U.S. Airport Infrastructure Funding and Financing

Issues and Policy Options Pursuant to Section 122 of the 2018 Federal Aviation Administration Reauthorization Act: Appendixes

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Preface

Passenger air travel is at an all-time high. In 2018, passengers boarded (enplaned) domestic flights more than 780 million times at the nation's 506 *commercial service airports*, which are publicly owned airports that serve at least 2,500 enplanements per year and receive scheduled passenger service. Demand for air travel has increased over time, and projections suggest that trend will continue. In response, commercial service airports have been investing in the infrastructure required to meet future demand for air travel. A key question for Congress is whether current levels of spending will be sufficient under existing federal policies to enable commercial service airports to make appropriate and timely infrastructure investments to meet future demand.

Congress authorized a study of commercial service airports' infrastructure needs and existing financial resources in the Federal Aviation Administration (FAA) Reauthorization Act of 2018. Section 122 of the Act directed the FAA to engage an independent research organization to consider these issues, as well as related concerns, and to "make recommendations on the actions needed to upgrade the national aviation infrastructure system to meet the growing and shifting demands of the 21st century." RAND, a nonprofit and nonpartisan policy research organization, was selected by the FAA through a competitive qualifications-based process to conduct this study. These appendixes present additional information to supplement the main report.[1] These appendixes and the main report, like all RAND reports, are published independently by the RAND Corporation and do not require the consent or approval of the FAA or any other government agency.

The RAND research team commenced the study in late December 2018. Throughout the study period, we gathered and analyzed data, reports, and other materials relevant to funding, financing, and infrastructure conditions at U.S. airports. As required in Section 122(b) of the Act, we convened a panel of national experts drawn from a variety of stakeholder perspectives. The first meeting of this panel occurred in March 2019, and a second meeting occurred in August 2019. We also sought the perspectives of additional experts in the field. The report is the product of these research activities and fulfills the mandate of Section 122 that the independent organization (RAND) submit a report of its findings directly to Congress and the Secretary of Transportation by January 2020.

The primary audience for the report is members of Congress and their staffs as well as officials in the U.S. Department of Transportation, which includes the FAA. However, the report has been written to make this important but complex topic accessible to a broader audience. To this end, the purposes of the report are to explain how airports in the United States currently fund

[1] The main report (Miller et al., 2020) is available at www.rand.org/t/rr3175.

and finance their infrastructure needs, assess the adequacy of those mechanisms for maintaining a well-functioning aviation system, and present findings and recommendations to policymakers. In support of these purposes, we describe airports' planning and business processes; examine airports' interactions with the airline industry, local and state governments, and other stakeholders; and describe the federal government's role in funding, regulating, and otherwise affecting the decisionmaking behind airport infrastructure investment.

RAND Social and Economic Well-Being

RAND Social and Economic Well-Being (SEW), a division of the RAND Corporation, seeks to actively improve the health, social, and economic well-being of populations and communities throughout the world. This work has been managed within SEW's Community Health and Environmental Policy program, which focuses on such topics as infrastructure, science and technology, community design, community health promotion, migration and population dynamics, transportation, energy, and climate and the environment, as well as other policy concerns that are influenced by the natural and built environment, technology, and community organizations and institutions that affect well-being. For more information, email chep@rand.org.

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Abbreviations

ACI	Airports Council International
ACIP	Airports Capital Improvement Plan
AIP	Airport Improvement Program
ALP	Airport Layout Plan
ASQP	Airline Service Quality Performance
BTS	Bureau of Transportation Statistics
CATS	Certification Activity Tracking System
CFC	customer facility charge
CIP	capital improvement plan
DB1B	Airline Origin and Destination Survey
FAA	Federal Aviation Administration
FACT	Future Airport Capacity Task
FY	fiscal year
HHI	Herfindahl-Hirschman Index
IATA	International Air Transportation Association
ICAO	International Civil Aviation Organization
IQR	interquartile range
LCC	low-cost carrier
LOS	level of service
NPIAS	National Plan of Integrated Airport Systems
NPR	National Priority Rating
O&D	origin and destination
OPSNET	Operations Network
PFC	passenger facility charge
TAF	Terminal Area Forecast
TRB	Transportation Research Board

TSA	Transportation Security Administration
ULCC	ultra-low-cost carrier
USDOT	U.S. Department of Transportation

Appendix A. Section 122 of the 2018 Federal Aviation Administration Reauthorization Act

In this appendix, we reproduce verbatim the statutory language authorizing this study.

TITLE I—AUTHORIZATIONS

. . .

Subtitle B—Passenger Facility Charges

. . .

SEC. 122. FUTURE AVIATION INFRASTRUCTURE AND FINANCING STUDY.

(a) Future Aviation Infrastructure and Financing Study.--Not later than 60 days after the date of enactment of this Act, the Secretary of Transportation shall enter into an agreement with a qualified organization to conduct a study assessing the infrastructure needs of airports and existing financial resources for commercial service airports and make recommendations on the actions needed to upgrade the national aviation infrastructure system to meet the growing and shifting demands of the 21st century.

(b) Consultation.--In carrying out the study, the qualified organization shall convene and consult with a panel of national experts, including representatives of--

(1) nonhub airports;
(2) small hub airports;
(3) medium hub airports;
(4) large hub airports;
(5) airports with international service;
(6) nonprimary airports;
(7) local elected officials;
(8) relevant labor organizations;
(9) passengers;
(10) air carriers;
(11) the tourism industry; and
(12) the business travel industry.

(c) Considerations.--In carrying out the study, the qualified organization shall consider--

(1) the ability of airport infrastructure to meet current and projected passenger volumes;

(2) the available financial tools and resources for airports of different sizes;

(3) the available financing tools and resources for airports in rural areas;

(4) the current debt held by airports, and its impact on future construction and capacity needs;

(5) the impact of capacity constraints on passengers and ticket prices;

(6) the purchasing power of the passenger facility charge from the last increase in 2000 to the year of enactment of this Act;

(7) the impact to passengers and airports of indexing the passenger facility charge for inflation;

(8) how long airports are constrained with current passenger facility charge collections;

(9) the impact of passenger facility charges on promoting competition;

(10) the additional resources or options to fund terminal construction projects;

(11) the resources eligible for use toward noise reduction and emission reduction projects;

(12) the gap between the cost of projects eligible for the airport improvement program and the annual Federal funding provided;

(13) the impact of regulatory requirements on airport infrastructure financing needs;

(14) airline competition;

(15) airline ancillary fees and their impact on ticket pricing and taxable revenue; and

(16) the ability of airports to finance necessary safety, security, capacity, and environmental projects identified in capital improvement plans.

(d) Large Hub Airports.--The study shall, to the extent not considered under subsection (c), separately evaluate the infrastructure requirements of the large hub airports identified in the National Plan of Integrated Airport Systems (NPIAS). The evaluation shall--

(1) analyze the current and future capacity constraints of large hub airports;

(2) quantify large hub airports' infrastructure requirements, including terminal, landside, and airside infrastructure;

(3) quantify the percentage growth in infrastructure requirements of the large hub airports relative to other commercial service airports;

(4) analyze how much funding from the airport improvement program (AIP) has gone to meet the requirements of large hub airports over the past 10 years; and

(5) project how much AIP funding would be available to meet the requirements of large hub airports in the next 5 years if funding levels are held constant.

(e) Report.--Not later than 15 months after the date of enactment of this Act, the qualified organization shall submit to the Secretary and the appropriate committees of Congress a report on the results of the study described in subsection (a), including its findings and recommendations related to each item in subsections (c) and (d).

(f) Definition of Qualified Organization.--In this section, the term “qualified organization” means an independent nonprofit organization that recommends solutions to public policy challenges through objective analysis.

Appendix B. Overview of Study Approach

This appendix provides an overview of our approach to the research and analysis underlying this report. Additional details are provided within the individual chapters or in other appendixes.

Literature Review

We tapped the vast trove of scholarly literature on the business of airports and airlines and their relationship to one another. However, given the financial and technological changes that routinely have occurred in air travel over the past few decades, some of the findings of this research have been overtaken by events and are no longer valid. For example, one dominant response among airlines to the growing number of enplanements in the past decade following the 2008 financial crisis has been to increase the size of aircraft on high-demand routes, thus increasing capacity while lowering the number of flights. Running fewer flights reduces congestion on runways and requires fewer (albeit larger) gates.

Understanding the nature of competition in the airline industry is important to this study from several angles. First, increasing competition and lowering fares was the primary motivation for the Airline Deregulation Act of 1978 (Pub. L. 95-504). Second, increasing competition also was a primary motivation for Congress to initiate the passenger facility charge (PFC) program. Finally, the status of airline competition at a particular airport can have a bearing on that airport's ability to raise capital for improvements and expansion. We therefore examined the literature on metrics of competition within industry generally and the airline industry in particular.

Expert Elicitation

Following the specific requirement of Section 122(b) that the independent organization conducting the study "convene and consult with" experts (see the full text in Appendix A), we assembled a panel that included representatives of

- non-hub airports
- small-hub airports
- medium-hub airports
- large-hub airports
- airports with international service
- nonprimary airports
- local elected officials
- relevant labor organizations
- passengers

- air carriers
- the tourism industry
- the business travel industry.

We identified 16 individuals who covered one or more of the categories listed above through internet searches and consultations with knowledgeable individuals in the industry and at the Federal Aviation Administration (FAA). The decision to tap a particular individual was exclusively the RAND team's decision. The names of the members of our expert panel are listed in the Acknowledgments.

We convened the expert panel for daylong sessions on March 20, 2019, and August 12, 2019. In between meetings, we had additional contact with members on an as-needed basis as we sought to identify additional experts to address specific questions related to financing, needs surveys, master planning, and other topics. At the March 20 meeting of the panel, the RAND team solicited views from panel members on the many questions raised in the 21 issues of Section 122(c). Panel members were invited to follow up with us after that meeting to provide us with further amplification of their views or additional citable sources of information. On July 15, we provided panel members with a draft copy of this report for the express purpose of soliciting their views about its structure, content, tone, and balance. After receiving written feedback on the July draft, we used the August 12 meeting of the panel to delve into panel members' comments in more depth.

In addition to soliciting the views of the members of the expert panel, the RAND team sought other experts on specific technical questions. We have included their names in the Acknowledgments section as well. Most of these discussions were conducted through teleconferencing. We also maintained regular contact with FAA staff, who were in a position to help us quickly retrieve data from FAA databases and to connect us to the experts within the FAA who could explain the value and limitations of the data.

Data Sources

We drew data from a wide variety of sources, mainly from the FAA and the U.S. Department of Transportation (USDOT). We briefly summarize these sources in Table B.1 and describe select data sets in more detail below

Table B.1. Summary of Key Sources of Data

Data Source	Citation	Use
Certification Activity Tracking System (CATS)	FAA, undated a	Revenues and expenditures of airports from 1990 to present
Airline Service Quality Performance (ASQP)	USDOT, 2019	Flight on-time performance and delays
Electronic Municipal Market Access	Municipal Securities Rulemaking Board, undated	Municipal bond issues
T-100 database	Bureau of Transportation Statistics (BTS), 2019b	Enplanements, total, by air carrier, and by airport
T1: U.S. Air Carrier Traffic and Capacity Summary by Service Class	BTS, 2019a	Revenue passenger miles
Airline Origin and Destination Survey (DB1B)	BTS, 2019c	Airfares
Airport Improvement Program (AIP) Grant History Look Up	FAA, 2019c	AIP grants
PFC Approved Locations, Collections, and Expiration Dates	FAA, 2019e	PFC rates and starting and ending collection dates
Terminal Area Forecast (TAF)	FAA, 2019b	Enplanement projections by airport
Operations Network (OPSNET)	FAA, undated b	Flight on-time performance and delays

In contrast to the wealth of data on airport expenditures and airline operations, there is a dearth of data on other relevant topics. For example, there is no comprehensive list of use-and-lease agreements, rate-setting mechanisms, airport expansion plans, or airline bankruptcies and mergers. Our information in these areas was taken either from reliable but admittedly not comprehensive sources or from anecdotal evidence in the press. We did not have sufficient time or resources to contact all 61 large- and medium-hub airports to gather comprehensive information on each one.

The T-100 database is maintained by the BTS and contains domestic and international airline market and segment data. In other words, the T-100 data are a full count of commercial flight segments that originate or arrive at U.S. airports, including the number of passengers. The data elements for each segment include

- the origin airport
- the destination airport
- whether a passenger transited an airport between its origin and destination (this distinguishes T-100 market data from T-100 segment data)
- the number of enplaned passengers
- the ID of the airline that operated the flight.

Both T-100 segment and market data contain these elements; however, they count enplanements differently. T-100 market data count passengers when they board the plane and remain on the same flight number. T-100 segment data record the number of passengers "transported" on a segment. For example, assume 100 people take a flight from Point A to Point B. At Point B, 30 passengers deplane and 50 new passengers board. At Point C, all 120 passengers disembark. Table B.2 displays how T-100 Segment and T-100 Market would each record the number of passengers. Note that the 70 passengers who stayed on from Point A to Point C were counted twice in the segment data and once in the market data. T-100 segment data is thus expected to report a higher number of enplanements than the T-100 market data.

