CHAPTER VIII

FORECAST ACCURACY

The Federal Aviation Administration (FAA) has developed econometric forecast models and established a forecast process that attempts to anticipate changes that may affect the future direction of the aviation industry. Using this forecast process, the FAA annually provides 12-year forecasts of aviation demand and activity measures, that are, in turn, used for aviation-related personnel and facility planning. The FAA frequently sponsors workshops to critique techniques and practices currently used by the FAA and other aviation forecasters, and to examine the outlook for the aviation industry and its prospects for future growth. The workshops focus on the forecasting process and ways to improve the reliability and utility of forecasting results.

Tables VIII-1 and VIII-2 provide some measure of the accuracy of FAA projections of aviation demand and workloads at FAA facilities. The tables compare forecasts for both short- and long-term periods. The short-term period, 1 to 5 years, is the critical period for personnel planning; the long-term period, 10 years out, is important for facility planning. The two key FAA forecasts are domestic revenue passenger miles (RPMs) and aircraft handled at FAA en route centers, the former used as one of the predictors of the latter.

For short-term trends, forecast errors normally tend to be modest. However, evaluation of the 2003 forecasts demonstrates the impact that exogenous variables can have on forecast accuracy. As a result of the uncertain environment created by the Iraq War and Severe Acute Respiratory Syndrome (SARS), the 2003 domestic RPM forecast was 0.6 percent higher than the actual results for the year—452.8 billion compared to a forecast of 455.6 billion.[1] Despite these two events, the forecast error is the lowest one-year error recorded since 1997. Over the last 7 years, the average absolute 1-year RPM forecast error is 2.2 percent (2.5 percent for the 6 years prior to 2003, and 2.2 percent for the 5 years prior to 2002). The average 1-year forecast error is 0.2 percent for the 7 years--4 of the forecast years being underestimated and 3 of the forecast years being overestimated.

The forecast for aircraft handled in 2003 was 43.6 million compared to an actual of 43.7 million--resulting in the forecast being 0.4 percent lower than actual. The average absolute 1-year forecast

[1]The definition of air carriers was changed in 2002 to exclude regional/commuters reporting on Form 41. Previous forecasts were rebased using the new historical database and previous forecast growth rates.

TABLE VIII-1

U.S. LARGE COMMERCIAL AIR CARRIERS
SCHEDULED DOMESTIC REVENUE PASSENGER MILES (RPMs)
FORECAST EVALUATION

Year Being Forecast	Actual RPMs (Billions)	Forecast RPMs (Billions) Published -- Years Earlier					
		1 Year	2 Years	3 Years	4 Years	5 Years	10 Years
1996	412.7	399.3	406.1	383.2	405.5	403.0	465.0
1997	434.6	433.2	420.3	426.6	399.9	422.0	507.5
1998	444.7	453.0	451.6	441.0	443.8	414.9	509.2
1999	463.1	455.0	467.6	467.7	455.2	459.5	496.4
2000	490.0	479.0	466.1	482.4	484.1	469.6	492.6
2001	483.8	506.3	493.9	477.9	498.8	501.4	485.0
2002	443.2	425.8	527.0	515.7	505.7	528.8	509.8
2003	452.8	455.6	485.4	548.1	533.2	527.5	499.9
2004		***475.9***	473.0	507.7	571.7	556.2	553.3
2005			***502.6***	489.6	530.6	596.9	567.6
2006				***521.7***	506.5	553.1	622.1
2007					***539.4***	523.9	649.6
2008						***558.8***	650.4
2009							682.4
2013							***667.5***

Year Being Forecast	Forecast RPMs Percent Error Published--Years Earlier					
	1 Year	2 Years	3 Years	4 Years	5 Years	10 Years
1997	(0.3)	(3.3)	(1.8)	(8.0)	(2.9)	16.8
1998	1.9	1.5	(0.8)	(0.2)	(6.7)	14.5
1999	(1.8)	1.0	1.0	(1.7)	(0.8)	7.2
2000	(2.3)	(4.9)	(1.6)	(1.2)	(4.2)	0.5
2001	4.7	2.1	(1.2)	3.1	3.6	0.3
2002	(3.9)	18.9	16.4	14.1	19.3	15.0
2003	0.6	7.2	21.0	17.8	16.5	10.4

Note on how to read this table: In 2002 the FAA forecast 455.6 billion RPMs would occur in 2003. In fact, 452.8 billion RPMs were recorded, meaning the forecast was 0.6 percent higher than actual.

