foreign countries is paid for by the grant to other counries of increased access to the home market (*1*).

CONCLUSIONS

The North Atlantic market is expected to continue growing, but at an average annual growth rate ranging from a low of 3.3 percent to a high of 3.5 percent, compared with an average annual growth rate of 5.3 percent from 1978 to 1989. The market share growth in the North Atlantic should be absorbed at the gateways except in New York, which would experience gateway boarding growth but market share decline.

Under the high-growth scenario, 7 percent more passenger traffic is forecast by 2000 than under the status quo scenario. This change is not as dramatic as was originally anticipated.

TABLE 13 ANNUAL AIRCRAFT OPERATIONS (ARRIVALS PLUS DEPARTURES) AT U.S. GATEWAYS

	Aircraft Operations								
	1989	2000				2010			
Gateway	Estimated	Status Quo	Low	Medium	High	Status Quo	Low	Medium	High
New York	61964	81694	83145	84848	87233	97304	98099	99685	102334
Chicago	11458	19740	20091	20502	21079	27892	28119	28574	29333
Los Angeles	9561	16547	16841	17186	17669	23041	23229	23605	24232
Miami	7718	11285	11485	11720	12050	14346	14463	14697	15087
Boston	9646	13919	14166	14456	14863	17164	17304	17584	18051
Atlanta	6393	10712	10902	11126	11438	14210	14326	14558	14945
Washington DC	5217	8872	9029	9214	9473	11312	11405	11589	11897
Newark	4014	6296	6408	6439	6723	9268	9344	9495	9747
Dallas	4800	8672	8826	9007	9260	12203	12302	12501	12833
San Francisco	3291	5039	5128	5234	5381	6586	6639	6747	6926
Orlando	3208	5298	5393	5503	5658	6916	6972	7085	7273
Houston	1857	2688	2736	2792	2870	3371	3399	3454	3545
Seattle	1563	2249	2289	2335	2401	2896	2920	2967	3046
Detroit	1924	3713	3779	3856	3964	5018	5059	5140	5277
Philadelphia	908	1123	1143	1167	1199	1204	1213	1233	1266
Cincinnati	1078	1726	1756	1792	1843	2500	2521	2561	2629
Minneapolis	633	1051	1069	1091	1122	1558	1570	1596	1638
St. Louis	718	767	781	797	819	246	248	252	259
Charlotte	666	1113	1133	1156	1189	1419	1431	1454	1493
Baltimore	722	1037	1056	1077	1107	1311	1321	1343	1378
Denver	545	1392	1417	1446	1487	2361	2380	2419	2483
Raleigh	655	1381	1405	1434	1474	2231	2250	2286	2347
Pittsburgh	156	230	234	239	246	296	298	303	311
San Diego	189	0	0	0	0	0	0	0	0
Total	141227	207245	210927	215248	221298	265156	267322	271644	278863

Note: Estimated 1989 aircraft operations used 1991 average seats per aircraft

Source: FAA Forecast 1991 - 2002
1989 Load Factor = 65.7%
2000 Load Factor = 66.7%
Extrapolated 2010 Load factor = 68.0%

The direct traffic from Eastern European countries will grow rapidly from just under 500,000 boardings to more than 1.5 million by 2000. This will cause only a slight ripple in the market, which is dominated by Western Europe.

Air traffic control will need to contend with an average annual increase in North Atlantic traffic of about 4.1 percent in operation per year between now and 2000, due to both forecast increases in passengers and a decrease in average seats from 278 to 266 as many European carriers follow the United States carriers' lead and make greater use of twin-engine wide-bodies. Between 2000 and 2010, the operations should increase at a lower rate of 2.3 percent as a result of a lower passenger growth rate and an increase in average seats per aircraft during the latter period.

The major deterrent to growth on both continents will be capacity constraints in the air traffic control system and airports. The transatlantic airways may also become saturated unless the present separation rules are changed or more corridors are used.

FURTHER RESEARCH

This study has raised two important issues that deserve further research.

Inadequacy of the Data

The data are not fine enough to indicate the effects of service changes. Without finer data, it is impossible to predict what percentage of the passengers on a new route shift from a previous routing to the new gateway and what percentage is due to induced demand.

Regression Analysis Anomaly

The other area of further research is the positive correlation between yield and gateway boardings. Research should be done to determine whether this was a product of the data used or there is a more significant underlying reason.

ACKNOWLEDGMENTS

The author wishes to thank the following people and organizations: FAA, for sponsoring the Graduate Research Award Program; TRB program coordinators Tom Burnard and Larry Jenney; TRB monitors Vicki Golich and Bruce McClelland; John Drake of Purdue University for assistance in locating resources; and faculty advisor Robert Whitford. This material is based on work supported under a combination of FAA Graduate Research Award and National Science Foundation Graduate Fellowship.

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