Table B.2. Example of the Difference Between T-100 Segment and Market Enplanement Data

	Segment	Market
Point A to Point B	100	30
Point B to Point C	120	50
Point A to Point C	Not a segment	70
Total Enplanements	220	150

The T-100 market and segment data are further split into international and domestic airlines and flights (i.e., the location of the origin and destination [O&D]). Specifically, they are broken into four groups:

- domestic airline and domestic flight
- domestic airline and international flight
- international airline and domestic flight
- international airline and international flight.

A domestic flight occurs when both the origin and destination are within the United States. If at least one point of service is within the United States but not all are, then the flight is considered international. There are international airlines that operate domestic flights, but they are few in number.

For this report, our count of enplanements uses T-100 segment data, and specifically those data associated with domestic flights. This count includes all passengers who boarded flights in the United States, for all flight segments (a passenger who originated in Washington and changed planes in Kansas City en route to Seattle is considered two enplanements), flights to both domestic and international airports, and flights on both U.S. and foreign airlines. It does not include passengers who arrived at U.S. airports from foreign airports. Although these passengers use U.S. airport infrastructure, most airports have roughly equal numbers of enplanements and arrivals over any period of time over a few days, and including arriving passengers in a count of enplanements would overcount passengers at airports with high proportions of international flights.

The CATS database, managed by the FAA, contains financial information from 1994 to the present of all commercial service airports, per congressional mandate. CATS contains airport-level information on revenues, expenditures, restricted and unrestricted assets, indebtedness, debt service, and other data used throughout the report.

The ASQP database, maintained by the USDOT BTS, contains airline on-time performance data from June 2003 to the present for nonstop commercial flights submitted by reporting carriers.[2] ASPQ reports the minutes of gate arrival delays, gate departure delays, and block delays (those that occur between departure and arrival). For gate arrival delays, ASQP also contains the cause of delay, reported in minutes. These causes include carrier, national aviation system, security, extreme weather, and late-arriving aircraft. The OPSNET database, maintained by the FAA, is the FAA's primary data source for air traffic operations and delays. OPSNET contains operations data (*operation* is defined as an arrival or departure) at individual airports from 1989 through the present. OPSNET also contains departure and airborne delays of 15 minutes or more that aircraft experience while under FAA control. Delay records stretch from 1999 through the present. The FAA records the cause of a delay in OPSNET as one of five categories—weather, volume, equipment, runways, or other—and matches these categories, by flight, to delays reported as national aviation system delays in ASQP. For more information on the cause of delay information in OPSNET and its relationship with the ASQP database, see Figure 8.6 in the main report.

The TAF is the FAA's official forecast for aviation activity. Published annually, the TAF forecasts without consideration of capacity constraints, providing outlooks for enplanements, airport operations, Terminal Radar Approach Control operations, and based aircraft (FAA, 2019b). The most recent TAF includes historical data on total enplanements and total operations by airport, beginning in 1990, and projections from the present to 2045. For large- and medium-hub airports, the TAF provides both optimistic and pessimistic scenarios in addition to its baseline forecast, as shown in Figure 8.3 in the main report. These forecasts are made by aggregating O&D-level forecasts. These O&D forecasts are generated using the BTS DB1B data (a 10 percent sample of tickets) and other sources, with forecasts estimated via regression analysis using fares, fleet mix forecasts, regional demographics, and regional economic factors. For the first two years of forecasts, the TAF also incorporates airline schedules for individual airports (FAA, 2019b).

The DB1B data set is a 10 percent sample of airline tickets from reporting carriers and is collected quarterly, dating from 1993 to the present. There are three subsets within the DB1B: DB1B Coupon, DB1B Market, and DB1B Ticket. This report uses the DB1B Market data, which capture the reporting carrier, O&D airports, prorated market fare, number of market coupons, and other data points for each domestic itinerary sampled, as well as the DB1B Ticket data, which capture the reporting carrier, itinerary fee, number of passengers, origin airport, round-trip

[2] In 2018, the definition of a *reportable flight* was changed to include all flights to or from any primary airport by a reporting carrier per 14 CFR § 234.2. In the same year, the definition of a *reporting carrier* was expanded from an air carrier that accounted for at least 1 percent of domestic scheduled-passenger revenue to 0.05 percent of domestic scheduled-passenger revenue.

indicator, and miles flown for each domestic itinerary. Within this report, these data sets are primarily used to estimate competition in the aviation industry over time.

Appendix C. Characteristics of Large- and Medium-Hub Airports

As a supplement to the information presented in Chapter Three of the main report, this appendix provides further detail on airport ownership and configuration. Table C.1 summarizes the ownership and airline/airport agreement type for large- and medium-hub airports. Where the operating entity is different from the owner, we list the operating entity in parentheses.

Table C.1. Characteristics of Large- and Medium-Hub Airports

Location	IATA Code	Airport Name	Overall Method (as of 2017)	Airport Owner	More than One Large or Medium Hub in Metro Area?	Hub or Focus City Number of Airlines	Fortress Hub for an Airline
Large Hubs							
Atlanta	ATL	Hartsfield-Jackson Atlanta International Airport	Compensatory	City of Atlanta	No	2	Delta
Baltimore	BWI	Baltimore/Washington International Thurgood Marshall Airport	Compensatory	Maryland Aviation Administration	Yes	1	
Boston	BOS	Boston Logan International Airport	Compensatory	Massachusetts Port Authority	No	2	
Charlotte	CLT	Charlotte Douglas International Airport	Hybrid	City of Charlotte	No	1	American
Chicago	MDW	Chicago Midway International Airport	Residual	City of Chicago	Yes	1	Southwest
Chicago	ORD	O'Hare International Airport	Residual	City of Chicago	Yes	3	
Dallas	DFW	Dallas/Fort Worth International Airport	Compensatory	Cities of Dallas and Fort Worth	Yes	1	American
Denver	DEN	Denver International Airport	Hybrid	City/County of Denver	No	2	United
Detroit	DTW	Detroit Metropolitan Airport	Residual	Wayne County Airport Authority	No	2	Delta
Fort Lauderdale	FLL	Fort Lauderdale–Hollywood International Airport	Residual	Broward County	Yes	3	
Honolulu	HNL	Daniel K. Inouye International Airport	Hybrid	Hawaii Department of Transportation	No	0	
Houston	IAH	George Bush Intercontinental Airport	Compensatory	City of Houston	Yes	1	United
Las Vegas	LAS	McCarran International Airport	Hybrid	Clark County	No	2	
Los Angeles	LAX	Los Angeles International Airport	Compensatory	City of Los Angeles (Los Angeles World Airports)	Yes	6	
Miami	MIA	Miami International Airport	Residual	Miami-Dade Aviation Department	Yes	1	

Location	IATA Code	Airport Name	Overall Method (as of 2017)	Airport Owner	More than One Large or Medium Hub in Metro Area?	Hub or Focus City Number of Airlines	Fortress Hub for an Airline
Minneapolis	MSP	Minneapolis–Saint Paul International Airport	Compensatory	Metropolitan Airports Commission	No	1	Delta
New York	JFK	John F. Kennedy International Airport	Compensatory	City of New York (Port Authority of New York and New Jersey)	Yes	3	
New York	LGA	LaGuardia Airport	Compensatory	City of New York (Port Authority of New York and New Jersey)	Yes	3	
Newark	EWR	Newark Liberty International Airport	Compensatory	State of New Jersey (Port Authority of New York and New Jersey)	Yes	2	United
Orlando	MCO	Orlando International Airport	Compensatory	Greater Orlando Aviation Authority	No	2	
Philadelphia	PHL	Philadelphia International Airport	Residual	City of Philadelphia	No	1	American
Phoenix	PHX	Phoenix Sky Harbor International Airport	Compensatory	City of Phoenix	No	2	
Portland	PDX	Portland International Airport	Compensatory	Port of Portland	No	1	
Salt Lake City	SLC	Salt Lake City International Airport	Hybrid	City of Salt Lake City	No	1	Delta
San Diego	SAN	San Diego International Airport	Compensatory	San Diego County Regional Airport Authority	No	1	
San Francisco	SFO	San Francisco International Airport	Residual	City and County of San Francisco	Yes	2	United
Seattle	SEA	Seattle-Tacoma International Airport	Compensatory	Port of Seattle	No	2	
Tampa	TPA	Tampa International Airport	Hybrid	Hillsborough County (Hillsborough County Aviation Authority)	No	1	
Washington, D.C.	DCA	Ronald Reagan Washington National Airport	Hybrid	Federal government (Metropolitan Washington Airports Authority)	Yes	1	American
Washington, D.C.	IAD	Dulles International Airport	Hybrid	Federal government (Metropolitan Washington Airports Authority)	Yes	1	United

Location	IATA Code	Airport Name	Overall Method (as of 2017)	Airport Owner	More than One Large or Medium Hub in Metro Area?	Hub or Focus City Number of Airlines	Fortress Hub for an Airline
Medium Hubs							
Albuquerque	ABQ	Albuquerque International Sunport	Hybrid Compensatory	City of Albuquerque	No	0	
Anchorage	ANC	Ted Stevens Anchorage International Airport	Residual	Alaska Department of Transportation and Public Facilities	No	1	
Austin	AUS	Austin-Bergstrom International Airport	Compensatory	City of Austin	No	1	
Buffalo	BUF	Buffalo Niagara International Airport	Hybrid Residual	Niagara Frontier Transportation Authority	No	0	
Burbank	BUR	Hollywood Burbank Airport	Unknown	Burbank-Glendale-Pasadena Airport Authority	Yes	1	
Cincinnati	CVG	Cincinnati/Northern Kentucky International Airport	Hybrid Residual	Kenton County Airport Board	No	1	
Cleveland	CLE	Cleveland Hopkins International Airport	Residual	City of Cleveland	No	0	
Columbus	CMH	John Glenn Columbus International Airport	Hybrid Compensatory	Columbus Regional Airport Authority	No	0	
Dallas	DAL	Dallas Love Field Airport	Hybrid Compensatory	City of Dallas	Yes	1	Southwest
Fort Myers	RSW	Southwest Florida International Airport	Hybrid Compensatory	Lee County Port Authority	No	0	
Hartford	BDL	Bradley International Airport	Unknown	Connecticut Airport Authority	No	0	
Houston	HOU	William P. Hobby Airport	Compensatory	City of Houston	Yes	1	Southwest
Indianapolis	IND	Indianapolis International Airport	Residual	Indianapolis Airport Authority	No	0	
Jacksonville	JAX	Jacksonville International Airport	Residual	Jacksonville Aviation Authority	No	0	
Kahului	OGG	Kahului Airport	Hybrid Residual	Hawaii Department of Transportation	No	0	
Kansas City	MCI	Kansas City International Airport	Compensatory	City of Kansas City	No	0	
Milwaukee	MKE	General Mitchell International Airport	Residual	Milwaukee County	No	0	

Location	IATA Code	Airport Name	Overall Method (as of 2017)	Airport Owner	More than One Large or Medium Hub in Metro Area?	Hub or Focus City Number of Airlines	Fortress Hub for an Airline
Nashville	BNA	Nashville International Airport	Hybrid Compensatory	Metropolitan Nashville Airport Authority	No	1	
New Orleans	MSY	Louis Armstrong New Orleans International Airport	Unknown	City of New Orleans	No	0	
Oakland	OAK	Oakland International Airport	Hybrid Compensatory	Port of Oakland	Yes	1	
Omaha	OMA	Eppley Airfield	Compensatory	Omaha Airport Authority	No	0	
Ontario	ONT	Ontario International Airport	Residual	Ontario International Airport Authority	Yes	0	
Pittsburgh	PIT	Pittsburgh International Airport	Residual	Allegheny County Airport Authority	No	0	
Raleigh-Durham	RDU	Raleigh-Durham International Airport	Compensatory	Raleigh–Durham Airport Authority	No	0	
Sacramento	SMF	Sacramento International Airport	Compensatory	Sacramento County	No	1	
San Antonio	SAT	San Antonio International Airport	Unknown	City of San Antonio	No	0	
San Jose	SJC	Norman Y. Mineta San Jose International Airport	Hybrid Residual	City of San Jose	Yes	1	
San Juan	SJU	Luis Muñoz Marín International Airport	Hybrid Compensatory	Puerto Rico Ports Authority (Aerostar)	No	1	
Santa Ana	SNA	John Wayne Airport	Compensatory	Orange County	Yes	0	
St. Louis	STL	St. Louis Lambert International Airport	Unknown	City of St. Louis	No	1	
West Palm Beach	PBI	Palm Beach International Airport	Hybrid Residual	Palm Beach County	Yes	0	

SOURCES: Rate-setting method: Wu, 2017; information on airport owners and hub status from airport and airline websites as of spring 2019.
NOTE: IATA = International Air Transportation Association.

Emerging Business Models

The airline industry has been somewhat volatile since deregulation, and several new business models have emerged. This section provides some clarification about how these terms are generally used (along with other frequently discussed characteristics of airlines) and characterizes airlines by generally understood types.

Certification

The FAA provides safety operating certificates to three types of aircraft operators. 14 CFR Part 121 governs scheduled air carrier operations, 14 CFR Part 135 governs smaller commercial aircraft, which could be used for scheduled service or on demand, and 14 CFR Part 91 governs general aviation, which is on demand.

Majors

Majors commonly refers to the size of an airline according to revenues. The BTS has distinct reporting requirements for three groups of airlines: I, II, and III. Group III airlines have more than $1 billion in annual revenue, Group II airlines have $100 million to $1 billion, and Group I has two subgroups: $20 million to $100 million and less than $20 million. As of January 1, 2019, 17 airlines were categorized as Group III, although four of these were primarily cargo airlines. There were 12 airlines in Group II and 21 in Group I (BTS, 2018).