The 2004 forecast is shown in bold italics.

TABLE VIII-2

FAA ARTCC AIRCRAFT HANDLED FORECAST EVALUATION

Year Being Forecast	Actual Activity (Millions)	Forecast Activity Level (Millions) Published -- Years Earlier					
		1 Year	2 Years	3 Years	4 Years	5 Years	10 Years
1996	40.4	41.1	40.7	39.4	40.0	41.1	44.0
1997	41.4	40.9	42.2	41.5	40.3	40.7	46.0
1998	43.2	42.0	41.8	43.4	42.4	41.1	46.1
1999	44.7	44.2	42.6	42.5	44.4	43.4	46.0
2000	46.0	45.7	45.2	43.2	43.5	45.3	47.1
2001	45.2	47.0	46.8	46.2	44.2	44.4	46.6
2002	43.7	43.2	48.1	48.0	47.3	45.2	45.1
2003	43.7	43.6	45.4	49.3	49.0	48.4	45.0
2004		***45.1***	44.8	46.5	50.4	50.1	47.3
2005			***46.8***	46.0	47.6	51.8	49.3
2006				***47.9***	47.0	48.6	48.5
2007					***48.9***	48.0	49.6
2008						***49.9***	54.2
2009							56.7
2013							***55.7***

Year Being Forecast	Forecast Activity Percent Error Published--Years Earlier					
	1 Year	2 Years	3 Years	4 Years	5 Years	10 Years
1997	(1.2)	1.9	0.2	(2.7)	(1.7)	11.1
1998	(2.8)	(3.2)	0.5	(1.9)	(4.9)	6.7
1999	(1.1)	(4.7)	(4.9)	(0.7)	(2.9)	2.9
2000	(0.7)	(1.8)	(6.1)	(5.5)	(1.6)	2.3
2001	4.0	3.5	2.1	(2.3)	(1.8)	3.0
2002	(1.2)	10.1	9.8	8.2	3.4	3.1
2003	(0.4)	3.8	12.7	12.0	10.6	2.9

Note on how to read this table: In 2002 the FAA forecast 43.6 million aircraft would be handled in 2003. In fact, 43.7 million aircraft were recorded, meaning the forecast was 0.4 percent lower than actual.

The 2004 forecast is shown in bold italics.

error over the last 7 years is 1.6 percent (1.8 percent for the 6 years prior to 2003, and 2.0 percent for the 5 years prior to 2002). The average 1-year forecast error is 0.5 percent, with 6 out of the last 7 forecasts underestimating the number of aircraft handled.

The 10-year out forecast errors tend to be larger because of unanticipated external events that have long-term impacts on the aviation system. Contributing external factors impacting the long-term forecasting accuracy of RPMs and aircraft handled include the 1991 Gulf War and the concomitant rise in fuel prices; the outbreaks of terrorism in 1986, 1991, and 2001; the Southeast Asian financial crisis in 1997-98; and the Iraq War along with the outbreak of SARS in 2003. Since the FAA does not use cyclical economic projections in preparing its long-term forecasts, the 2001 economic recession was not considered in any of the forecasts prepared prior to 2001.

For the 7-year period 1997 through 2003, the average absolute 10-year forecast error for domestic RPMs is 9.2 percent and the average absolute 10-year forecast error for aircraft handled is 4.6 percent. The evaluation of forecasts published in 1993 (for 2002) and 1994 (for 2003) indicate that the forecast errors for domestic RPMs was 15.0 and 10.4 percent, respectively. For aircraft handled, the error for the forecasts published in 1993 and 1994 was 3.1 and 2.9 percent, respectively. This statistical comparison highlights the significant impact that unanticipated exogenous events, or the lack thereof, can have on the long-term accuracy of the forecasts. It should be noted, however, that the errors for forecasts prepared prior to 2002 will continue to widen because of the events of September 11th.

THE FAA AVIATION FORECASTING PROCESS

INTRODUCTION

The FAA's forecasting process is a continuous and interactive one that involves the FAA Statistics and Forecast Branch, as well as other FAA offices, government agencies, and aviation industry groups. In addition, the process uses various economic and aviation databases, econometric models and equations, and other analytical techniques.

Forecasting aviation activity is an essential component of the FAA's planning process. The forecasts are used to determine staffing levels and capital expenditures required to accommodate the growth of aviation activity while maintaining a safe, secure, and efficient environment. The forecasts are also used for short-term budget preparation and trust fund analyses as well as cost-benefit and regulatory analyses.

The relative importance of the forecasting function in the planning process can be gauged by examining the National Airspace System (NAS) Architecture. The NAS architecture is a 15-year plan, with the first 5 years focusing on the Capital Investment Plan (CIP). The CIP identifies the short-term requirements for sustaining and improving the safety, security, and efficiency in the NAS. The sizable investments being made in the National Airspace System make it essential for the FAA to develop and use the most accurate and reliable forecasts possible. Thus, the periodic review and evaluation of the forecasting procedures, models, assumptions, and results constitute essential parts of the process.

The FAA considers over 100 variables when producing a set of national forecasts. Of these, four economic independent variables are obtained from sources external to the FAA. Consequently, the FAA has no control over these truly exogenous variables. There are 12 quantifiable air carrier forecast assumptions and 3 quantifiable regional/commuter carrier forecast assumptions. These forecast assumptions are made by the FAA analysts who develop the forecast. There are 83 aviation variables that are not FAA workload measures, but influence the workload measures in one way or another. Finally, there are over 30 aviation variables that are workload measures used by the FAA for policy and planning considerations, and for personnel and investment planning.

Table VIII-3 at the end of this chapter contains a list of the variables, the sources of the data, and their relationship to the forecast process. Forecasts of the economic variables are developed outside the FAA. All other forecasts are developed by the FAA.

Research undertaken in the early- and mid-1970s indicated that some measures of economic activity (such as gross domestic product or total employment) and some measures of prices (for example, airline fares and aviation fuel prices) were useful predictors of aviation activity. Some unique events (including the failure of U.S. air carriers to follow rational pricing policies; e.g., the destructive fare wars of 1986 and 1992; the prolonged depressed state of the general aviation manufacturing industry; and the September 2001 terrorist attacks) have altered the relationships between key aviation variables and the economic variables used previously. It has been difficult, therefore, to produce economic or econometric models that predict aviation activity with the same degree of reliability as the models developed in earlier periods. Thus, for the present, the forecasters must rely to a greater degree on subjective judgment, evaluation, and expertise than was required previously. This is not at all unusual in times when significant structural changes are taking place in a volatile industry.