Network Airlines

Network airlines are those with national networks operating on a hub-and-spoke system. In contrast, most other airlines concentrate their flights in certain geographic regions. In the United States, only three airlines currently fit this description: American, Delta, and United. Airlines for America calls these three airlines “global network carriers,” since their networks extend internationally (Kasper and Lee, 2017).

Legacy Airlines

A *legacy airline* is one that was operating before deregulation occurred in 1978. Because of a wave of mergers, the only legacy carriers today are the same as the network airlines: American, Delta, and United.

Regional Airlines

Regional airlines are not precisely defined but are generally considered those that fly shorter-distance routes (on average, fewer than 500 miles) with smaller aircraft (on average, fewer than 70 seats). Most regional airlines fly passengers under arrangements with other carriers, called “marketing” or “ticketing” carriers, and their aircraft are painted to look like the marketing carrier's aircraft. Some regional airlines are wholly owned subsidiaries of the marketing carrier, while others fly for multiple airlines (Regional Airline Association, 2019). Some operate under their own name, but they are a relatively small proportion of overall regional airline activity. In 2018, regionals carried just over 17 percent of all enplanements; of these, only 0.8 percent of enplanements were on regionals flying under their own name (according to T-100 international segment data). Regional airlines can hold either Part 121 or Part 135 operating certificates, and some are large enough to be in BTS Group III.

The Regional Airline Association's 2018 annual report lists 65 regional carriers that were operating in 2017. Fifteen of these are either wholly owned subsidiaries of larger airlines or fly under contract with larger airlines (American, Alaska, Delta, or United) (Regional Airline Association, 2019). The other 50, which collectively account for fewer than 1 percent of all enplanements, fly in small markets (such as Alaska and Hawaii), operate charter services, or fly Essential Air Service routes.

Low-Cost Carriers and Ultra-Low-Cost Carriers

Low-cost carriers (LCCs) are likewise not precisely defined but are generally considered to be airlines whose business model depends on keeping operating costs lower. As the model developed after deregulation, these carriers were distinguished by using their aircraft more extensively (e.g., more turns per day), eliminating previously widespread practices (such as pre-assigned seats), and charging passengers for amenities that were once included in the ticket price, such as checked bags and in-flight meals. However, other airlines have now adopted some of these practices, so these are no longer distinguishing characteristics. Some airlines are now called *ultra-low-cost carriers* (ULCCs) because of their model for charging additional fees for nearly every service, including those that are not optional (e.g., seat selection).

Generally speaking, LCCs and ULCCs operate more on a point-to-point service model (as opposed to a hub-and-spoke system), serve vacation destinations that attract leisure travelers as opposed to business travelers, and have entirely economy seating (e.g., no business or first class). But none of these are hard-and-fast rules, so whether an airline is an LCC or ULCC is more about perception and market positioning. As of a 2017 competition analysis, Airlines for America categorized six airlines as "LCCs and Low Fare Premium Carriers" (Alaska, Hawaiian, JetBlue, Southwest, Sun Country, and Virgin America) and another three as ULCCs (Allegiant, Frontier, and Spirit) (Kasper and Lee, 2017). In its definition, the International Civil Aviation Organization (ICAO) calls all of these carriers LCCs except Alaska and Hawaiian (ICAO, 2017). Other observers note that the line between LCCs and "full service carriers" is increasingly blurry (Centre for Asia Pacific Aviation, 2018).

Appendix D. Revenues, Expenses, and Debt Activities in 2017

As a supplement to the information in Chapter Four, this appendix provides additional details about airport revenues, expenses, and debt activities for 2017, the most recent year for the complete data set (see Table D.1). Table D.2 lists the proportions of airport revenue sources in 2017.

Table D.1. Revenue, Expenses, and Debt Activities in 2017, by Airport Size ($M)

Inflows and Outflows	Type of Source	Items	Large	Medium	Small	Non-Hub	Nonprimary	Total
Revenue	Operating revenue	Apron charge/tie downs	112	61	29	8	1	211
		Cargo and hangar rentals	403	78	84	54	26	645
		Fixed-base operator revenue	115	47	45	47	15	270
		Fuel sales and taxes	192	46	47	54	50	390
		Hotel	206	8	9	1	2	227
		Land rental and nonterminal	420	105	99	118	19	761
		Landing fees	2,980	591	290	92	23	3,977
		Other aeronautical fees	841	73	57	50	29	1,050
		Other non-aeronautical fees	691	120	112	50	6	980
		Parking	2,706	882	509	149	3	4,249
		Rental car	1,106	368	272	104	5	1,856
		Terminal services and other	381	54	38	11	1	484
		Terminal concessions	1,256	215	94	19	1	1,585
		Terminal rentals (aero)	4,144	688	311	107	6	5,256
	Non-operating revenue	Capital contributions	285	139	102	112	18	655
		Grants	601	245	428	650	220	2,144
		Interest revenue	238	44	20	9	1	312
		Other non-operating	175	134	58	84	30	480
		PFC	2,429	525	228	88	2	3,271

Inflows and Outflows	Type of Source	Items	Large	Medium	Small	Non-Hub	Nonprimary	Total
Expense	Operating expense	Communications and utilities	683	168	115	69	15	1,050
		Contractual services	3,369	757	337	198	45	4,706
		Insurance (claims and settlements)	126	33	26	23	5	214
		Other operating expenses	1,108	204	147	98	19	1,576
		Personal compensation and benefits	3,729	854	649	386	92	5,710
		Supplies and materials	362	103	96	66	24	651
	Non-operating expense	Interest expense	2,725	466	172	44	26	3,433
Capital expenditures	Capital expenditures	Airfield	1,303	435	434	548	167	2,887
		Other capital/construction expenses	1,070	537	214	213	51	2,086
		Parking	774	227	88	15	4	1,108
		Roadways, rail, and transit	921	136	54	43	13	1,168
		Terminal	4,680	390	250	175	12	5,508
Bond proceeds	Bond proceeds	Bond proceeds	7,734	1,447	306	46	0	9,534
Debt service	Debt service (principal and interest)	Debt service (principal and interest)	5,532	1,019	399	104	30	7,084

SOURCE: FAA CATS (FAA, undated).

Table D.2. Percentage Share of Total Revenues in 2017, by Airport Size

Items	Large	Medium	Small	Non-Hub
Apron charge/tie downs	0.4%	1.0%	0.9%	0.4%
Bond proceeds	28.6%	24.7%	9.3%	2.1%
Capital contributions	1.1%	2.4%	3.1%	6.0%
Cargo and hangar rentals	1.5%	1.3%	2.6%	3.7%
Fixed-base operator revenue	0.4%	0.8%	1.5%	2.7%
Fuel sales and taxes	0.7%	0.8%	1.2%	5.2%
Grants	2.2%	4.2%	14.0%	38.7%
Hotel	0.8%	0.1%	0.3%	0.1%
Interest revenue	0.9%	0.7%	0.6%	0.4%
Land rental and nonterminal	1.6%	1.8%	3.3%	5.9%
Landing Fees	11.0%	10.1%	9.2%	4.8%
Other aeronautical fees	3.1%	1.2%	1.8%	3.5%
Other non-aeronautical fees	2.6%	2.0%	3.5%	2.4%
Other non-operating	0.6%	2.3%	2.9%	3.5%
Parking	10.0%	15.0%	16.0%	6.2%
PFC	9.0%	8.9%	7.3%	3.6%
Rental car	4.1%	6.3%	8.5%	4.7%
Terminal services and other	1.4%	0.9%	1.2%	0.5%
Terminal concessions	4.7%	3.7%	2.9%	0.8%
Terminal rentals (aero)	15.3%	11.7%	9.9%	4.5%

NOTE: Percentages might not sum to 100 because of rounding.

Definitions of Revenue and Expense Items

Definition information has been drawn from various FAA sources, as noted within the text.

Aeronautical Operating Revenues

Apron Charge/Tie Downs

Aprons are where airplanes are parked to board, load and unload, and fuel. Airports charge airlines for the use of aprons, similar to cargo and hangar rentals. In some cases, airplane operators have to tie the airplane to the ground using ropes so that the airplane stays stationary. Providing such a facility is another source of revenue for airports.

Aviation Fuel Sales and Taxes

Airports provide refueling services for airplanes. Airports can source jet fuel directly from refineries or through third-party suppliers to sell to airlines, and airports generate revenue and collect taxes by doing so. Airlines can also directly acquire fuel from refineries. In such a case, airlines still pay various types of fees, such as a fuel flowage fee, for using airport property as a fueling depot.

Cargo and Hangar Rentals/Terminal Rentals

Airlines pay fees to rent space at airports, including space to store cargo and aircraft. Terminal rentals, which are rental fees based on the amount of space an airline uses in a terminal, are the largest single source of aeronautical revenues. Airports define the amount of rentable space in the terminal and assign it as nonairline (e.g., food and beverage space) or airline space. Space can also be weighted in the rental formula by type (e.g., airlines might pay more for ticket counter space than baggage claim space). If space is shared, as opposed to exclusive or preferential use, airline payment might also be weighted by the airline's number of enplaned passengers. Some airports have also begun charging per-turn fees, which is a fixed payment per departure that might cover the ticket counter, baggage claim, and jet bridge (Wu, 2016).

Federal Inspection Fees

Federal inspection fees, which include fees for the services of immigration, customs, and animal and plant inspections, are collected by airlines from international passengers and remitted to airports.

Fixed-Base Operator Revenue

Fixed-base operators are the third-party businesses that provide services to aeronautical users. Such services include airplane maintenance, jet fuel services, pilot training, and other facility services. Airports generate revenue from fixed-base operators based on their use of airport land and facilities.

Landing Fees

Landing fees are assessed on all types of flights, including passenger flights, cargo, general aviation, and military. Landing fees are assessed on a per-aircraft basis, generally based on the weight of the aircraft as measured per 1,000 lbs of maximum gross landed weight.

Other Aeronautical

Other sources of aeronautical revenue include federal inspection fees, security reimbursement from the federal government, and fees characterized in CATS as "other aeronautical fees."

Security Reimbursements

Reimbursements are paid by the Transportation Security Administration (TSA) and other federal and state organizations to airports for providing personnel, facility, and equipment (such as bag screening machines) related to security.

Terminal Services and Other

Terminal services and other includes revenues from providing services (such as internet access, telecommunications, and advertisements) and other non-aeronautical terminal uses.

Non-Aeronautical Operating Revenues

Hotels

As with land and nonterminal leases, the amount of revenue generated by hotels on airport property varies widely. Most large- and medium-hub airports report zero or negligible (less than $1 million) revenue in this category. For several airports, however, 2017 hotel revenues were substantial: $5 million at Port Columbus (all other medium-hub airports reported less than $1 million), $9 million at Logan (Boston), $11 million at Miami, $29 million at Detroit, $41 million at Orlando, $47 million at Denver, and $51 million at Dallas/Fort Worth.

Land and Nonterminal Leases

According to FAA guidance, this category includes "revenues received for non-aeronautical rentals and leases or the use of airport land, buildings, and property, including manufacturing, warehousing, farming, and other activities" (FAA Advisory Circular 150/5100-19D, 2011). The majority of airports in the medium- and large-hub categories receive less than $10 million annually in this category. Only at a half-dozen airports does this category constitute more than $20 million.[3] The particulars vary by airport. Dulles Airport describes its nonairline rents as "hangars, airmail facilities, cargo facilities, and fueling systems" (Metropolitan Washington Airports Authority, 2018). At Dallas/Fort Worth, the "ground and facility leases" category includes a hotel, a golf course, and right-of-way leases (Dallas/Fort Worth International Airport, 2017).

Other Sources

Other sources of non-aeronautical revenue vary greatly from airport to airport. Examples include fuel farms, trash removal, natural gas revenues, and pet kennels (Kramer et al., 2015).

Parking and Ground Transportation

Airports as a whole make the largest proportion of their non-aeronautical revenues from parking and ground transportation (these are categorized separately from rental cars). Ground transportation includes revenues from shuttle services, taxis, and ride-hailing services (such as Uber and Lyft).

Parking fees vary by airport, but most airports have short-term, long-term, and economy parking options at different prices. According to a 2015 survey, 17 percent of airports also offer "premium" services, such as valet parking and car washes, and some also charge privilege fees to

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[3] According to FAA CATS data for 2017 (FAA, undated a).

privately operating off-airport parking lot owners. Revenues per parking transaction (one vehicle parking) vary from less than $7 for short-term parking at small hubs to $46 for economy parking at large hubs. Most airports also charge employees for parking; these monthly fees tend to range from $50 to $100 (InterVISTAS Consulting Inc., 2017).

Parking transactions are highly dependent on passenger characteristics. Airports with high proportions of transfer passengers tend to have fewer transactions, as do airports that primarily serve visitors rather than residents (such as Orlando and Las Vegas). Regardless of size, average airport revenue per originating enplaned passenger tends to be around $7.50 (InterVISTAS Consulting Inc., 2017).