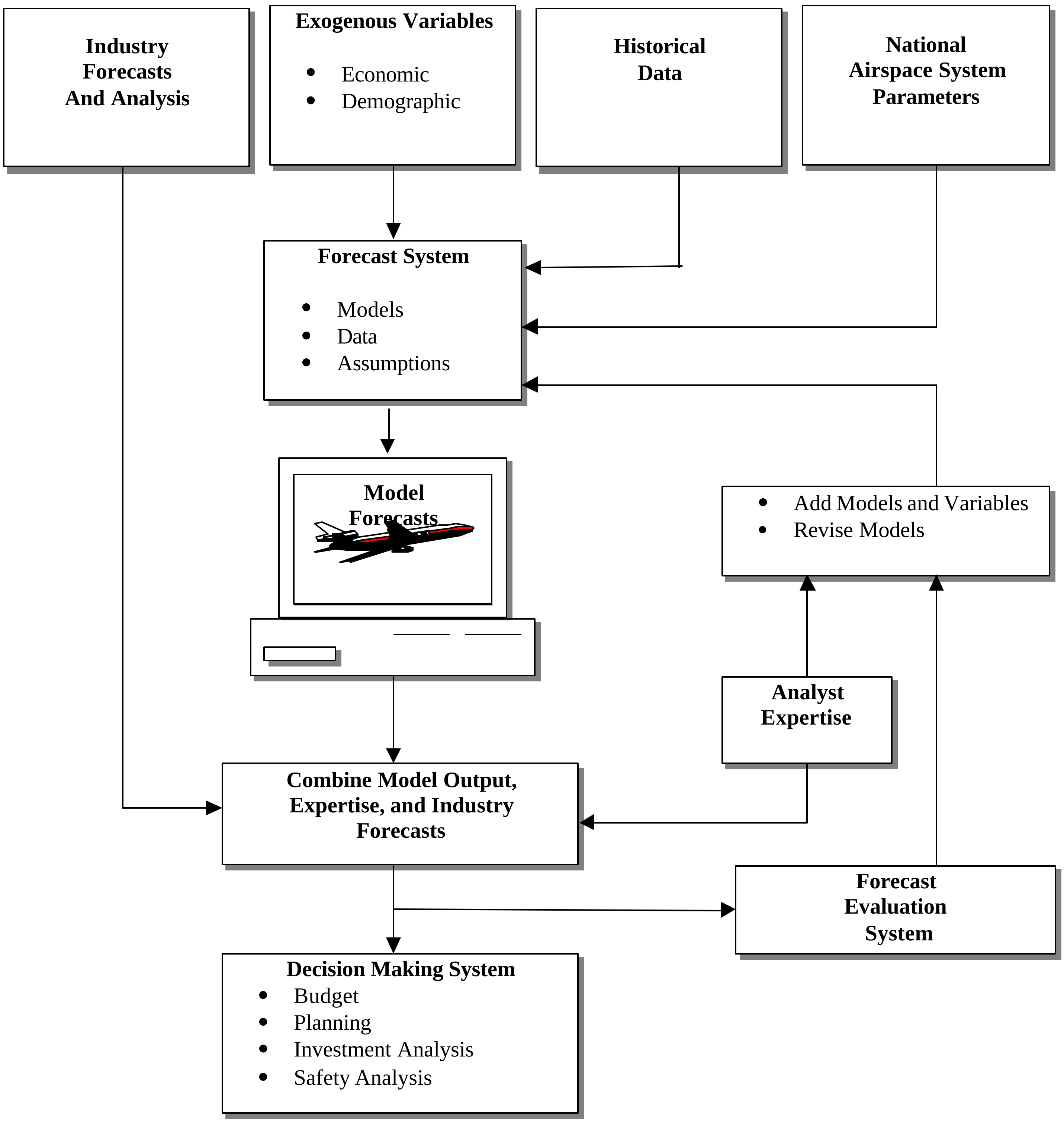
THE FAA FORECASTING PROCESS

During the past several years the FAA has adopted a decision-theoretic forecasting system. The approach is generally accomplished in two stages. Initially, projections are made with the use of econometric and time-series models. The model equations and outcomes are then adjusted based upon "expert industry opinion" to arrive at posterior forecasts for use in the decision-making process. The flow diagram on page VIII-6 shows a generalized version of the FAA aviation forecasting process.

In light of the Iraq War and the outbreak of SARS, this year's forecast process was similar to the process put in place after September 11th. Near-term forecasts (2004) were developed utilizing assumptions regarding capacity and expert judgment as to the degree and timing of the industry recovery. For the remaining years (2005-2015) the air carrier forecasts were based on results derived from econometric and time-series models. The regional/commuter forecast combined assumptions relating to capacity as well as results from econometric models. It is believed that optimum policy forecasts can only be achieved by combining model forecasts and judgment.

In general, these models are relatively simple descriptions of very complex systems, they cannot account for all the political, social, psychological, and economic factors and their interactions that will lead to a particular set of outcomes. Therefore, it is essential to use judgment to account for the complexities of the operating environment. This can be accomplished by adjusting the exogenous variables, adjusting the model outputs, or revising the models initial parameter estimates.

FAA FORECASTING SYSTEM



FORECASTING EVALUATION

It is important to evaluate the forecast results and to determine the causes of the deviations of the forecast values from the actual values observed in the real world. Large forecast errors can lead to inefficient allocation of resources which, in turn, could lead to capacity constraints and delays or to excess capacity in the National Airspace System. For this reason, the FAA continuously evaluates the forecasting process and its results.

The analysis of the errors generally identifies the causes of the deviations and helps determine the proportion due to improper model specifications, erroneous forecasts of independent variables, erroneous forecast assumptions, or incorrect judgments and opinions. If warranted, the forecast error analysis may lead to a reformulation or respecification of the model and to additions or deletions of independent variables, revisions of forecast assumptions, and/or changes in analysts' opinions and judgments about future events.

The evaluation of the forecast process proceeds on several fronts. On a monthly basis, the FAA tracks its short-term forecasts of commercial air carrier traffic (enplanements and RPMs), aircraft operations, instrument operations, IFR aircraft handled, and flight services vis-à-vis actual carrier traffic data reported to DOT and actual activity counts at the FAA facilities. This tracking system alerts FAA management to unexpected deviations from the trends suggested by the forecasts. Inquiries are then initiated to determine the cause(s) of the differences and revised short-term forecasts may be generated, if necessary.

To help the analysts make correct decisions and informed judgments when developing the forecast assumptions, the FAA meets with industry representatives to discuss industry trends, recent developments, and possible future courses of events. Every two years, for example, in cooperation with the National Academy of Sciences, Transportation Research Board (TRB), the FAA sponsors an International Workshop on Future Aviation Activities--"Forecast Assumptions Workshop." This "by invitation only" workshop is attended by some 120-140 industry planners and forecasters representing airlines, aircraft manufacturers, engine manufacturers, trade associations, academic institutions, and other industry groups. The 13th International Workshop on Future Aviation Activities is scheduled to be held in Washington, DC on September 29 through October 1, 2004.

Workshop participants are divided into nine concurrent panels to discuss sectoral trends and problems in the following areas: (1) domestic air carriers, (2) international air carriers, (3) regional and commuter airlines, (4) air cargo, (5) airports and infrastructure, (6) commercial aircraft fleets and manufacturers, (7) light personal and general aviation, (8) business aviation, and (9) vertical flight (rotorcraft).

The subgroups are instructed to critique FAA aviation forecasts for their specific areas. Each subgroup is asked to identify specific assumptions about the short- and long-term future trends of the economic and aviation variables that are important to their segments of the industry, to indicate why these trends are considered important, and to explain why specific trends are anticipated. After discussing the FAA forecast and the group's assumptions, each group attempts to reach a consensus about the key variables affecting the industry and the most likely future courses of these variables. The findings of these workshops are published by the TRB.

In past years, the TRB workshops have provided discussions beneficial to the participants, while at the same time providing FAA analysts with a benchmark for preparing future aviation forecasts and for evaluating forecasts prepared by other organizations. These meetings are even more valuable for gaining insight, as the industry continues to be impacted by major world events.

Throughout the year formal and informal meetings with individuals and representatives of specific aviation groups are held, and this is another method used by the FAA to solicit input and comments on FAA forecasts. Meetings are held regularly with aircraft manufacturers and with members of the various aviation trade associations. In addition, FAA analysts maintain one-on-one contact with many industry representatives and also attend annual conferences/meetings conducted by the aviation trade associations.