Anecdotally, the rising proportion of passengers who arrive at the airport via ride-hailing services seems to be depressing parking revenues (Bergal, 2017). Henao and Marshall, 2019, looks at data from four airports and finds that parking revenues peaked 12 to 24 months after ride-hailing firms entered the market. However, two of those airports introduced new fees, and those revenues increased to between $600,000 and $2 million per month. FAA CATS data bundle parking and ground transportation revenues, so it could be difficult to discern this shift.

According to the Airport Ground Transportation Association, ground transportation fees are generally set by competitive proposals, if the provider holds an airport concession, or charged on other bases if it does not. Nonconcession airport access privilege fees can include “a per trip access fee, a dwell time fee, a vehicle and/or driver registration fees, inspection fees, drop-off fees, or even municipal convention center fees based on a per trip basis.” (Airport Ground Transportation Association, 2011).

Rental Cars

Rental car operations generate multiple types of revenue, as follows:[4]

- Percentage (also called privilege) fees: Fees of up to 10 percent of on-airport rentals and 8 percent of off-airport rentals.
- Terminal rental fees: For counter space in the terminal.
- Land leases: For land used for rental car operations (e.g., vehicle maintenance and storage).
- Contingent rent: If revenues received from rental car operations fall short of the costs of operating those facilities, rental car operators may be charged to make up the difference.
- Customer facility charge (CFC): Per-transaction or per-day charges (Nichol, 2007).

CFCs are paid by users, collected by the rental car companies, and remitted to the airport. As of 2016, CFCs ranged from less than $1 to $8 (Wu and Zhu, 2016). As of 2015, about 110 airports had CFCs in place (Kramer et al., 2015). CFCs are regulated by states rather than at the federal level, and there is no federal role in approving the level of the fee or project eligibility. Individual airports can set CFCs within the states’ parameters. State regulations can address the

[4] This discussion is largely drawn from Wu and Zhu, 2016, and Nichol, 2007.

maximum level of the fee, whether it can be per-transaction or per-day, the projects it can be used for, and can place a ceiling on the number of days it can be collected. Generally, CFCs are used to build consolidated rental car facilities and fund their operations, including shuttles from the terminals to the consolidated rental car facility. CFCs can also be used as payment for bonds issued against them.

Terminal Concessions (Food and Beverage, Retail, Services)

Almost all hub airports have concession programs,[5] which are generally broken down into food and beverage, convenience retail, specialty retail, services, advertising, and (for airports with international flights) duty-free retail. The laws and regulations governing how airports manage and charge their concessionaires are set by local or state governments.

Generally, concessionaires pay either a minimum annual guarantee or a percentage of their total receipts, whichever is higher. According to surveys of airport operators, their percentages can range from 10 to 15 percent, and from 8 to 20 percent for food and beverage. Some airports set the percentage rate; others accept bids from concessionaires during a formal proposal process. Other fees paid by concessionaires can include office space, common area maintenance, storage and delivery fees, utilities, and employee parking and badging. Retail concessionaires at most airports are restricted to charging "street prices" (that is, the same price as in nonairport stores) or are allowed to charge 5 percent to 10 percent over street prices.

Spending on concessions is usually calculated on a per-passenger basis, although some sales are to other airport employees. Large hubs tend to have higher spending than medium and small hubs, and international passengers tend to spend more than domestic passengers. Airports might even see different rates of spending from terminal to terminal, depending on the passenger mix and whether international flights are involved. At Dallas/Fort Worth, spending per passenger at Terminal D was nearly double that of Terminal C ($12.15 versus $6.85) (LeighFisher and Exstare Federal Services Group, 2011, Table 14-2). However, most large- and medium-hub airports earn less than $1.50 per enplaned passenger in concession sales (according to 2008 data) (LeighFisher and Exstare Federal Services Group, 2011, Table 8-4).

Operating Expenses

Communications and Utilities

Communications and utilities include the cost of telecommunications, electricity, air conditioning, heating, water, and other utilities incurred for the operation of the airport.

Contractual Services

Contractual services include the services received from external parties, both commercial and public, such as consulting, accounting, maintenance, and financial services and firefighters.

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[5] This discussion is largely drawn from LeighFisher and Exstare Federal Services Group, 2011.

Insurance Claims and Settlements

Airports purchase insurances to cover various aspects of operation for both bodily injuries and property damages. Examples include airstrips, hangars, parking lots, fuel trucks, pollution, and workers' compensation. This category includes the costs of such coverage and the claims and settlements thereof.

Other

This category includes all operating costs that are not included in the other operating expense categories.

Personnel (Compensation and Benefits)

Personnel expenses are related to the salaries, wages, insurance, employee pensions, and any other benefits for the employment of airport personnel. This category includes only the personnel directly employed by airports and excludes contractual workers. For the airports that are operated by a local government, this category is only for the personnel assigned to the airport operating department.

Supplies and Materials

This category includes the supplies and materials used for the operation of the airport that are not included in the other expense items.

Capital Expenditures

Capital expenditures are categorized into the following items:

- airfield
- parking
- roadways, rail, and transit
- terminal
- other capital and construction expenses.

These items include capital expenditures incurred for both new construction and improvements or renewals in the fiscal year, even if the facility did not become operational in the fiscal year.

Non-Operating Expense

Interest Expense

Interest expense includes all interest expense incurred from the leverage of the capital market, including long-term bonds and short-term and interim financing.

Appendix E. Prior Federal Legislation

Table E.1 shows the legislative time line that led to current funding and regulatory arrangements governing the FAA and its administration and oversight of airport infrastructure funding and operations.

Table E.1. Major Federal Legislation Affecting Airport Operations

Date of Passage	Statute	Comments
1970	Airport and Airway Development Act of 1970	Established the Airport and Airway Trust Fund
1982	Airport and Airway Improvement Act of 1982, as amended	Created the AIP and established the prohibition on revenue diversion
1987	Airport and Airway Safety and Capacity Expansion Act of 1987	Increased AIP funding and allowed cargo
1990	Aviation and Airway Safety and Capacity Act of 1990	Created the PFC
1994	FAA Authorization Act of 1994	
1996	FAA Authorization Act of 1996	Created a pilot privatization program
2000	Wendell H. Ford Aviation Investment and Reform Act for the 21st Century	Increased AIP funding and increased the per-passenger PFC charge to $4.50
2003	Vision 100: Century of Aviation Reauthorization Act of 2003	Allowed small airports to use the AIP to pay debt service and repealed the ability to use the AIP and PFCs for most security projects
2012	FAA Modernization and Reform Act of 2012	
2016	FAA Extension, Safety, and Security Act of 2016	
2018	FAA Reauthorization Act of 2018	

SOURCE: Tang, 2019.

Appendix F. Airport Master Planning Process

Nearly all commercial airports produce individual master plans that present the distinct short-, medium-, and long-term development needs of the airport according to forecast passenger demand. Each airport's master plan will vary because of local conditions, with some covering elements that others would not. Most commercial airports receive AIP funds for master planning and seek AIP funds for future development to meet future aviation demand (making them likely to follow FAA guidance and meet FAA requirements).

The FAA, although able to provide guidance during the entire master planning process, only requires and must approve of two elements: aviation forecasts and airport layout plans. Aviation forecasts provide the primary motivation and justification for future airport development. Accordingly, the FAA attempts to ensure that the forecasts included in master plans are reasonable and accurate. The FAA requires commercial airports to submit aviation forecasts for enplanements and aircraft operations for each year during the period that justifies the development for which the airport is requesting federal funds. For general aviation airports, the FAA requires forecasts to also include the number and type of based aircraft. Because average demand over the year does not capture peak demand within each period, forecasts must also include peak period activity levels when seeking federal funds for facilities planning. Furthermore, there must be ample documentation for each forecast element. Once complete, the forecasts are submitted to the FAA for review.

The FAA review process of aviation forecasts is designed to ensure that the forecasts have an acceptable analytical foundation and align with the TAF, which is the FAA's in-house forecast for unconstrained aviation demand at individual airports. For all commercial airports and general aviation and reliever airports with more than 100,000 total annual operations or 100 based aircraft, master plan forecasts must differ from the TAF by "less than 10 percent in the 5-year forecast and 15 percent in the 10-year forecast" or "not affect the timing or scale of an airport project" (FAA Advisory Circular 150/5070-6B, 2015). Forecasts for non-hub, general aviation, and reliever airports with more than 100,000 operations are also considered consistent if the forecasts do not change the airport's role within the NPIAS. Inconsistencies with these criteria must be addressed, either by revising the master plan forecast or by providing advance notice to changes the TAF might not have considered (e.g., a new airline beginning service) before continuing the master plan process.

Once the forecast is approved, the airport master plan should translate aviation demand forecasts into a set of facility developments necessary to meet future demand. The desired development projects are then organized in an Airport Layout Plan (ALP), a set of detailed diagrams that depicts all current and planned airport facilities in five-, ten-, and 20-year intervals. The ALP must meet FAA requirements and be approved by the FAA for the airport to receive federal funding under the Airport and Airway Improvement Act of 1982. Furthermore, the ALP must be kept current. Generally, an ALP is considered current for five years but must be updated if there are major changes to the airport or airport master plan.

A Facilities Implementation Plan, which contains an airport's capital improvement plan (CIP), typically accompanies an ALP in the master plan (although a CIP is not necessarily required) to translate the ALP's future developments into specific projects with precise descriptions. Project descriptions within the CIP might contain such elements as project scope, purpose, schedule, budget, funding sources, environmental processing (if required), identification of key activities and responsibilities, interrelated projects, and benefit cost information. The CIP is critical to ensure that the airport has adequate resources and a clear path forward to execute through the NPIAS and Airports Capital Improvement Plan (ACIP), which then awards AIP funds according to project priority and other factors.

Appendix G. Additional Background Information on the Airport Improvement Program

This appendix provides additional details on the AIP, expanding on the material in Chapter Five. It includes a discussion of AIP eligibility criteria, AIP grant assurances (i.e., the set of obligations that AIP recipients agree to as a condition of applying for and receiving AIP funding), and the distribution of AIP grants across types of projects.

Airport Improvement Program Eligibility Criteria

The FAA notes in its *AIP Handbook* that the set of projects eligible for the AIP under the "airport development" category is "extensive," and the handbook provides voluminous details in appendixes on how the terms in statute are operationalized and used to determine individual project eligibility (FAA Order 5100.38D, 2019, p. A-2).

A useful reference for understanding not only which projects are eligible but which are more likely to receive discretionary AIP funding (i.e., amounts in addition to annual apportionments) is FAA Order 5100.39A on the ACIP, which "serves as the basis for the distribution of grant funds under the [AIP]" (FAA Order 5100.39A, 2000, p. 1). Notably, this document describes how the National Priority Rating (NPR) is calculated according to the airport and proposed project type, with the NPR being a key consideration when determining whether a given project will receive funding "in conjunction with qualitative factors" (FAA Order 5100.39A, 2000, p. 3).

The equation takes as its inputs the size of the airport, the purpose of the project (from eight purposes), the component involved (from 17 components), and the type of work being done (from 38 type options), and generates a rating from 0 to 100, with 100 most closely aligning with FAA objectives. In order of priority, the purposes are: safety/security (10 points); statutory emphasis programs (9 points); environment, planning, and reconstruction (all 8 points); capacity (7 points); standards (6 points); and other (4 points). The values for components range from runway (10 points) to terminal (1 point). Large and medium hubs get slight preference over small- and non-hub airports among primary commercial service airports (5 points versus 4 points), while nonprimary airports can earn from 2 to 5 points depending on their operations. FAA Order 5090.5, published in September 2019, updated and revised the NPR equation (among other changes to the NPIAS and ACIP Orders) (FAA Order 5090.5, 2019). The order states that the goal of the revisions to the equation is "to consider the airport's role in the National Airport System" (FAA Order 5090.5, 2019, p. ii).

Grant Assurances

When sponsors seek AIP funding, they must agree to a set of obligations known as *grant assurances*. Currently, there are 39 such grant assurances, including general federal requirements (e.g., adherence to the Davis-Bacon Act and the Federal Fair Labor Standards Act), planning requirements, and how airport revenues can be used (FAA, 2014a). Some of these assurances are part of the grant application and approval process, while others are in force for the useful life of the infrastructure funded by the AIP grant. Still other assurances are made in perpetuity and never expire as long as the airport remains in operation. The grant assurances that never expire are the following (FAA Order 5100.38D, 2019, Table 2-5):

- **23. Exclusive Rights.** It will permit no exclusive right for the use of the airport by any person providing, or intending to provide, aeronautical services to the public. . . .
- **25. Airport Revenue.** All revenues generated by the airport and any local taxes on aviation fuel established after December 30, 1987, will be expended by it for the capital or operating costs of the airport; the local airport system; or other local facilities which are owned or operated by the owner or operator of the airport and which are directly and substantially related to the actual air transportation of passengers or property; or for noise mitigation purposes on or off the airport. . . .
- **30. Civil Rights.** It will promptly take any measures necessary to ensure that no person in the United States shall, on the grounds of race, creed, color, national origin, sex, age, or disability be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination in any activity conducted with, or benefiting from, funds received from this grant. . . .
- **31. Disposal of Land.** For land purchased under a grant for airport noise compatibility purposes, including land serving as a noise buffer, it will dispose of the land, when the land is no longer needed for such purposes, at fair market value, at the earliest practicable time. . . . For land purchased under a grant for airport development purposes (other than noise compatibility), it will, when the land is no longer needed for airport purposes, dispose of such land at fair market value or make available to the Secretary an amount equal to the United States' proportionate share of the fair market value of the land (FAA, 2014a, pp. 12–17).

Box G.1 lists the full set of 39 grant assurances, by number, categorized by the duration for which they are in force.

Box G.1
Airport Improvement Program Grant Assurances for Airport Sponsors

Must be met before a grant is offered:

- #2 Responsibility and Authority of the Sponsor
- #3 Sponsor Fund Availability
- #4 Good Title
- #6 Consistency with Local Plans
- #7 Consideration of Local Interest
- #8 Consultation with Users
- #9 Public Hearings
- #12 Terminal Development Prerequisites.

Apply until the grant is closed:

- #1 General Federal Requirements (except for 49 CFR Part 23)
- #10 Air and Water Quality Standards
- #14 Minimum Wage Rates
- #15 Veteran's Preference
- #16 Conformity to Plans and Specifications
- #17 Construction Inspection and Approval
- #18 Planning Projects
- #32 Engineering and Design Services
- #33 Foreign Market Restrictions
- #34 Policies, Standards, and Specifications
- #35 Relocation and Real Property Acquisition.

Apply for three years after the grant is closed:

- #13 Accounting System, Audit, and Record Keeping Requirements
- #26 Reports and Inspections.

Apply for the useful life of the project (not to exceed 20 years from the grant acceptance date):[a]

- #5 Preserving Rights and Powers
- #11 Pavement Preventive Maintenance
- #19 Operations and Maintenance
- #20 Hazard Removal and Mitigation
- #21 Compatible Land Use
- #22 Economic Nondiscrimination
- #24 Fee and Rental Structure
- #27 Use by Government Aircraft
- #28 Land for Federal Facilities
- #29 Airport Layout Plan
- #36 Access by Intercity Buses
- #37 Disadvantaged Business Enterprises
- #38 Hangar Construction
- #39 Competitive Access.

Last for as long as the airport is owned and operated as an airport:

- #23 Exclusive Rights
- #25 Airport Revenue
- #30 Civil Rights
- #31 Disposal of Land.

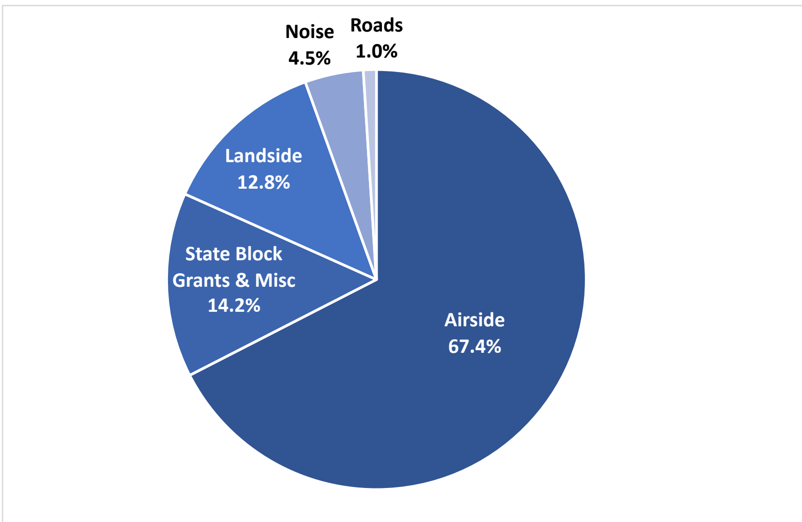
SOURCE: FAA Order 5100.38D, 2019, Table 2-5.
[a] For land acquisition grants, the useful life is indefinite, and the assurance obligations do not expire.

These grant assurances can be considered "strings attached" to AIP grants by airports and sponsors (Tang, 2019, p. 12). They also could affect the incentives for privatization of airports because, as currently constructed, potential private-sector operators would assume these grant assurances (Tang, 2017).

Distribution of Airport Improvement Program Grants by Type of Project

AIP grants most commonly go to meet the airside needs of airports, such as runways, taxiways, and aprons. This distribution is consistent with the NPR method described earlier, which gives the most points for a runway project and the fewest for a terminal project (FAA Order 5100.39A, 2000, Appendix 5). As Figure G.1 shows, about two-thirds of AIP grant dollars in fiscal year (FY) 2018 went to airside projects while a much smaller share went to landside projects. Note that state block grant amounts went to a mix of projects in the other categories and are not tracked in the same manner as individual AIP grants outside the State Block Grant Program.

Figure G.1. Airport Improvement Program Grant Distribution, Share of Dollars, by Project Type, FY 2018



SOURCE: FAA, cited in Tang, 2019.

Table G.1 provides a more granular breakdown by project type for FYs 2015 to 2017, the last years covered in the FAA's most recent Report to Congress on the AIP (FAA, 2019a). The data reinforce that runway, taxiway, and apron projects account for a majority of AIP grant dollars. In contrast, terminal projects received less than 5 percent of AIP grant dollars in those years.

Table G.1. Airport Improvement Program Projects, by Project Type, FYs 2015 to 2017

	Total Awarded (millions)			Percentage of Awards		
Project Type	**2015**	**2016**	**2017**	**2015**	**2016**	**2017**
Apron	$381.4	$374.8	$448.7	11.9%	11.4%	13.5%
Airport rescue and firefighting	$32.7	$59.0	$56.0	1.0%	1.8%	1.7%
Equipment	$6.5	$5.4	$8.6	0.2%	0.2%	0.3%
Heliport	$1.0	$5.7	$0.0	0.0%	0.2%	0.0%
Land	$30.8	$16.5	$21.1	1.0%	0.5%	0.6%
New airport	$76.0	$34.7	$45.1	2.4%	1.1%	1.4%
Noise	$127.4	$143.4	$91.6	4.0%	4.4%	2.7%
Planning	$115.4	$103.5	$77.8	3.6%	3.1%	2.3%
Roads	$26.3	$18.3	$24.9	0.8%	0.6%	0.7%
Runway safety area	$149.4	$77.0	$36.4	4.7%	2.3%	1.1%
Runway	$1,096.0	$1,031.0	$1,167.0	34.2%	31.3%	35.0%
Security	$50.8	$75.8	$42.4	1.6%	2.3%	1.3%
Snow removal	$63.6	$97.6	$57.3	2.0%	3.0%	1.7%
State block grant	$278.6	$250.5	$237.3	8.7%	7.6%	7.1%
Taxiway	$515.6	$677.7	$771.0	16.1%	20.6%	23.1%
Terminal	$106.8	$156.7	$128.9	3.3%	4.8%	3.9%
Voluntary Airport Low Emissions	$28.3	$33.6	$15.3	0.9%	1.0%	0.5%
Zero emissions	$1.0	$2.6	$9.7	0.0%	0.1%	0.3%
Other	$115.5	$132.5	$92.7	3.6%	4.0%	2.8%
Total	**$3,203.0**	**$3,296.0**	**$3,332.8**	**100.0%**	**100.0%**	**100.0%**

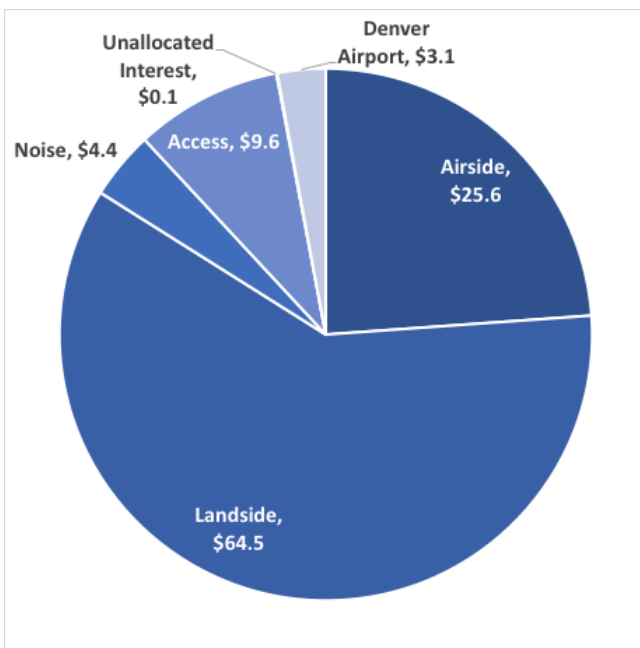
SOURCE: FAA, 2019a, Table 2.
NOTE: “Other” category includes constructing utilities, removing obstructions, improving airport drainage, installing airport beacons, and other related projects. Percentages might not sum to 100 because of rounding.

Appendix H. Distribution of PFC Project Approvals

This appendix expands on Chapter Six by providing additional details on the distribution of PFC dollars by type of project (e.g., airside or landside) and by project objective (e.g., capacity or competition).

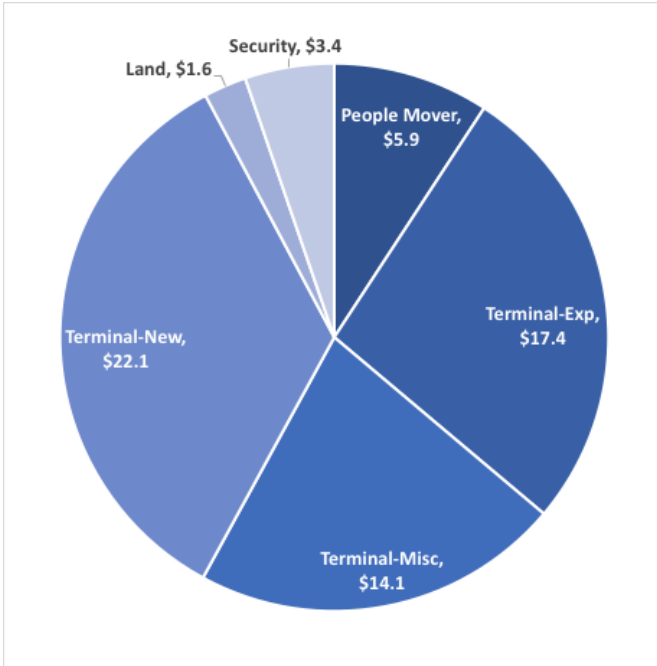
Landside projects account for about 60 percent of the $107 billion in approved eligible projects (as of August 2019), while airside projects represent about one-quarter of the total, as Figure H.1 shows. Figure H.2 drills down into landside projects, while Figure H.3 depicts airside projects. It is important to note that these figures allocate interest and financing costs to the projects for which debt is incurred; considered separately, interest and financing costs account for about one-third of the total of approved collections ($35.2 billion). Although PFC revenues are often used to pay back debt principal, these principal payments are not identified separately from direct "pay-as-you-go" project expenses in this categorization scheme.

Figure H.1. Billions of Dollars of PFC Approvals, by Category, Through August 2019



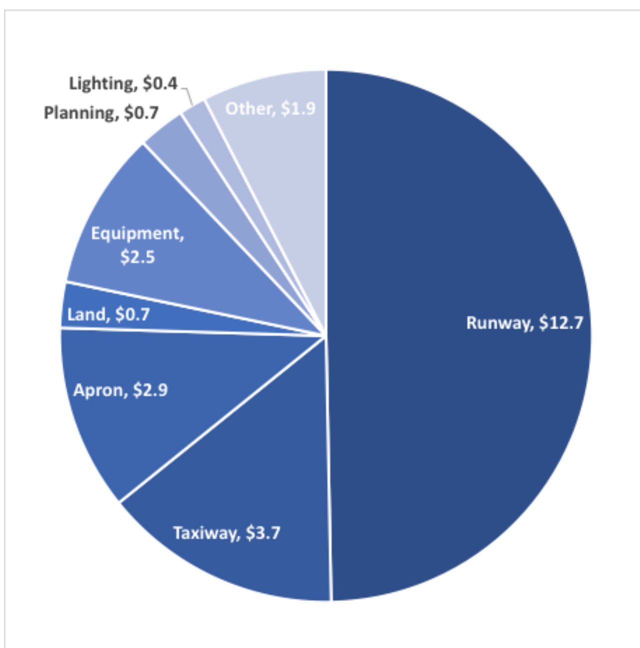
SOURCE: FAA, 2019d.
NOTE: A small number of projects in early stages have not yet allocated interest costs to specific projects. Denver International Airport is separately identified in FAA data because of the large size of this project.

Figure H.2. Billions of Dollars of PFC Approvals, Landside Projects, Through August 2019



SOURCE: FAA, 2019d.
NOTE: Exp = expansion; Misc = miscellaneous.

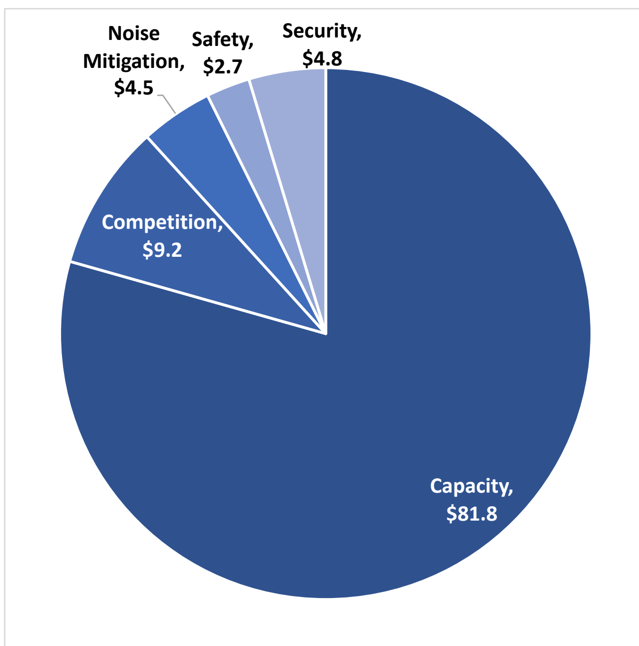
Figure H.3. Billions of Dollars of PFC Approvals, Airside Projects, Through August 2019



SOURCE: FAA, 2019d.