The largest setting for industry dialogue and critique regarding the FAA aviation forecast process is the annual FAA Aviation Forecast Conference. Now in its 29th year, the conference is used as a forum to release the forecast results for the upcoming 12 years. The last conference was held March 18-19, 2003, in Washington, DC. Participants and attendees were over 500 strong and included airline and airport executives, aircraft and engine manufacturers, trade associations, aviation consultants, consumer groups, industry representatives, and the news media. To the maximum extent possible, the FAA responds to questions raised about the forecasts both during and after the conference.

An important part of the conference is the opportunity for various leaders and experts in the aviation industry to make technical presentations on a variety of topics of interest to the aviation community. The FAA also receives valuable information and insights through the papers presented at the forecast conference. Last year's proceedings can be found at the following address: http://apo.faa.gov/Conference/2003/agenda.htm.

Finally, the FAA requests FAA regional and state participation in the evaluation of the forecast process. For example, the aircraft handled and terminal area forecasts are distributed to FAA regional offices for review and comment. The comments and changes are incorporated in final facility-level reports. In the case of terminal area forecasts, the FAA regions can make changes directly on personal computers. However, the final facility-level forecasts derived by this procedure must be consistent with the national forecasts.

Periodically, the FAA prepares technical reports comparing forecast accuracy of key workload measures with forecast accuracy of economic variables prepared by the major forecasting services. Based on the results of these studies, the FAA forecasts compare favorably with those produced by the major forecasting services.

TABLE VIII-3

FAA AVIATION FORECAST VARIABLES AND DATA SOURCES

TYPES OF VARIABLES AND VARIABLE NAMES	HISTORICAL DATA SOURCES
ECONOMIC	
ECONOMIC ASSUMPTIONS	
Gross Domestic Product (GDP)	OMB, CBO, Global Insight
Consumer Price Index – All Urban Consumers (CPIU)	OMB, CBO, Global Insight
Oil and Gas Deflator	OMB, Global Insight
Energy Deflator	CBO
AIR CARRIER	
FORECAST ASSUMPTIONS	
Domestic Operations	
Average seats per aircraft	BTS/computed
Average passenger trip length[2]	BTS/computed
Revenue per passenger mile (current $)	BTS/computed
Revenue per passenger mile (2003 $)	Computed
Average jet fuel prices (current $)	BTS/computed
Average jet fuel prices (2003 $)	Computed
International Operations (U.S. Carriers)	
(Same as Domestic)	(Same)
SCHEDULED PASSENGER TRAFFIC	
Domestic	
Revenue passenger miles (RPMs)	BTS
Revenue passenger enplanements	BTS
Available seat miles (ASMs)	BTS
Load factors	Computed
International (U.S. Carriers)	
RPMs by World Regions	BTS
Revenue passenger enplanements by World Regions	BTS

[2] Result of econometric models for RPMs and Enplanements

FAA AVIATION FORECAST VARIABLES AND DATA SOURCES (CONTINUED)

TYPES OF VARIABLES AND VARIABLE NAMES	HISTORICAL DATA SOURCES
AIR CARRIER (CONTINUED)	
SCHEDULED PASSENGER TRAFFIC (CONTINUED)	
International (U.S. Carriers)	
ASMs by World Region	BTS
Load factors	Computed
International (U.S. and Foreign Flag Carriers)	
Passenger enplanements	INS
SCHEDULED AND NONSCHEDULED CARGO TRAFFIC	
Domestic and International (U.S. Flag Carriers)	
Total Air Cargo Revenue Ton Miles (RTMs)	BTS
Air Cargo RTMs: All-Cargo Carriers	BTS
Air Cargo RTMs: Passenger Carriers	BTS
FLEET	
Large jet aircraft: Passenger	FAA
Large jet aircraft: Cargo	FAA
HOURS FLOWN BY EQUIPMENT TYPE	
Large jet aircraft	BTS
FUEL CONSUMED	
Jet	
Domestic air carriers	BTS
International air carriers	BTS
General aviation	FAA/APO-110
Aviation Gasoline	FAA/APO-110