Another way to characterize the distribution of PFC-approved projects is in terms of the stated objective of the project: to preserve or enhance capacity, preserve or enhance safety, preserve or enhance security, enhance competition, or mitigate noise. Figure H.4 shows the distribution of PFC project dollars by stated objective, combining projects intended to "preserve" and projects intended to "enhance" into a general category and without separately identifying 2001–2018 projects that met the stricter "significant contribution" standard (identified separately in FAA data provided to RAND). The figure shows that "capacity" projects account for about three-quarters of all project dollars, a finding that holds true for all airport categories save for nonprimary commercial service airports. These smallest of airports still devote a majority of PFC dollars to capacity projects but devote a notably higher 40 percent of dollars to safety projects. Also noteworthy is that large- and medium-hub airports devote a higher share of PFC dollars to competition-enhancing projects (9 percent and 13 percent, respectively) than smaller airports, which dedicate less than 5 percent to these projects.

Figure H.4. Billions of Dollars of PFC Approvals, by Objective, 1992 to August 2019



SOURCE: FAA data provided to RAND, current as of August 28, 2019.

Appendix I. Airport Revenue and Expense Sources

As a supplement to the discussion in Chapter Four, Tables I.1 and I.2 provide additional information on airport revenues and expenses, by airport size.

Table I.1. Proportion of Revenue Sources from 2009 to 2017, by Airport Size

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total									
Total revenue (nominal $M)	22,067	22,579	22,897	23,224	24,603	25,526	25,713	27,519	28,802
Aeronautical operating revenue	38.1%	39.4%	40.2%	40.8%	40.7%	41.3%	41.7%	41.2%	41.0%
Non-aeronautical operating revenue	31.1%	31.2%	33.0%	33.9%	33.5%	33.9%	35.4%	35.2%	35.2%
Non-operating revenue	6.5%	5.6%	4.7%	3.4%	4.7%	4.8%	2.1%	4.7%	5.0%
PFC	11.5%	11.7%	11.7%	11.9%	11.4%	11.2%	11.8%	11.5%	11.4%
AIP and other grants	12.8%	12.1%	10.4%	10.0%	9.8%	8.8%	8.9%	7.4%	7.4%
Large-Hub Primary									
Total revenue (nominal $M)	13,841	14,122	14,736	14,950	15,932	16,595	16,753	18,458	19,281
Aeronautical operating revenue	44.3%	45.5%	45.3%	46.0%	46.2%	46.8%	47.4%	45.7%	45.6%
Non-aeronautical operating revenue	32.1%	32.3%	33.4%	34.2%	34.1%	34.5%	36.0%	35.1%	35.1%
Non-operating revenue	4.4%	4.1%	3.9%	2.0%	1.7%	1.4%	-0.8%	3.3%	3.6%
PFC	13.4%	13.7%	13.5%	13.5%	12.8%	12.7%	13.4%	12.8%	12.6%
AIP and other grants	5.9%	4.4%	4.0%	4.2%	5.3%	4.5%	4.0%	3.2%	3.1%
Medium-Hub Primary									
Total revenue (nominal $M)	3,503	3,779	3,525	3,585	4,051	4,117	3,936	4,235	4,422
Aeronautical operating revenue	35.0%	34.8%	37.4%	38.0%	34.4%	35.5%	37.1%	36.2%	35.8%
Non-aeronautical operating revenue	35.1%	32.8%	37.3%	37.8%	35.2%	36.2%	40.6%	39.5%	39.6%
Non-operating revenue	7.8%	10.1%	4.7%	4.1%	12.5%	12.2%	4.0%	6.2%	7.2%
PFC	11.9%	11.4%	11.2%	12.1%	10.8%	10.5%	11.7%	11.6%	11.9%

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017
AIP and other grants	10.1%	10.9%	9.4%	8.0%	7.0%	5.5%	6.6%	6.4%	5.5%
Small-Hub Primary									
Total revenue (nominal $M)	2,633	2,612	2,472	2,515	2,617	2,641	2,765	2,738	2,834
Aeronautical operating revenue	25.1%	27.5%	29.7%	29.5%	29.0%	29.4%	28.7%	30.3%	30.5%
Non-aeronautical operating revenue	31.4%	33.0%	36.5%	36.6%	36.2%	37.2%	36.2%	38.7%	40.0%
Non-operating revenue	9.3%	4.6%	4.7%	5.1%	6.2%	6.9%	9.8%	5.6%	6.3%
PFC	7.5%	7.7%	8.7%	9.2%	8.6%	8.6%	8.2%	8.1%	8.0%
AIP and other grants	26.8%	27.1%	20.4%	19.6%	20.0%	17.9%	17.0%	17.3%	15.1%
Non-Hub Primary									
Total revenue (nominal $M)	1,632	1,729	1,795	1,669	1,526	1,700	1,798	1,718	1,806
Aeronautical operating revenue	16.7%	19.5%	19.6%	21.4%	23.7%	22.0%	21.3%	23.4%	22.8%
Non-aeronautical operating revenue	19.8%	20.2%	20.9%	25.8%	26.5%	24.6%	24.3%	25.9%	25.0%
Non-operating revenue	12.7%	10.5%	10.7%	9.0%	10.4%	13.0%	11.3%	13.5%	11.3%
PFC	4.2%	4.5%	4.6%	5.1%	5.8%	5.2%	6.0%	4.9%	4.8%
AIP and other grants	46.6%	45.4%	44.3%	38.7%	33.6%	35.3%	37.1%	32.3%	36.0%
Nonprimary									
Total revenue (nominal $M)	458	337	368	505	478	473	462	370	459
Aeronautical operating revenue	25.9%	30.9%	34.3%	26.6%	28.8%	31.7%	31.0%	39.3%	32.8%
Non-aeronautical operating revenue	8.3%	8.4%	9.6%	7.4%	7.5%	8.7%	8.0%	10.0%	8.2%
Non-operating revenue	23.4%	-0.4%	11.6%	10.9%	13.5%	19.1%	9.4%	12.0%	10.5%
PFC	0.9%	1.0%	1.0%	0.7%	0.9%	0.6%	0.5%	0.5%	0.4%
AIP and other grants	41.4%	60.2%	43.5%	54.4%	49.4%	39.9%	51.1%	38.1%	48.0%

Table I.2. Proportion of Expense Sources from 2009 to 2017, by Airport Size

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total									
Total expense (nominal $M)	24,462	24,547	23,508	23,407	24,087	24,750	26,115	27,055	30,097
Operating expense	42.5%	43.0%	46.7%	48.1%	48.6%	49.8%	49.1%	49.4%	46.2%
Non-operating expense	12.3%	12.6%	14.3%	14.2%	14.5%	14.4%	13.5%	12.7%	11.4%
Capital expenditure	45.2%	44.4%	39.1%	37.8%	36.9%	35.8%	37.4%	37.9%	42.4%
Large-Hub Primary									
Total expense (nominal $M)	15,503	15,729	15,201	15,570	16,023	16,662	17,761	18,636	20,851
Operating expense	44.1%	44.2%	47.5%	47.8%	48.2%	49.1%	48.6%	48.4%	45.0%
Non-operating expense	14.7%	14.9%	16.8%	16.1%	16.7%	16.5%	15.5%	14.5%	13.1%
Capital expenditure	41.1%	40.9%	35.7%	36.1%	35.1%	34.3%	35.9%	37.0%	42.0%
Medium-Hub Primary									
Total expense (nominal $M)	4,034	3,965	3,763	3,314	3,332	3,377	3,453	3,792	4,310
Operating expense	42.4%	42.7%	46.1%	53.1%	54.7%	55.8%	55.2%	53.1%	49.2%
Non-operating expense	11.7%	11.6%	13.4%	15.8%	16.7%	15.4%	14.7%	12.9%	10.8%
Capital expenditure	45.8%	45.7%	40.5%	31.1%	28.6%	28.8%	30.1%	34.0%	40.0%
Small-Hub Primary									
Total expense (nominal $M)	2,770	2,584	2,360	2,470	2,504	2,477	2,517	2,423	2,582
Operating expense	38.1%	42.2%	47.9%	45.9%	47.4%	49.5%	50.1%	52.8%	53.1%
Non-operating expense	8.1%	8.7%	8.7%	8.4%	7.7%	8.0%	7.4%	7.5%	6.7%
Capital expenditure	53.8%	49.1%	43.4%	45.7%	44.9%	42.5%	42.5%	39.8%	40.3%

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017
Non-Hub Primary									
Total expense (nominal $M)	1,704	1,900	1,851	1,639	1,666	1,778	1,874	1,850	1,880
Operating expense	37.5%	36.7%	39.7%	45.6%	45.9%	45.9%	43.0%	44.8%	44.7%
Non-operating expense	1.5%	2.8%	3.0%	3.3%	2.8%	3.1%	2.6%	2.5%	2.4%
Capital expenditure	61.0%	60.5%	57.3%	51.1%	51.3%	51.0%	54.4%	52.7%	52.9%
Nonprimary									
Total expense (nominal $M)	451	369	333	414	561	456	510	353	474
Operating expense	30.9%	33.9%	45.1%	41.9%	39.6%	47.3%	44.5%	57.5%	42.4%
Non-operating expense	-0.2%	6.9%	10.0%	6.1%	4.3%	5.0%	3.9%	5.7%	5.4%
Capital expenditure	69.2%	59.2%	44.9%	52.1%	56.1%	47.6%	51.6%	36.8%	52.2%

Appendix J. Allowable Uses of Funding Sources

The following notes are associated with Table 3.7 in the main report.

Aeronautical Funds

- All: Airlines, the typical source of aeronautical funds, can restrict the use of aeronautical funds toward non-aeronautical (landside) expenditures through use-and-lease agreements.
- Roadways, rail, and transit: The project must be on airport property (FAA Order 5190.6B, 2009, p. 15-6).

Non-Aeronautical Funds

- Airfield: Tenants and concessionaires, both sources of non-aeronautical funds, can use aeronautical funds toward aeronautical (airside) expenditures through use-and-lease agreements.
- Roadways, rail, and transit: The project must be on airport property (FAA Order 5190.6B, 2009, p. 15-6).

Non-Operating Funds

- Roadways, rail, and transit: The project must be on airport property (FAA Order 5190.6B, 2009, p. 15-6).

Airport Improvement Program

- Noise: To be eligible for AIP funding, a noise compatibility project must be included in an FAA-approved 14 CFR Part 150 program, used primarily for medical or educational purposes, in a land use compatibility plan, or in a record of decision (FAA, 2014a, p. R-1).
- Emissions: Must go through the Voluntary Airport Low Emissions Program or Airport Zero Emissions Vehicle and Infrastructure Pilot Program (FAA, 2014a, pp. 6-26 to 6-29).
- Parking: AIP funds cannot be used to construct parking lots, except for nonrevenue-producing parking facilities associated with a commercial service or general aviation terminal buildings at non-hub primary airports, nonprimary commercial service airports, and reliever airports (FAA, 2014a, pp. 4-16, 4-19).
- Roadways, rail, and transit: AIP funds are restricted to roadway, rail, and transit projects on airport property. AIP funds cannot be used to construct roads connecting parking lots and access roads but can be used to connect parking lots to terminals. Rail and people mover construction costs cannot be used to construct access to commercial areas, maintenance areas, employee parking lots, or ticketing or fare collection areas (FAA, 2014a, pp. P-2 to P-7).

- Terminal nonrevenue-producing areas: Terminal projects in nonrevenue-producing areas must be for public use and for the movement of passengers or baggage (FAA, 2014a, p. N-1).
- Terminal revenue-producing areas: AIP funds cannot be used for projects in revenue-producing areas at large-, medium-, and small-hub airports. At other commercial service airports, the project must be public use per 49 U.S.C. § 47119(a)(1). The project cannot defer any needed project affecting safety, security, or capacity (FAA, 2014a, p. N-2).

PFC

PFC projects must meet one or more of the objectives of 14 CFR §158.15(a). Specifically, PFC projects must (1) preserve or enhance safety, security, or capacity of the national air transportation system; (2) reduce noise or mitigate noise impacts resulting from an airport; or (3) furnish opportunities for enhanced competition between or among air carriers (FAA Order 5500.1, 2001, p. 55).

- Noise: All AIP-eligible projects plus "noise projects eligible under 49 U.S.C. §47504, even if a Part 150 program for those projects has not been approved" (FAA Order 5500.1, 2001, p. 12).
- Emissions: AIP eligibility applies (FAA Order 5500.1, 2001, p. 12).
- Parking: AIP eligibility applies (FAA Order 5500.1, 2001, pp. 12, 50).
- Roadways, rail, and transit: AIP eligibility applies (FAA, 2016).
- Terminal revenue-producing areas: Nonconcession areas related to the movement of passengers and baggage, including ticket counters, bag facilities, and baggage carousels are eligible. Projects in concession facilities, such as public seating in a food court, are not eligible (FAA Order 5500.1, 2001, pp. 12, 52). Gate projects include "air carrier or airport operations space, concession space, and aircraft fueling facilities directly under or adjacent to a gate and its associated hold room or ticket counter" (FAA Order 5500.1, 2001, pp. 12, 52–53). Public seating for a food court is not eligible because the food court seating is a concession facility. For non-hub and nonprimary airports, AIP eligibility applies (FAA Order 5500.1, 2001, pp. 12, 53).