FAA AVIATION FORECAST VARIABLES AND DATA SOURCES (CONTINUED)

TYPES OF VARIABLES AND VARIABLE NAMES	HISTORICAL DATA SOURCES
REGIONAL/COMMUTER	
FORECAST ASSUMPTIONS	
Average seats per aircraft	BTS/Computed
Average passenger trip length	BTS/Computed
Average load factor	BTS/Computed
PASSENGER TRAFFIC	
Revenue passenger enplanements	BTS
RPMs	BTS
ASMs	BTS
FLEET	
Aircraft less than or equal to 70 seats	FAA
HOURS FLOWN	
Total for all passenger airlines	BTS
GENERAL AVIATION	
FLEET	
Active aircraft by equipment type	FAA/APO-110
NUMBER OF AIRCRAFT BY REGION	
Total aircraft in each of nine FAA Regions	FAA/APO-110
HOURS FLOWN	
Hours flown by equipment type	FAA/APO-110
FUEL CONSUMED	
Fuel consumed by equipment type	FAA/APO-110
PILOTS	
Active pilots by certificate type	FAA/Mike Monroney Aeronautical Center

FAA AVIATION FORECAST VARIABLES AND DATA SOURCES (CONTINUED)

TYPES OF VARIABLES AND VARIABLE NAMES	HISTORICAL DATA SOURCES
FAA WORKLOAD MEASURES	
FAA TOWERS	
Number of FAA Towers	FAA/APO-130
Number of Contract Towers	FAA/ATP-140
Aircraft Operations:	
Itinerant and local operations by aviation category	FAA/APO-130
Instrument operations by aviation category	FAA/APO-130
Non-IFR Instrument Operations:	
Terminal control areas	FAA/APO-130
Expanded radar service areas	FAA/APO-130
AIR ROUTE TRAFFIC CONTROL CENTERS	
IFR departures by aviation category	FAA/APO-130
IFR overs by aviation category	FAA/APO-130
FLIGHT SERVICE STATIONS	
IFR-DVFR flight plans originated	FAA/APO-130
VFR flight plans originated	FAA/APO-130
Pilot briefings	FAA/APO-130
Aircraft contacted by aviation category	FAA/APO-130
IFR-DVFR aircraft contacted	FAA/APO-130
VFR aircraft contacted	FAA/APO-130

FAA AVIATION FORECAST VARIABLES AND DATA SOURCES (CONTINUED)

TYPES OF VARIABLES AND VARIABLE NAMES	HISTORICAL DATA SOURCES
TERMINAL AREA FORECASTS (3,404 Towered and Nontowered Airports)	
ENPLANEMENTS	
U. S. Flag Carrier	BTS
Foreign Flag Carrier	INS/BTS
Regional/Commuter	BTS
Air Taxi	FAA/VNTSC
OPERATIONS	
Towered Airports:	
Aircraft operations by aviation segment	FAA/APO-130
Scheduled commuter	OAG
Nontowered Airports	FAA/NFDC
Scheduled commuter	OAG

APO-110--Statistics and Forecast Branch, FAA
APO-130--Information Systems Branch, FAA
ATP-140--Contract Air Traffic Services, FAA
BTS--Bureau of Transportation Statistics, Department of Transportation
CBO--Congressional Budget Office
Global Insight--formerly DRI-WEFA, Inc.
INS--Immigration and Naturalization Service, Department of Justice
NFDC--National Flight Data Center, FAA
OAG--North American Official Airline Guide
OMB--Office of Management and Budget
VNTSC--Volpe National Transportation Systems Center, Research and Special Programs Administration, Department of Transportation