Bonds

- Planning and project administration: Bond proceeds are unlikely to be used for planning purposes.
- Debt service: Bonds are unlikely to be used for debt service.

Appendix K. Approach to Understanding the Role of PFCs in Fostering Competition

In this appendix, we describe the details of the statistical analyses, the results of which are presented in Chapter Six.

The Probability of Using PFCs for Competition Enhancement

In Table K.1, we provide statistical support for the assertion that, for medium- and non-hub airports, airports that are more competitive are statistically more likely to pursue competition-enhancing PFC projects than less competitive airports, as measured by the Herfindahl-Hirschman Index (HHI). More- and less-competitive airports at large- and small-hub airports are relatively similar in their likelihoods for pursuing these projects. To provide support for this assertion, we calculate an odds ratio for each hub size designation, as defined by passenger counts in 2018. For each year, we calculate the average HHI by hub size and determine, for each airport, whether its HHI is above or below the mean. We then calculate the number of competition-enhancing PFC projects and the number of PFC projects across all objectives (i.e., noise, security, safety, competition, and capacity) for airports above and below the mean value of the HHI by year. To calculate the odds ratio, we use the following formula:

$$OR_H = \frac{\left({}^{\#comp_{above}} / {}_{\#comp_{below}} \right)}{\left({}^{(\#All - \#comp)_{above}} \Big/ {}_{(\#All - \#comp)_{below}} \right)},$$

where OR_H is the odds ratio for hub size, $H \in \{\text{Large, Medium, Small, Nonhub}\}$; $\#comp_i$ is the number of competition-enhancing PFC projects for airports either above or below (denoted by i) the mean HHI for that year-quarter; and $(\#All - \#comp)_i$ is the number of PFC projects, not including competition-enhancing projects, by airports above or below the mean HHI for that year-quarter.

A value of 1 for OR_H implies that airports above and below the mean HHI for that hub size pursue competition-enhancing projects at similar ratios. A number greater than 1 implies that airports above the mean HHI (i.e., that are less competitive) are more likely to pursue competition-enhancing projects, while a value less than 1 implies that airports below the mean HHI (i.e., that are more competitive) are more likely. As Table K.1 shows, the odds ratios for medium- and non-hub airports are statistically different from 1, and therefore provide support for the claim that more competitive airports (i.e., airports with below-average HHI) are more likely to pursue competition-enhancing PFC projects in these hub classifications. Large- and small-hub airports have an odds ratio that is not statistically different from 1, implying that airports above and below the mean pursue competition-enhancing PFC projects at similar odds.

Table K.1. Odds Ratio Calculations

Hub Size	Airport HHI Relative to Quarterly Mean HHI	Total Number of PFC Projects (Noise + Safety + Security + Competition + Capacity)	Total Number of Competition-Enhancing PFC Projects (Competition + Enhancing Capacity)	Odds Ratio	*P*-Value
Large Hub	Above mean	1047	209	1.019	87.34%
	Below mean	763	150		
Medium Hub	Above mean	549	79	0.743	4.92%
	Below mean	835	154		
Non-hub	Above mean	2967	499	0.809	0.06%
	Below mean	4607	921		
Small Hub	Above mean	737	178	1.137	21.85%
	Below mean	1682	368		

Methodology

In this section, we provide a more thorough treatment of our statistical analysis presented in Chapter Six of the main text. In general, we adopt a basic linear regression framework to estimate the impact of competition-enhancing PFC projects on competition (as measured by the HHI) and average ticket fares. In an ideal analytical setting, we would compare markets that completed competition-enhancing projects with otherwise similar markets that did not complete competition-enhancing projects. However, 93.3 percent (28 out of 30) of large hubs, 96.8 percent (30 out of 31) of medium hubs, and 97.2 percent (70 out of 72) of small hubs (as defined by their hub status in 2018) have completed at least one competition-enhancing project since 1991, so we cannot easily identify a set of markets to act as the reference group that have never completed a competition-enhancing project.

We can, however, take advantage of the time-series component of our data set to construct a reference group. For every point in time, we identify airports for which no competition-enhancing PFC projects were completed within +/− 16 quarters. We compare these "control group" markets with airports that have completed a single competition-enhancing project within a window of +/− 16 quarters.[6] We compare only with those observations in which a single competition-enhancing project has been completed within a window of +/− 16 quarters because this avoids complexities caused by airports that completed multiple projects in rapid succession.

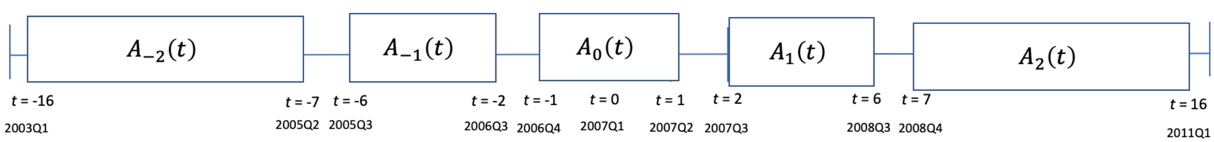
[6] Conversations with stakeholders suggested that +/− 16 quarters (+/− 4 years) is sufficient time for the impact of PFC projects to be realized.

We segment these rolling windows to investigate the impacts of competition-enhancing projects over time. We define $A_j(t)$, where *t* is the current quarter (for example, 2007Q1), as follows:

- $A_0(t)$: $k \in [t-1, t, t+1]$ denotes the transition period around quarter *t*
- $A_{-1}(t)$: $k \in [t-6, t-5, t-4, t-3, t-2]$ denotes 2 to 6 quarters before quarter *t*
- $A_{-2}(t)$: $k \in [t-16, t-15, t-14, t-13, t-12, t-11, t-10, t-9, t-8, t-7]$ denotes 7 to 16 quarters before quarter *t*
- $A_1(t)$: $k \in [t+2, t+3, t+4, t+5, t+6]$ denotes 2 to 6 quarters after quarter *t*
- $A_2(t)$: $k \in [t+7, t+8, t+9, t+10, t+11, t+12, t+13, t+14, t+15, t+16]$ denotes 7 to 16 quarters after quarter *t*.

Figure K.1 presents an illustration of the segmented rolling window, with *t* = 0 = 2007Q1 as an example.

Figure K.1. Example Segmented Rolling Window



Our linear regression equation is as follows:

$$Y_{i,t} = \sum_{k=-2}^{2} \left(\beta_{1,k} IQR_{i,A_j(t)} + \beta_{2,k} Big_{i,A_j(t)} \right) + \delta_y + \delta_q + \delta_i + \varepsilon_{i,t},$$

where *i* is a distinct city-market, *y* is a year, and *q* is the quarter of the year (*t* is a year-quarter, e.g., 2007Q1). The dependent variable, $Y_{i,t}$, is either the HHI (when analyzing competition) or the average ticket fare for market *i* in quarter *t*.[7] $IQR_{i,A_j(t)}$ is an indicator variable that takes a value of 1 if market *i* falls within the interquartile range (IQR) of total spending on projects (i.e., the 25th to the 75th percentile) in window $A_j(t)$ across all markets (referred to as *medium-sized projects* in the main text). $Big_{i,A_j(t)}$ is an indicator variable that takes the value of 1 if market *i* has total spending on projects in window $A_j(t)$ that is greater than the 75th percentile of total spending on projects across all markets in $A_j(t)$.[8] δ_y is fixed-effects for year to control for

[7] The HHI is calculated as enplanements for every flight segment in each ticket from the DB1B Market database (see Appendix B for a description of the data source). Average ticket fare is the inflation-adjusted, passenger-weighted average ticket price as published by the BTS in its Average Domestic Airline Itinerary Fares database, which uses data from the DB1B Ticket database.

[8] $IQR_{i,A_j(t)}$ and $Big_{i,A_j(t)}$ are calculated based on total spending at a project end date from the PFC database provided by the Federal Aviation Administration.

changes over time, δ_q is fixed-effects for quarter-of-the-year to control for seasonality, and δ_i is fixed-effects for distinct city-markets to control for unobservable, time-invariant, market-specific characteristics. Finally, $\varepsilon_{i,t}$ is the error term.

We include observations for which $\sum_{k=-2}^{2}\left(IQR_{i,A_j(t)} + Big_{i,A_j(t)}\right) \leq 1$, which is the condition that only one window segment is nonzero, as mentioned earlier in this section. Running the regression on this subsample excludes markets that are completing competition-enhancing PFC projects in rapid succession. Including these observations would obscure the true impact of PFC projects because multiple projects could be jointly affecting competition in a particular market. By excluding these observations, we can ensure that we attribute any change in competition to one segment of projects.

The results from the regressions are listed in Tables K.2 and K.3 and are shown in Figure K.2. The interpretation is as follows: Compared with the reference group (i.e., markets that completed no competition-enhancing PFC projects around quarter *t*), markets that completed projects in the IQR of total project spending and markets that completed projects in the "big" range (i.e., greater than the 75th percentile) had a lower HHI, on average, by between 80 and 162 points two to six quarters after completing a project, controlling for changing economic conditions over time at the individual market level and for seasonality in the airline industry. The average difference becomes smaller (ranging from 42 to 67 points) over time, indicating that any impact on competition dissipates over time. Regarding fares, markets that completed competition-enhancing PFC projects in the IQR of total project spending had a high price, on average, ranging from \$9 to \$17 more per ticket. Markets that completed big projects only had higher prices in the transition period and immediately after projects were completed ($A_0[t]$ and $A_{-1}[t]$, respectively). However, none of the estimates are statistically significant, and we therefore cannot say with any certainty that markets that complete projects are fundamentally different from those that do not in terms of competition or average ticket prices.

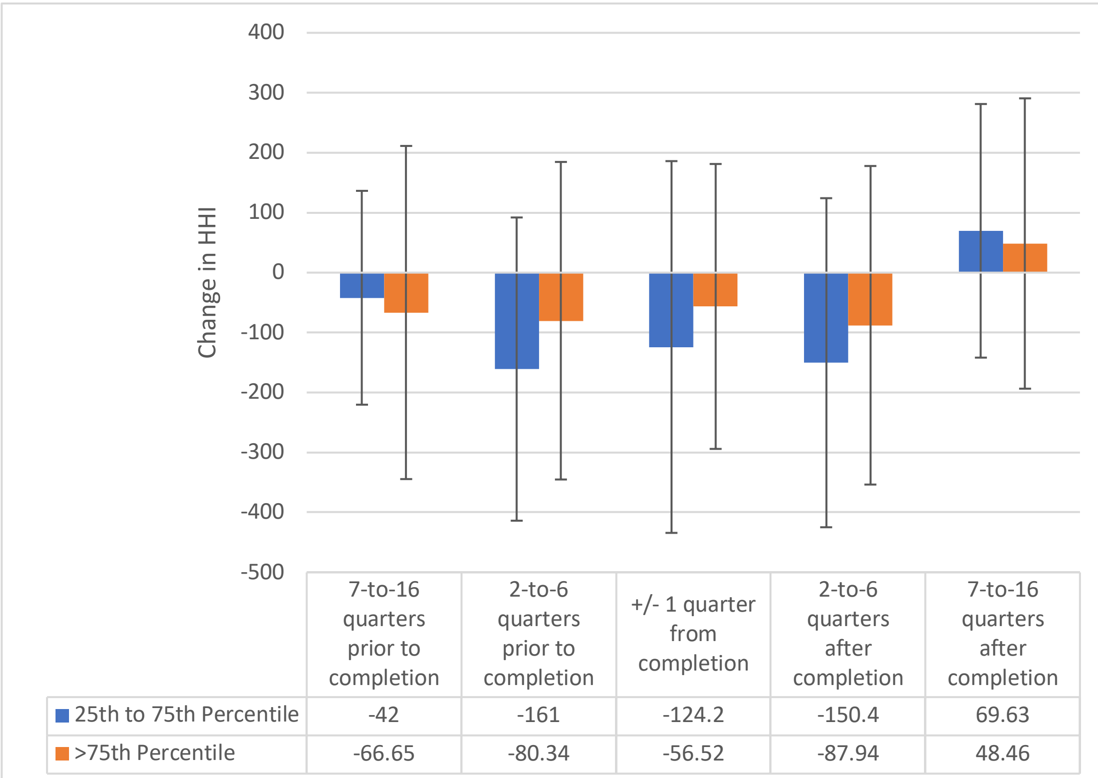
Interestingly, there is a difference in competition prior to projects being completed (see the results for "Coming up [2 quarters, 6 quarters]" for both IQR and big projects when analyzing competition, and IQR when analyzing average ticket fares). Our data on PFCs only contain information on total project spending and the date the project was started and completed. Because we do not have any information on spending per project over time, we aggregate total spending according to each project's completion date. Therefore, airlines in specific markets might be able to infer when projects will be completed, which could cause conditions to change prior to a project actually being completed. This possibility provides further justification for the identification strategy in our linear regression and for looking at the window of time prior to projects being completed.

Table K.2. Regression Results for Competition

Period	IQR	Big
$A_{-2}(t)$: Completed in the past [−16 quarters, −7 quarters] before t	−42.00	−66.65
	91.03	*141.82*
$A_{-1}(t)$: Completed recently [−6 quarters, −2 quarters] before t	−161.00	−80.34
	129.08	*135.18*
$A_0(t)$: Transition period [−1 quarter, 1 quarter]	−124.20	−56.52
	158.26	*121.29*
$A_1(t)$: Coming up [2 quarters, 6 quarters] after t	−150.40	−87.94
	140.09	*135.61*
$A_2(t)$: Future completion planned [7 quarters, 16 quarters] after t	69.63	48.46
	107.96	*123.59*
Observations	16,791	
Markets	398	
R-squared	0.847	
City-market fixed effects	Yes	
Year fixed effects	Yes	
Quarter fixed effects	Yes	

NOTE: Clustered standard errors at the market level are in italics. No coefficients are statistically significant.

Figure K.2. Estimated Impact of PFC Projects on Market Herfindahl-Hirschman Index



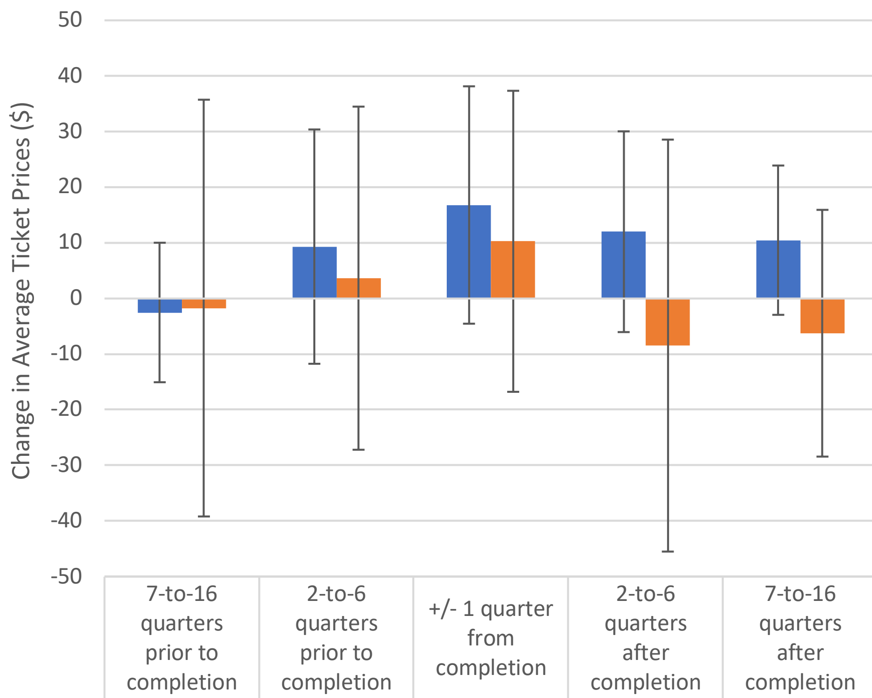
SOURCE: RAND analysis of FAA, 2019e, and DB1B data (BTS, 2019c).
NOTE: Brackets represent 95 percent confidence intervals according to standard errors clustered at the market level. "25th to 75th Percentile" and ">75th Percentile" refer to the distribution of project costs for the 3,156 PFC projects that we identified as potentially enhancing competition.

Table K.3. Regression Results for Average Fares

Period	IQR	Big
Completed in the past [−16 quarters, −7 quarters] before *t*	−2.516	−1.74
	6.40	*19.12*
Completed recently [−6 quarters, −2 quarters] before *t*	9.32	3.64
	10.75	*15.74*
Transition period [−1 quarter, 1 quarter]	16.80	10.27
	10.89	*13.81*
Coming up [2 quarters, 6 quarters] after *t*	12.00	−8.48
	9.21	*18.90*
Future completion planned [7 quarters, 16 quarters] after *t*	10.48	−6.25
	6.85	*11.32*
Observations	17,195	
Markets	398	
R-squared	0.618	
City-market fixed effects	Yes	
Year fixed effects	Yes	
Quarter fixed effects	Yes	

NOTE: Clustered standard errors in italics. No coefficients are statistically significant.

Figure K.3. Estimated Impact of PFC Projects on Average Prices



	7-to-16 quarters prior to completion	2-to-6 quarters prior to completion	+/- 1 quarter from completion	2-to-6 quarters after completion	7-to-16 quarters after completion
25th to 75th Percentile	-2.516	9.32	16.8	12	10.48
>75th Percentile	-1.74	3.64	10.27	-8.48	-6.25

SOURCE: RAND analysis of FAA, 2019e, and DB1B data (BTS, 2019c).
NOTE: Brackets represent 95 percent confidence intervals according to standard errors clustered at the market level. “25th to 75th Percentile” and “>75th Percentile” refer to the distribution of project costs for the 3,156 PFC projects that we identified as potentially enhancing competition.

Appendix L. Approaches to Measuring Capacity Constraints

As a supplement to the information presented in Chapter Eight on capacity constraints, this appendix provides further detail on approaches to measuring airside and landside capacity constraints. A comprehensive, objective assessment of whether airports are currently at capacity or will become capacity constrained in the future requires a clear definition of capacity and measuring where capacity at U.S. airports currently stands. ICAO, 2004, p. 5.4-1, defines airport capacity as "the number of passengers and amount of cargo which an airport can accommodate in a given period of time" and "a combination of runway capacity and terminal capacity."[9]

Operationalizing these conceptual definitions, however, is challenging, in particular for terminal and other landside infrastructure, such as the amount of space in terminal areas, baggage handling processes, and ground access. As Transport Canada put it when developing its airport terminal design standards, "Since an airport is capable of operating at varying degrees of congestion and delay, the capacity figure must always be related to the [level of service (LOS)] being provided" (Landrum & Brown et al., 2010, p. 147). The Transportation Research Board (TRB) also has noted that "estimates of passenger capacity are meaningful only when they are referenced to the service level provided to passengers," adding that this "[makes] the measurement of capacity an iterative process" (TRB, 1987, p. 2).

Although there are some official assessments of airside capacity (described in the following section) and other proxies for airside capacity constraints that can be constructed from available data, there is no comprehensive, objective metric or set of metrics that encompasses the totality of ways in which both airside and landside infrastructure can be capacity constrained. Rather, measures of airport capacity and an airport's ability to meet current and anticipated enplanements and operations at an acceptable LOS are often developed at an individual airport or regional planning level. These measures draw on analyses by airport consultants who use a variety of methods, including observational study, passenger surveys, demand forecasts, capacity equations, and simulation modeling.[10]

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[9] *Runway capacity* is the number of aircraft movements that aeronautical authorities determine can safely be operated (usually stated as the total number of landings and take-offs per hour), taking into account such factors as the physical characteristics of the runways and the surrounding area, altitude, the types of aircraft involved (larger aircraft might mandate greater separation) and air traffic control (approach and aerodrome control) capabilities.

Terminal capacity is the number of passengers and tonnes of cargo per hour that can be processed in a terminal building (sometimes referred to as *passenger throughput* or *cargo throughput*). The type of passenger or passenger mix can influence the rate of passenger throughput (ICAO, 2004, p. 5.4-1).

[10] See, for example, the discussion in IATA, 2014, pp. 183–188.

Measuring Airside Capacity

The most well-developed measures of airport capacity relate to airfield capacity and the number of aircraft operations that can occur in a specified period, typically an hour or a year.[11] Airfield infrastructure, and in particular runway capacity, is the focus of the FAA's Future Airport Capacity Task (FACT) reports (FAA, 2015) and the airport capacity profiles (FAA, 2014b) that feed into those reports. The FAA's Advisory Circular on airport capacity and delay, which dates to 1983, also describes airport capacity in the context of airside operations (FAA Advisory Circular 150/5060-5, 1983).

Numerous factors influence the number of take-offs and landings that can occur per hour or per year, including the number of runways, runway configuration, aircraft fleet mix, weather conditions, air traffic control technology, and noise and environmental restrictions (Gillen, Jacquillat, and Odoni, 2016; LeighFisher et al., 2012). The aircraft capacity profiles construct estimates of per-hour arrivals and departures under three types of weather conditions that require different aircraft approaches and spacing between operations for 30 "core" airports (FAA, 2014b, Table 1).[12] The FACT reports (the most recent being FACT3, published in 2015) extend these estimates by incorporating basic measures of taxiway and gate capacity, moving from an hourly capacity to an annual service volume metric. FACT reports then compare capacity estimates against projected enplanements and operations (as indicated by the TAF) to estimate average delays and the share of "congested hours" per airport (FAA, 2015, p. B-6).[13]

Two reports published by the TRB's Airport Cooperative Research Program explore methods to define and measure airfield capacity using available data and modeling capabilities (LeighFisher et al., 2012; TransSolutions et. al., 2014). One publicly available data source for characterizing the degree of congestion at airports is BTS data on airtime on-time performance and the causes of flight delays. Some researchers have used the share of delays at an airport that are not weather related to control for airport congestion when assessing airport efficiency (Lin, Choo, and Oum, 2013).[14] Our analysis in Chapter Eight of the main report draws on this BTS data set to characterize capacity-constrained airports.

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[11] Young and Wells, 2011, p. 429, refers to "aircraft operating capacity" as the "traditional definition" of airport capacity. A 2014 TRB report also focuses on the airside (see TransSolutions et al., 2014).

[12] The definition of a core airport is identical to the definition of a large-hub airport, with the exception that it adds another condition to qualify: being responsible for 0.75 percent or more of total nonmilitary itinerant operations. However, no airport that meets this additional condition can also meet the condition of being responsible for 1 percent of total enplanements that is required to be a large hub. Three other airports, identified in the FACT2 report as likely to become capacity constrained, were included in addition to the 30 core airports in the 2014 airport capacity profiles: Long Beach, Oakland, and Orange County.

[13] The FACT3 report defines a congested hour as "an average arrival delay of 6.22 minutes per flight or an average departure delay of 6.65 minutes per flight" (FAA, 2015, p. B-6).

[14] A body of literature that attempts to measure airport efficiency—the ratio of outputs to inputs—also can shed light on the types of airport infrastructure inputs (on both the airside and landside) that could be subject to capacity constraints. See, for example, Gutiérrez and Lozano, 2016, p. 3.

Measuring Landside Capacity

Although it is recognized that there must be balance between airside and landside infrastructure (Landrum & Brown et al., 2010, p. 145; LeighFisher et al., 2012, p. 145), defining and measuring capacity away from the runway is complicated by questions about what levels of density and congestion are acceptable. Airport planning documents released by the FAA (FAA Advisory Circular 150/5360-13A, 2018) and outside organizations, such as IATA (IATA, 2014) and Airports Council International (ACI), are instructive in identifying standards for LOS for landside infrastructure (e.g., square footage per passenger). The TRB has also released reports describing how to design landside infrastructure to avoid overcrowding and poor LOS (TRB, 1987; Landrum & Brown et al., 2010; TransSolutions et al., 2011). Among numerous possible categories of landside infrastructure, the TRB has described the following as "critical": aircraft parking position and gate, passenger waiting area, passenger security screening, terminal circulation (corridors, stairs, etc.), ticket counter and baggage check, terminal curb, parking area, ground access, baggage claim, customs and immigration, and connecting passenger transfer.

The FAA's Advisory Circular on airport terminal planning states that "[a]irport owners/operators are encouraged to design terminal projects to maintain a balanced LOS that results in an optimal (neither overbuilt nor underbuilt) and practical facility for the existing and planned activity levels" (FAA Advisory Circular 150/5360-13A, 2018, p. 5-1). The FAA Advisory Circular points to three sources for guidance on LOS: two Airport Cooperative Research Program reports (Landrum & Brown et al., 2010; TransSolutions et al., 2011) and the *Airport Development Reference Manual*, a collaboration between IATA and ACI (IATA, 2014). Exhibit 3.4.5.2 from the *Airport Development Reference Manual* displays two possible avenues for landside constraints: processing times (i.e., the number of passengers that the infrastructure can handle in a given amount of time) and space (i.e., the amount of space per passenger for a particular piece of infrastructure) (IATA, 2014, p. 200).

Exhibit 3.4.5.3 from the *Airport Development Reference Manual* maps space per passenger and queuing time to standards for various types of landside infrastructure (IATA, 2014, p. 202).[15] For example, 1.5–1.7 square meters per seated passenger in a boarding gate lounge is considered "optimum," as is a security checkpoint time of between five and ten minutes. As IATA, undated, describes, it is expected that "during peak traffic periods the optimum LOS may not be achieved;" rather, the goal should be to plan for a "typical busy period," such as the "second busiest day in an average week during the peak month," which it calls the "design day."

The IATA manual includes capacity equations for these landside infrastructure components "to determine the theoretical capacity and LOS given the traffic volume and areas available" (IATA, 2014, p. 188). IATA, 2014, p. 190, notes that "[o]nsite surveys are recommended whenever possible to gather data for input in the capacity equations," and adds that "[d]etailed

[15] Note that standards vary by class of passengers, with higher expectations for business and first class.

design should make use of simulation modeling techniques to refine the space requirements and to assist with detailed LOS."

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